Universität Bielefeld
Interdiziplinäres Zentrum für Frauen- und Geschlechterforschung

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DOING GENDER IN MATHEMATICS. INDICATIONS FOR MORE GENDER EQUALITY IN GERMAN UNIVERSITIES?

IFF-Forschungsreihe
Band 16

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Bibliografische Information Der Deutschen Bibliothek

Anina Mischau, Birgit Blättel-Mink, Judith Daniels and Jasmin Lehmann:
Doing gender in mathematics. Indications For more gender equality in German Universities?

Translation by Angela Rast-Margerison and Darrell Arnold

(IFF-Forschungsreihe Band 16)
ISBN 3-932869-16-8

2004, Interdisziplinäres Frauenforschungs-Zentrum (IFF)
Universität Bielefeld
Postfach 10 01 31
33501 Bielefeld
Telefon 0521/106-4574
Druck: Zentrale Vervielfältigung, Universität Bielefeld

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Introduction

On exploring the gender imbalances in german higher education, two paths can be deduced from the empirical data. The higher the status, the lower the female participation ratio ("vertical gender inequality"); and there is "horizontal gender inequality", i.e. with the exception of medicine and economics, women and men choose different subjects. When it comes to deciding on courses of study, men prefer science and engineering, and women prefer the humanities and social sciences, i.e. men prefer to take courses leading to graduation in the german system with a "diploma", i.e. courses in theoretical mathematics, while women prefer courses leading to the "state examination" and a teaching certificate, i.e. mathematics education. The ratio of women students of mathematics – a former men's domain – has more or less continuously increased over the past 25 years, without being followed by higher numbers of women in the higher status positions of the academia. With a survey (standardized questionnaire) issued at three german universities, the situation and perspectives of students of mathematics has been explored. A follow-up in-depth survey gave insight into the individuals' experiences during their studies of mathematics. The goal of these surveys was to ascertain whether the increase in female participation in mathematics has led to changes in the issues surrounding gender imbalance. We take an organizational theory approach, arguing with Joan Acker (1992) that universities are gendered organizations where gender imbalances exist and are reproduced on the structural level, on the symbolic level, on the level of interactions and, finally, on the mental level. Our assumption is that gendering also occurs within scientific disciplines. The question that we try to answer runs as follows: once structural processes of gendering begin to diminish – as is the case with mathematics – can we observe processes of de-gendering on the other three levels as well? The paper starts with a short overview on gender relations in german academia, with the main emphasis on mathematics and science & technology. In the second part of the paper, we explain the theoretical framework of the project as well as the methods applied. We then present the main results of our study and finally discuss whether our assumption proves to be right or has to be modified.

1. Empirical data on women in mathematics in Germany

What is the current situation regarding the gender imbalance in mathematics? Within the last twenty years the imbalance has fallen at german universities. The ratio of female beginners in the winter term 2001/02 was 44%, compared to 37% in 1987 and 20% in 1950, respectively. By contrast, there has seemingly been no change in the ratio of females in theoretical mathematics (“Diploma”): In 2001 the female ratio was 24%, as in 1987. If we look at the curve somewhat closer, we see that the ratio was higher between 1990 and 1998 (up to 30%). Between 1987 and 2001 the ratio of female PhDs in mathematics doubled and reached 22%. The ratio of female postdoctoral works (the german “Habilitationen”) is about 13%. The percentage of women professors in mathematics, however, is still under 5%; even fewer women hold top positions in mathematics outside of the Academia (see BLK 2002).

Chart 1 Female first-year students at german universities
(Winter term; in %)*

	All students	Science and Technology	Mathematics
1975/76	33.7	32.9	35.6
1980/81	36.7	33.5	35.2
1985/86	37.8	31.8	33.6
1990/91	38.3	31.8	36.6
1995/96	41.7	33.0	38.3
2000/01	46.1	34.8	43.7

* until 1990 data for Western Germany only
Source: BLK 2002; Statistisches Bundesamt

This means that the increase in the ratio of female students in mathematics has not led to any real progress as far as higher positions at universities are concerned. Women tend far more than men to choose a path leading to the teaching profession; men more often take courses leading to the german "diploma" title, which include scientific aspects of mathematics and which lead to career opportunities in higher education, but also in other fields.

Regarding the situation of women's careers in science and technology in Europe, the authors of the "European Report on Science and Technology Indicators" (2003) argue that gender discrimination against women still exists on structural and cultural levels. "In conclusion, the results showed that factors such as age at promotion, field of science and number of publications only par-

tially explain the gender differences in the science hierarchy. The main explanatory factor is, and remains, gender. Accordingly, it can be stated with some confidence that gender discrimination against women still exists." (European Report on Science and Technology Indicators 2003: 266). A further hindrance factor to female careers in this field is that women are much more involved in family affairs than men are. The same report formulates three hypotheses concerning this issue. Women scientists are less likely to have a family than men; women still have to choose between children and a career; and for male scientists, having a family and children seems to have a positive impact on their career opportunities (see ibid.: 267). Finally, the authors address the claim that women are less productive than men and conclude: "[T]here does not seem to be any proof that women are a priori less productive. Lower productivity of women is mainly due to structural circumstances, such as their under-representation in science, but it is also due to the inequalities in career opportunities." (ibid.: 268).

It will now be interesting to explore whether young men and women, who obviously grew up with less discriminating experiences against women than previous generations, show more similarities in their reasons for studying mathematics, their attitudes towards mathematics, the experiences during their studies and their self-perceptions. Before this question is empirically investigated, a short overview of the status quo of german women and gender studies about the problematic ”gender relationships in mathematics” is offered, and the study is theoretically positioned.

2. Gender relationships in mathematics as an issue of women and gender studies

The research and studies about the complex of problems surrounding “gender relationships in mathematics“ can be combined into four thematic focal points, that in research practice are often combined with each other in one way or another.

2.1 The view from the history of science: women in mathematics

In 1974 the book, *Women in Mathematics,* was published by Lynn M. Osen. Since its publication, this book has given impetus to numerous biographical works about “women pioneers” in mathematics (cf. Teller 1984, Tuschmann/Hawig 1993, Tollmien 1997, Strohmeier 1998, Bölling 2000, Koreuber/Tobies 2002). The focus of all of these works is on drawing attention to women in mathematics and demonstrating their role in the development of the discipline. As important as the historical study of the lives and the work of women in mathematics is, one, however, still needs to critically note that many of these works describe successful women mathematicians as anomalies, and thus take their “exotic status” to be a fixed constant. In this strand of research there are, however, works in which the presentation of a biography of one of the more “exceptional women” is embedded in a general assessment of the marginalization of women in mathematics, the historical development of the academic education of women or in the study of the “closing” mechanisms specific to this discipline (segmentation and segregation), and cultural marginalization processes that exclude women from academic careers in mathematics (cf. Klens 1994, Tobies 1997a,b).

2.2 The epistemological perspective: feminist critique of mathematics

In 2001 the mathematician, Mechthild Koreuber, stated: “The relationship between gender studies and mathematics entails a mixture of successful historical women’s studies, if concerned with the isolated individuals who worked in this discipline, and a group of positions ranging from silence within the feminist theory debate to clear distancing” (Koreuber 2001, transl.). In fact it must be maintained: While women and gender studies have brought about a broad feminist debate on technology over the past 20 years and numerous articles offering a feminist critique of the natural sciences, mathematics, as a science discipline, has largely been ignored by the feminist critique of science. One searches in vain for works that question the male-dominated foundation of mathematics, let alone thematize the transformation of it, or that reformulate the scientific con-

texts of argumentation and discovery within this discipline, or question and reformulate its scientific methods. At most, mathematics is brought into the purview of a feminist critique of the natural sciences if its role or function – for example, in the development of the experimental basis of the exact natural sciences or in reference to the mathematical forms of knowledge in the development of scientific theories (as the division between nature/woman, on the one hand, and culture/man, on the other) - is reflected upon (e.g. Woesler 1978, Scheich 1993). The feminist view of the "core of mathematics", however, has thus far largely remained an unexplored area of research. The starting points are offered in the work of Trettin (1991), Frougny/Pfeiffer (1985), Schellhowe/Erb (1994) and Ortlieb (1998).

2.3 The perspective of social psychology and of educational theory: women and/or girls in mathematics classes

The research field "girls and mathematics classes" has certainly experienced a unique "boom" in the past 30 years, even in german women and gender studies. In a series of empirical studies, questions are examined such as the extent to which gender-specific differences regarding the interest in mathematics, the views towards mathematics and the performance in mathematics are manifest, and the explanations for this (cf. Hanna 2000, Kaiser/Steisel 2000, Kaiser et al. 2001, Kaiser et al. 2003). The search for the causes of gender-specific differences has essentially led to three explanatory approaches: 1. Approaches that attempt to explain these differences in reference to gender role stereotypes and the corresponding different self-concepts of boys and girls; 2. Approaches that set out to explain, above all, differences in the performance in reference to differences in cognitive abilities; 3. Approaches that view these differences as a result of a sophisticated interaction process between the environment, personality variables and perception (cf. Eckelt 1981, Kaiser-Meßmer 1989, Menacher 1994, Keller 1998).

Since the 1980s, studies in this field have increasingly dealt with the socialization effects of mathematics classes at schools and with the interaction patterns of or the interactive behavior of teachers and students (cf. Dick 1992, Effe-Stumpf 1995, Kinski 1999). Beyond that, they have critically dealt with the content of school lessons, with how courses are taught, and with the reproduction of role clichés in school mathematics books (cf. Enders-Dragässer et al. 1986, Glötzner 1991, Jahnke-Klein 2001a). The educational debates that have grown out of this have led to a further strand of research. It is primarily concerned with the development – but partially also with the testing – of various concepts for the advancement of girls in courses at schools, with implementing various conditions for learning mathematics by changing educational materials, with rede-

veloping mathematics books and "cleansing" them of role stereotypes or role clichés, as well as developing and testing special offers in the teacher education and further education, which primarily aim at making conscious and modifying gender-specific interaction structures and teaching behavior (cf. Keitel 1990, Öhler 1991, Kaiser-Meßmer 1994, Nyssen et al. 1996, Krahn/Niederdrenk-Felgner 1999, Jahnke-Klein 2001b, Niederdrenk-Felgner 2001).

2.4 The perspective of sociology of organization and sociology of profession: women in courses of studies and careers in mathematics

There have thus far only been a few studies in german women's and gender studies that have dealt with the topic of "women or gender relations in mathematics" from the perspective of sociology of education, profession or organization (cf. Pieper-Seier 1992, Gisbert 1995, Abele/Krüsken 2000, Daniels/Mischau 2003). An array of current research projects, however, indicates that this is increasingly becoming or can become established as an independent research area. Besides the study presented here, three further representative new research projects can be pointed out:

From 1999-2002, at the University of Oldenburg, a longitudinal study was carried out with female mathematics students of various universities who were majoring in theoretical mathematics and mathematics education. Explored are their discipline-related strategies, their attitudes and assessments toward mathematics. Starting with the observation that the number of female students in the discipline of mathematics is not inconsiderable, the study investigates why they are no longer present at universities after receiving their first degree – that is, why women, to a significantly lower extent than men, set out to do doctoral or postdoctoral work. To examine this, female students of mathematics were questioned at three different times; namely, when beginning their studies, after their basic studies, and just before their final exams. The content of the inquiry was, for one, their personal view of mathematics. This included aspects such as their view about the discipline, their expectations regarding their studies and their own abilities, the discrepancy between their expectations about their studies and the reality of them, and their respective views of the field. Additionally, these matters were connected with questions of general competence in mathematics and an assessment of this competence (cf. Pieper-Seier 2002, Curdes et. al 2003, Curdes 2003).

A very comprehensive research project concerning the professional and career development of mathematicians has been underway for three years at the University of Erlangen, and is about to be completed. The objective of this study is to designate the determinants of career development in mathematics from a comparative gender perspective, both historically, on the basis of records of

3.040 people, who obtained degrees in mathematics between 1902 and 1940, and currently, with the help of a forward-looking longitudinal study of 1998/1999 graduates in mathematics. In addition, the career development and the courses of life of male and female mathematicians were analyzed, and a retrospective inquiry of 600 employed mathematicians was carried out (cf. Abele et. al 2001, Abele et. al. 2002, Abele 2003, Abele et. al. 2004).

The University of Oldenburg is also the site of a qualitative research project about women professors in mathematics. Taking mathematics as an exemplary case of a scientific discipline strongly composed of and defined by men, the conditions are to be worked out under which women can successfully hold their ground in this area of university science; i.e. do doctoral and post-doctoral work and get appointments to chairs of mathematics. At the same time, it thematizes the structures of the discipline from a differentiated gender perspective and changes due to the increasing presence of women. About 60 successfully established women mathematicians at german universities, technical universities, and polytechnics are to be interviewed about which individual and institutional conditions and structures they think are necessary, and how they would characterize their status in the discipline (cf. http://www.mathematik.uni-oldenburg.de/frauen/projekt/professorinnen/).

3. Theoretical frame: universities as gendered organizations and mathematics as a gendered subject

The study presented in this report resembles work in the research field, "gender relationships in mathematics", especially from the perspective of organizational sociology.[1] This is because of the reliance on the process of "gendering" from and in organizations, formulated by Joan Acker (1992). This approach will be sketched out in summary in the following.

In order to challenge the idea that organizations are gender-neutral social units, Joan Acker (1992) describes four processes that, in her view, lead to organizations being gendered societal units. By the means of these sets of processes, "gendering" is continually reproduced. In addition to gender, Acker identifies race and social class, thereby placing the gender perspective within a broader diversity perspective. "As outlined above, gendering may occur in gender-explicit and gender-neutral practices; it occurs through concrete organizational activities; and its processes usually have class and racial implications as well. Sexuality, in its diverse forms and meanings, is implicated in each of these processes of gendering organizations" (Acker 1992: 252). Acker categorizes these processes in four classes of order.

(Re-)production of gender divisions (segmentation and segregation) – structural order

Women and men – more or less voluntarily – hold different societal positions and carry out different societal tasks that are unequally esteemed within society. The organizational consequences and preconditions of such a process are difference and hierarchy in accord with gender. The scope of these processes and the way they are manifest vary from one society to the other. This category of structural order concerns everyday life processes in which certain activities are ascribed to men and others to women; it also concerns the social construction of "skills" (see Schwarzkopf 1993). "For example, while employers can no longer, by law, advertise for female workers for some jobs and male workers for others, many still perceive women as suited for certain work and men as suited for other work. These perceptions help to shape decisions" (Acker 1992: 253).

(Re-)production of symbols, images and forms of consciousness that explicate, justify, and, more rarely, oppose gender – symbolic order

Acker describes the modern image of an organization as "lean, mean, aggressive, goal-oriented, efficient, and competitive but rarely empathetic, supportive,

[1] Besides this, social psychological aspects are taken up.

kind and caring" (Acker 1992: 253). This perception fits well with Lynne Zucker's (1983) understanding of organizations as modern institutions. Zucker identifies decision-makers as "metaphors of masculinity" who endeavor to imbibe a certain culture into an organization ("corporate culture"). "Organizational participants actively create these images in their efforts to construct organizational cultures that contribute to competitive success" (ibid.: 253).

Interactions between individuals in the multiplicity of forms that enact dominance and subordination and create alliances and exclusions – interaction order

According to Acker, within this set of processes, sexuality plays a crucial role. Ursula Müller (1999) provides empirical proof that women in an organization are perceived first as women and only secondly as workers, colleagues or superiors. Müller cites an observation of Barbara Gutek (1985): "Gender, sexuality and erotic only enter an organization when women enter it. Men are perceived as gender-neutral. It is not until women enter the organization that sexuality comes into a working day, where women do not really belong" (Müller 1999: 141; translation from german). To "be a woman", then, would be the "normal" case; to be a worker, a scientist, to take a superior position would be perceived as deviant. Acker argues that processes of interaction between men and women, between men and men, between women and women, and between superiors and subordinates (re-)produce "policies" that lead to gender segmentation and segregation, and give rise to "gender images". "Interactions are part of the concrete work of organization, and the production of gender is often 'inside' the activities that constitute the organization itself" (Acker 1992: 253).

Internal mental work of individuals – mental order

"[A]s they consciously construct their understanding of the organization's gendered structure of work and opportunity and the demands for gender-appropriate behaviors and attitudes" (Acker 1992: 253), these mental order processes force individuals to hide many facets of their personality that oppose organizational needs. For men this could be homosexuality or weakness, for women it could mean suppressing an ostensible lack of femininity or an ambitious attitude. "Such internal work helps to reproduce divisions and images even as it ensures individual survival" (Acker 1992: 254).

According to Acker, organizational gendering is embedded in society as a whole. Society and organizations are two sides of the same coin.

Our task here is to conceptualize these four processes of gendering, on the one hand, as distinct processes and, on the other, as being closely interrelated processes that mutually influence one another. If the logic of one process changes, this should affect and be reflected in the logic of the others. If gender segmentation decreases, then symbolic interaction and mental gendering should decrease as well. Empirical data for the last twenty years show that it is becoming more normal for women to study or to enter mathematics. Therefore, we assume that gender differences, reflected in the reasons for choosing this subject, the attitudes towards the discipline, the experiences during one's studies and the individuals' self-perception will have disappeared or that enduring differences will prove statistically non-significant. It would be fascinating to do an up-date survey in a few years to see if things are changing over time.

4. Conceptualization and implementation of the study

The entire study includes a quantitative and a qualitative inquiry of mathematics students. The surveys were carried out among students of mathematics at three german universities (Bielefeld, Hamburg and Stuttgart). The quantitative evaluation was carried out in the winter term 2002/2003 and the summer term 2003; the qualitative interviews were carried out in the winter term 2003/2004.

4.1 The questionnaire

The questionnaire consisted of 59 questions (respectively 62 for women) and dealt with the following issue areas: subject choice, the situation during the students' studies, and the satisfaction with the conditions at the university; the interest in and the views about mathematics, employment and family; career orientation and individual life planning. Students between the third and the twelfth semester of their studies in theoretical mathematics, econometrics and mathematics education were questioned.

Socio-structural description of the sample

We interviewed 306 students:

- 48.7% were women;
- 95.1% were of german nationality;
- 49.3% were single without a partner, and 47.7% single, with a partner; a far higher ratio of women surveyed had a live-in partner than the men (60.4% vs. 35.7%);
- the students questioned were between 20 and 43 years old; 83.9% were between 20 and 25;
- 36.9% were studying theoretical mathematics; 23.5% were studying econometrics; and 39.5% were studying mathematics education;
- breakdown men/women: theoretical mathematics 42.7%/30.9%, econometrics diploma 26.1% /20.8%, mathematics education 31.2% /48.3%.

These data are a fairly representative of mathematics students at german universities.

The statistical analyses[2] for the results presented in the following are two-sided in each case; the significance level was set at $p = 0.05$. We carried out the fol-

[2] The data of the standard inquiry was initially recorded separately for each individual university in an SPSS file. The individual data segments were then run through a data check, whereby, besides finding input mistakes, possible inconsistencies in filling out the questionnaire were checked. To the extent necessary and possible, the data was corrected with the help of the original questionnaire. Finally, the individual data entries were integrated into a single document.

lowing statistical tests: nominal scaled data: Chi^2, ordinal scaled data: Mann-Whitney-U-Test, interval scaled data: t-Test or ANOVA with Games-Howell-Post-Hoc-Test. When possible, the calculation for the testing ratios followed the more exact Monte Carlo method. The number of missing values vacillated between 0 and 9, and they are not reported separately.

4.2 The in-depth survey

The objective of the in-depth survey was to more closely explore the facets of the "vicious circle" of doing gender in mathematics from the subjective perspective of students of this discipline. Primarily we wanted to go deeper into questions about gender differences in accord with the perception of the symbolic interaction and the mental level in mathematics – how those differences can be understood, how they get reproduced in the individual, whether and where students perceive cracks in this "vicious circle", and whether those cracks affect processes of de-gendering mathematics at the university level. 24 students of the three universities were interviewed, of whom eight were pursuing a mathematics diploma, eight an econometrics diploma and eight a teaching certificate. In each group, four were women and four were men.

On average, the interviews lasted 90 minutes. They were recorded on tape and later written down.[3]

The qualitative research questions were to be answered through explorative, context analysis. For the interview analysis required for this purpose, classification schemes were developed inductively to interpret the issue-related arguments from the 24 interviews, relying on proposals from the literature (including Mayring 1983 and 1988, Lampert/Ervin-Tripp 1993). These schemes were drafted on the basis of the existing interview material and developed, checked, and modified iteratively in the course of applying them to this material. In order to be able to pursue the formulated questions, all of the oral contributions in which positions were assumed regarding individual issues or focal points had to be identified and classified. The systematization or classification of the comments thus forms the basis for the results that are to be described.

[3] For the transcription of interviews, all explicit statements were to be included that were important for the topic of focus in the discussions. Correspondingly, in the transcriptions, only the speakers (the interviewer and the respective interview partner) and the content they expressed were included in their complete verbal form, without consideration of colloquialisms and verbal forms influenced by dialects, or non-verbal characteristics such as pauses, intonations, interruptions. The interviews were thus transcribed according to the simplest rules of transcription.

5. Doing gender in mathematics – results of the two surveys

5.1 Individual characteristics of school achievement

Do male and female students (still) have different school experiences ("school biography"), and do they have different achievements in mathematics while in school? In total we formulated nine questions to investigate this. The answers to some of them – mainly those that deal with school achievement and the affinity for mathematics at school – are presented in the following.

Favorite subjects while at school

The students of our survey were asked to give their two favorite subjects during their final school years. Concerning their absolutely favorite subject, no significant difference exists. Mathematics featured prominently for women and men. 60.4% of the women and 67.5% of the men answered that mathematics was their favorite subject. When we look at the second favorite subject, however, considerable differences become evident. Women lean towards languages or the social sciences as their second favorite subjects (37.2%), whereas men prefer sciences (37.8%) (see Table 1). We then explored the combinations of the first and the second favorite subjects (see Figure 1). Female students chose the combination of mathematics and sciences less often than men, whereas they chose a combination of mathematics and languages or social sciences more often than men. A further difference can be found regarding mathematics and sports.

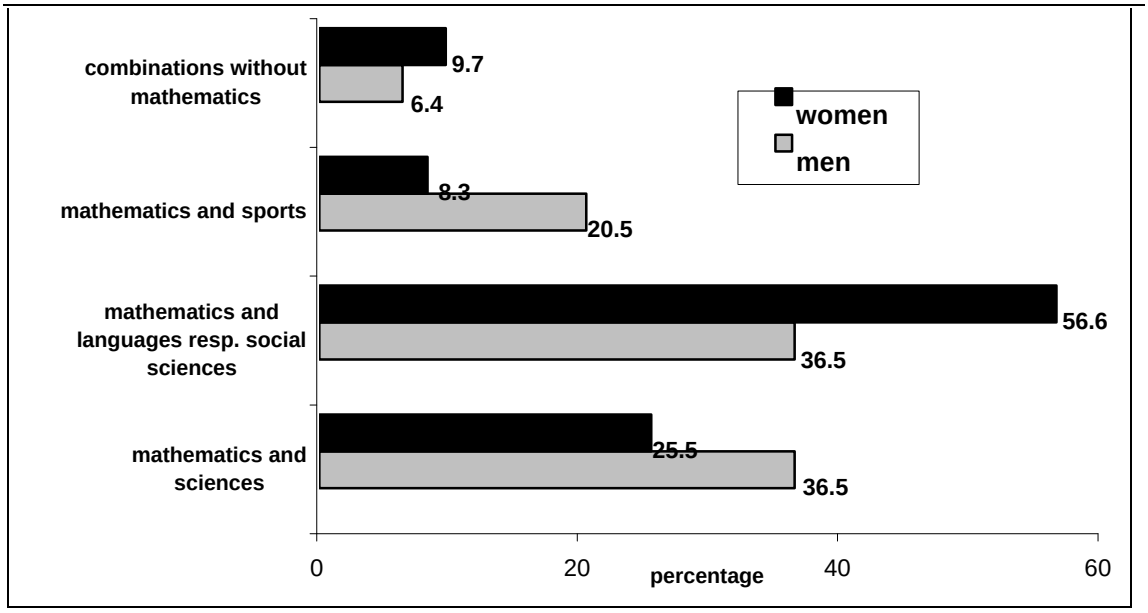

Figure 1: Combinations of favorite subjects in school (gender ratio in %)

School achievement

Consistent with the high affinity for mathematics, 94.8% of the female students and 98.7% of the male students chose mathematics for their college preparatory examination (the german "Abitur"), which is roughly equivalent to an A-level but includes multiple subjects. Moreover, 82.6% of the women and 91.7% of the men had already chosen mathematics as a major subject (so-called "Leistungskurs") during their final years at school. More than 50% of our sample (a somewhat higher figure for the women) had achieved a mark of between 2.0 and 1.0 on their *Abitur* certificate, corresponding to 'good' or 'very good'. As with the above issues, the marks for mathematics on the *Abitur* certificate show no statistically significant differences between men and women. 57.3% of the women in our survey and 65.3% of the men achieved the highest mark of "very good" (see Table 2).

It can be can summarized that students of mathematics were already very good pupils during their school years and that there was no difference between the performances of the sexes. In itself, this could be seen as a sign of "equality". A further result shows that girls and young women are as motivated and courageous as their male counterparts when it comes to participating in mathematical competitions at pre-university levels. There are some indications that, as far as later decisions on the specific courses of study are concerned, women tend to have broader interests and that this predisposes them to pursue teaching, while scientists in general obviously have more narrow areas of professional interest.

5.2 Reasons for choosing mathematics

The majority of our survey subjects said that mathematics was the subject they most wanted to study. There are no statistically significant differences between men (87.3%) and women (91.3%). In order to explore whether the reasons for choosing mathematics as a major subject are perceived or weighted differently by men and women, participants were asked to weight fourteen possible reasons on a scale ranging between "very important", "rather important", "less important" and "not at all important". In addition, they could also mark “does not apply” (see Table 3). For the students who answered this question, “aptitude and talent for mathematics” was the most important reason for having chosen this subject area (see Figure 2). Further reasons were a specific interest in mathematics, good marks – which was more important for women than men –, a preferred choice of profession and good future job prospects. Good career opportunities were much less important for both, although, in our sample, men stressed this issue more often than women did. In line with our hypotheses concerning the reasons for studying mathematics, there was no significant difference between women and men, with one exception. Women chose mathemat-

ics significantly more often than men because of a preferred choice of profession. The fact that women more often than men pursue mathematics education could be an accompanying factor here.

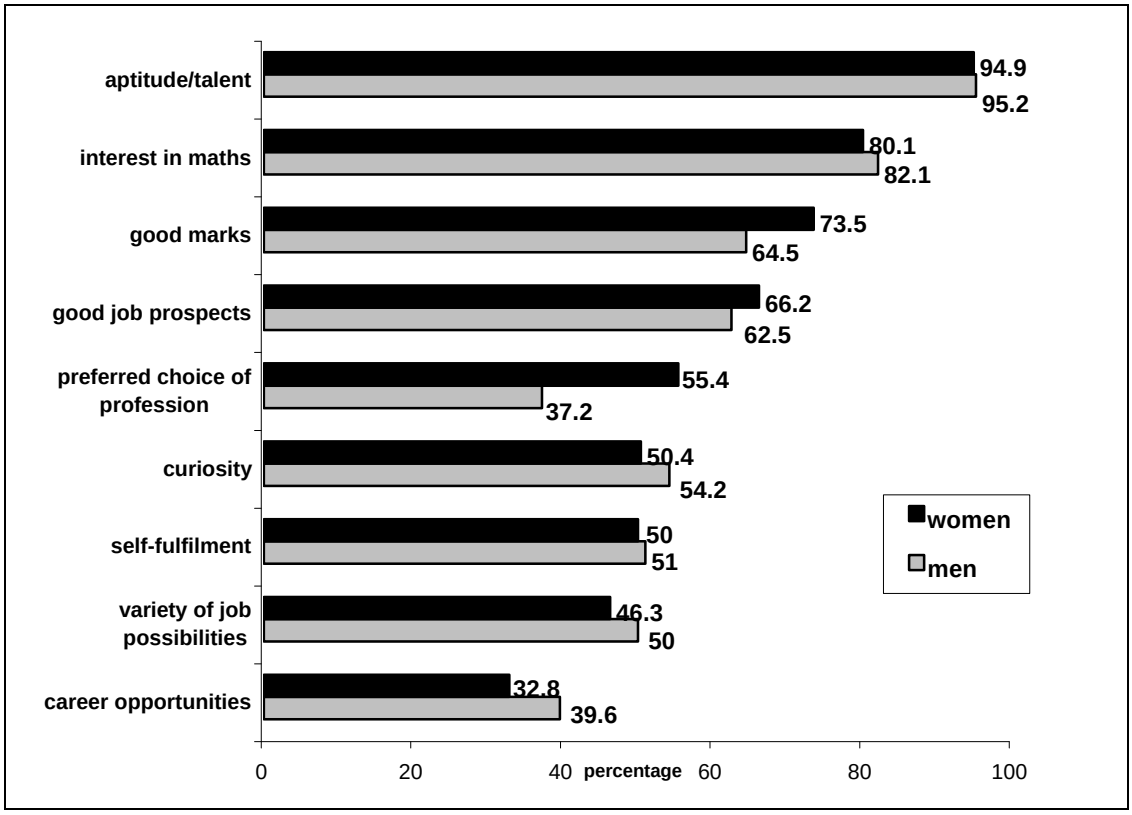

Figure 2: Reasons for choosing a subject area (gender ratio; those who answered "very important" or "rather important" in %)

Reasons for gender differences in the courses of study

In qualitative interviews with students in various courses of studies in mathematics, the results of a quantitative study were followed up: students were asked whether they thought that men and women have different reasons for studying mathematics.

The answers clearly showed that approximately the same number of women and men (5 to 4) thought that women's reasons for pursuing this course of study did not differ men's, and that their reasons for pursuing other courses of study didn't differ either. Men and women, it was thought, choose their course of study in mathematics and in secondary corresponding courses of study primarily in accord with their interests, leanings, talents or good notes. More women than men (4 to 2) believed that the motivations for studying mathematics differed.

They, however, related the difference between the sexes on this issue primarily to the decision for the respective course of study (i.e. the area of concentration in mathematics) and not so clearly to the discipline of mathematics as such. More men than women (about 5 to 2) were ambivalent in their answers: i.e. on the one hand, they could imagine possible differences; on the other hand, they held them, insofar as they existed, to be inessential. Two students were not able to answer the question. A few select quotes ought to make the breadth of views clear:

"Men lay a lot more importance – I think – on the financial or career considerations. They think...about that more. I mean, I'm not sure that they think about it more, but I think it is more significant for them than for women." [female, abstract math].

"Yea, I think...the decision, for example, whether one pursues a teaching certificate is related a lot...to the fact that they want to have a family and want to have children and...they say: It's possible to do that with a teaching job. Yea, so they say – if they want to study math: 'OK, then I'll do more practical mathematics and get the teaching certificate, because then you can get a job that you can somehow work when you have a family.' And those are maybe reasons that I think the men don't so often say: ...." [female, abstract math].

"Well,... for example, there are a lot more women in econometrics than in abstract math. And with women it is often the case, for example, in my...group that when we talked about 'Why are you studying here?' every girl said 'Well, I didn't really trust myself to do abstract math.'... They probably were afraid that it was too difficult.... And you can see it – that many women who attend mathematics lectures really are studying for the teaching certificate. Well, a large percentage of the women. I mean, my parents also asked me at some point: 'Petra, don't you want to be a teacher? That's not so bad. If you are thinking about a family and so on,… then it's easier.' I think that for a lot of women these kinds of reasons play a bit more of a role." [female, econometrics].

"It's not so essential, at least not in math. Either you like the subject, or you don't.... I think if you like math,...your gender doesn't play a role." [male, abstract math].

"I don't think so – well, not as far as I know. The reasons are pretty much the same for everybody – for men or women [female, econometrics].

"No, I think the reasons are the same. Just interest in it and talent. That is the most important criteria, and that is for men and women." [male, econometrics].

"I have noticed this in my experience.... In the end, it is the difference between the courses of study, not really between men and women. Of course, that's the way it is.... The more you move away from applications, the fewer women study these areas. You've got to admit that. But that doesn't have much to do with the subject, maybe with the emphasis of one's studies." [male, abstract math].

"Maybe the men are more fixed on a career... relate it all a little more to the job and to later prospects for salaries and wages and so on.... I don't know though.… Probably that's just a dumb prejudice, but it's the only place where I might say there are differences.... But...I don't think that women study the subject to really become housewives and mothers when they're finished with their studies. I think that they are up to a point pretty much oriented towards careers.… I don't know. [female, mathematics education].

"I can imagine that somewhere this sense, 'I want to be successful', is stronger with men. Probably. But otherwise, I wouldn't see such a great difference." [male, abstract math].

People who influenced the decision for mathematics

If we assume that studying mathematics has become more "normal" for young women, it seems interesting to analyse whether – during schooling – certain people fostered their interest in mathematics and whether those who did so tended to be women or men. The students of our survey were asked to assess fifteen individuals or groups of people and to note the level of influence they had had (from "very important" to "not at all important")[4] (see Table 4).

For both sexes, ten of the people or groups of people presented had a similarly strong or weak influence on their decision to study mathematics. For these, no significant differences were apparent. These people or groups were: siblings, friends, male and female teachers, partners, males with similar majors, male relatives, student advisors or others. By contrast, five of the people or groups mentioned were significantly more important in influencing women's choice of a major, as opposed to men's. For female students, the influence of their mothers, fathers, female friends with a similar major, and female relatives was significantly more important in influencing their choice of a major than for male students. It may be possible to interpret the influence of the female students' mothers, of female relatives or of women with similar majors, and in some cases also that of female friends, as a positive role model or example. The positive significance of fathers on women's decisions to study the natural or technical sciences has already been elaborated in another study (e.g. Blättel-Mink 2002).

5.3 Thoughts about changing one's subject, course of study, or leaving the university, and reasons for it

The students were asked whether they had ever considered changing their major, changing their chosen area of emphasis or leaving the university altogether, and if so, to give the reasons. About 50% said that, at one time or another, they had thought about one or more of these three options, women (57.7%) to a statistically significant higher degree than men (38.9%). Most of the women who had thought about a change of direction had considered changing their subject area; far fewer had considered changing their area of emphasis; fewer still had thought about breaking off their studies altogether. The most important reasons (16 reasons were given) for considering a change were the same for both

[4] In addition, they could also mark "does not apply" in non-applicable cases, such as, for example, if the question regarded the influence of a brother and they did not have one.

sexes. As the top reason, students said that they felt inadequate to the demands, unable to cope with their studies. The second most frequently given reason was that mathematics is too theoretical and not relevant enough to everyday life. The third most frequently given reason was that the contents of their studies were inconsistent with their own interests. There was only a significant difference between women and men with regard to one of the reasons: far more women than men (18.3% to 4.9%) said that they had considered breaking off their studies because of the "narrowness" of the subject area. We might keep in mind here that, already at secondary school level, girls and young women show a higher regard for variety than boys and young men.

The interviews that were carried out confirmed the results of the quantitative study, i.e. that a relatively high percentage of the students had already thought about changing their majors to another area of mathematics or to an area outside of mathematics altogether (namely 13 of 24 students). But the result of the quantitative study – that significantly more women than men think about changing their majors – couldn't be confirmed in this group. Among the students interviewed, the proportion was about equivalent: seven women and six men had thought about changing their majors; five women and six men had not thought about it.

As the quantitative outcomes also showed, the main reason for considering a change in the major was similar for the sexes and mostly related to the feeling that they were not up to the demands and the view that the field is too theoretical. Beyond that, for both sexes it could be seen that these thoughts only arise at the beginning of their studies, but that, after the "initial phase of frustration" was overcome along with the feeling "I can't handle it", they were increasingly more sure about their decision to study the subject or to major in the course of studies. The following quotes ought to clearly show the arguments and thoughts, both of those who had thought about changing majors and of those who had not:

"No, I sometimes thought, Ok, maybe econometrics wouldn't have been so bad...well, that econometrics gives you a broader qualification... And that's the reason I thought: OK, if I had been better informed when I started out, econometrics might have been the right thing for me, or might have been a better decision. But I never thought about changing majors...because the difference wasn't large enough for me. And because...I did place some importance on saying I really studied mathematics and not mathematical economics, but the real subject.... And anyway, to really change the major or break off my studies didn't really come into question, even when I at times didn't feel like doing it. There was nothing...where I would now say, I would much rather study this or that. I really didn't have an alternative...." [female, abstract math].

"Regarding math, God, I mean, I surely had some downs, where I'd say: 'why that?' Or 'Why not the polytechnic? Why these theoretical courses at the university?' But good, those are frustrating moments. You have them sometimes. I think that happens regardless of your course of studies. I never really seriously

considered, say, dropping mathematics and doing something complete new." [male, abstract math].

"No, well, if at all, then you think when you're frustrated: 'Man, why are you doing this? You're nuts.' But then, yea, you just keep going. You've just got to keep at it and do it one way or another. So, I never really seriously thought about changing games." [male, abstract math].

"In math, not really. Chemistry was more frustrating. There were more moments where I thought about stopping. In math, no. Clear, it was a little frustrating at the beginning. You turn in the first assignment and think you've got it all right, and half of its wrong. But after the first three or four weeks... In mathematics I never really thought: I can't handle it or I want to do something else." [male, mathematics education].

"Yea, as a matter of fact,... I thought about it right when starting out because I felt like I couldn't handle it in the first two semesters. But then everybody said, even my old teacher: 'You've got to get through the first two semesters, then it'll be better.' Even she said that, and she graduated with honors.... So I really thought about it right at the beginning of the first semester, because I thought that its really hard, and I thought I wouldn't get through it. But after all, after getting through the second or third semester, I thought: 'No, somehow I'm going to get through this.' Because I also didn't have any concrete idea of what I ought to study instead of that. Especially if I continued with mathematics education.... That is because I simply thought, I'd already lost three semesters, now I'm going just finish it, regardless of how hard it is." [woman, mathematics education].

"Yea, after the first semester, I was frustrated that I didn't understand it all that well. Then I sometimes wished I had done something more practical, something with my hands, where I wouldn't have to sit alone all day, racking my brains. But that got better pretty fast." [female, econometrics].

"Yea, you think that now and then when starting out, because in the first semester you think, 'Oh, what's going on here' and then 'You're never gonna get this' and you really think: 'Why don't you toss in the towel – and better now than in three, maybe four, semesters. But then...you think; 'How will it be, not to have mathematics anymore? Something will somehow be missing.'... Then you start thinking: 'OK, I'm going to do it. What you start, you're gonna finish.' And you see...that it might take a bit longer or that you sometimes have a couple of frustrating days, but really you can manage it, and you just do it, and it works out more or less." [male, econometrics].

5.4 Perception of the symbolic presentation of the subject, mathematics

In the following chapter we look at the way the university and the discipline of mathematics are symbolically presented from the perspective of the individual. We explore the attitudes to and the affinity for mathematics, and we ask if women and men approach this subject from different angles.

Reasons for interest in mathematics

In order to assess the students' attitudes to mathematics and their interest in this scientific discipline, we asked them to assign one of four degrees of accep-

tance to nine statements: ("fully agree", "more or less agree", "more or less disagree", "do not agree at all", see Table 5). As the top interest, we found the strictly logical structure of mathematics, in mid-field, the intellectual challenge, and as the lowest level of interest, the vitality of the discipline. For only three of the nine statements do we have significant differences: men indicated being more fascinated than women by the intellectual challenge of mathematics, its aesthetical structure and its vitality as a living branch of science (see Figure 3).

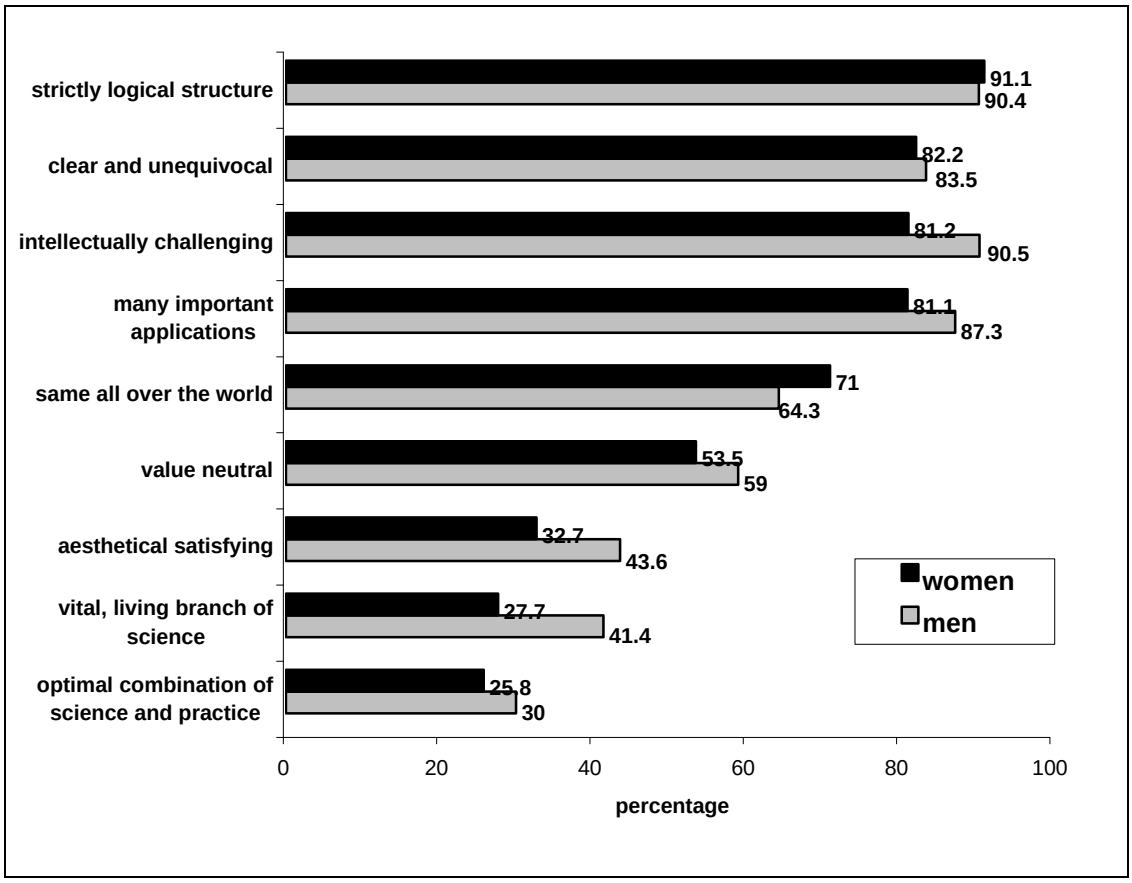

Figure 3: “I find mathematics an interesting subject because … " (gender ratio; those who marked "fully agree" or "more or less agree" in %)

In the qualitative interviews, the students were asked when they had discovered their interest in mathematics and what that interest is based on. Here it is evident, first of all, that nearly all of those interviewed (23 of 24 persons) developed their interest in mathematics while in school: on the one hand, of course, because they received good notes in this subject and enjoyed learning it, or because they found mathematics easier than other subjects; on the other hand, though, also because they already "sensed" a special affinity to this subject while at school, i.e. mathematics fascinated them in a special way. The reason

that they developed their particular "passion" for this subject during their school years did not differ – this is shown in the interviews – from the reason that they still had a particular fascination with mathematics. It is interesting to note that, when discussing this in their own words, the students normally again pointed to those facets that were mentioned most frequently in the quantitative research: the logical structure, the clarity, the intellectual challenge and the diversity (in the applications) were decisive reasons that mathematics became one of their favorite subjects and that this discipline still enthuses these students today. In contrast to the quantitative study, in which the men more often cited that they were fascinated by the intellectual challenge, in the qualitative interviews, no great difference was perceptible in the reasons cited by the women and the men. The following quotes offer an impression of the special affinity that the students have to their subject matter, which, in some cases, can almost be described as a libidinous relationship:

"I always found it cool that there you've got something correct and something false and not this wishy-washiness. It is all just very clear and logically structured for me. I can understand it completely, one thing after another, and every step is sensible and logical and demonstrable.... I always found that really cool, and now – I didn't see this earlier – mathematics comes up everywhere and is everywhere in our environment, and...if you do a lot of math, you can get a glimpse into a lot of areas." [female, mathematics education].

Well, the first thing that fascinated me was the density of the space,... the structure of numbers.... That starts at school, when real numbers are introduced.... well, that somehow structures can be described that don't really exist. So, precisely the transition to things that no longer really have anything to do with reality.... And what I find really fascinating is that, in mathematics, it is always possible to continue to fit and re-fit the models that you construct or the theories, that it is simply really flexible. You can really describe just about anything if you have a good idea.... It is possible." [male, abstract math].

"Like I said, I have always found puzzles and tangible tasks interesting. So, the way you can more or less solve problems in the everyday world with mathematics. An now mathematics is even characterized as a language, like German or English. Mathematics is a form of language – you can somehow translate everyday problems into mathematics and then solve them or work them out mathematically." [male, mathematics education].

"Well, I believe, I simply love math, if I have to put it so directly: I love the subject. Yea...because its so logical and playing with numbers." [male, mathematics education].

"In principle I always found the logic really appealing, and the, well, relatively tangible character." [female, mathematics education].

"It always fascinated me...these logical and simple connections, and that it is possible to so simply structure complex patterns.... I don't know, a lot of people can't relate to that, but I think it's...very clear and simple. You can present very abstract things formally and work them out precisely and logically. Somehow, there's nothing fuzzy about it.... So, in mathematics I always had the impression that when you have knowledge, it is definitely secure knowledge...and that was something...disappointing in the social sciences: This and that had been re-

flected upon, but...in the final analysis...it wasn't possible to prove that things really worked that way." [male, abstract math].

"Well, I used to find it good that it was just so clear, that it somehow all logically builds on one another and that, well, it isn't so fuzzy as a lot of other subjects – that there are clear rules that you can oriented yourself on. I still do." [female, econometrics].

Well, I always found it really interesting that...everything is very locally set up and that there is either a solution,... or there just isn't one, and that it is correct or false, and different from a german text, where it is just really subjective whether you like it or not. Now I find all the connections interesting and to know that an entire theory stands behind most things and that it's all really complex." [female, econometrics].

"The real beauty of mathematics, and that's what I love, is that there are...such clear situations. Either things are so or they are not so." [female, econometrics].

Interest in certain fields of applied mathematics

A further aspect, which might provide insight into potential gender-specific differences regarding attitudes to or affinity for mathematics (and therefore, to the degree to which mathematics is seen as a gendered subject), is the level of interest students bring to different areas of application. Nine potential areas of application were listed in the questionnaire, and the students were asked to assess each according to their own interest in each area ("very deep"; "deep", "weak", "very weak", see Table 6). Here we find very pronounced differences between women and men (see Figure 4).

With only slight exaggeration, we could say that interests in and affinities for different areas of application mirror societal gender stereotypes. Men are significantly more interested in and attracted to traditionally "male-labeled" fields of application of mathematics, such as the sciences and technology (applications in physics, in astronomy, in computer science and computer technology and in engineering). At the other end of the scale, women evince significantly higher levels of interest in mathematics as a subject in school or mathematical knowledge applied in the "soft" sciences (in biology, medicine), and finally in areas of research that go beyond the limits of mathematics (psychology and sociology). There are no significant differences in relation to economics, mathematics dealing with finances, or the earth sciences.

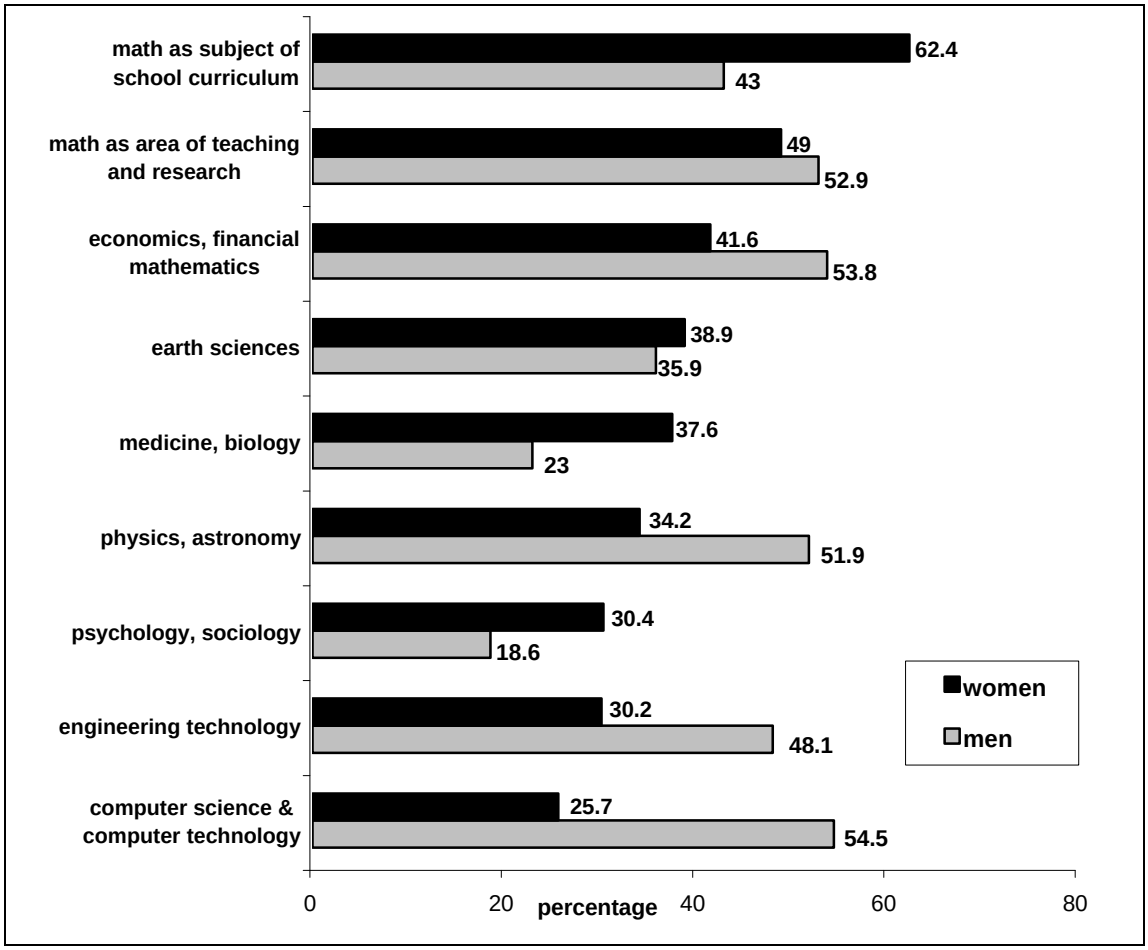

Figure 4: Interest in fields of application of mathematics (gender ratio; those who answered "very deep" and "deep" in %)

Explanations of the various interests in the particular areas of application of mathematics

Because the qualitative interviews were carried out after the quantitative investigation, it was possible both to delve into particular facets touched on in the survey and to confront the students, on some points, with the already existing quantitative results and to ask how they would assess these on the basis of their own experience. Because the quantitative study turned up very clear, significant differences – along gender lines – between the interests in the various areas of application in mathematics, this point was followed up in the interviews. On the one hand, the students were presented with the results of the quantitative study, showing the significant differences between the sexes that have already been presented here. On the other hand, the significant differences between the students in the respective courses of study were also presented to them. These showed that mathematical economists are more interested than

students in the other course of studies in "economics, finances, insurance"; students of abstract mathematics are more interested in "computer science, information technology and physics" and for "mathematics as a teaching and research area"; students of mathematics education were primarily interested in "mathematics as a school subject", but they were also more interested than the others in applying mathematics to "psychology and sociology" and "medicine and biology". Finally, the students were asked whether they could imagine why these differences between the sexes and the students of the respective courses of study exist and whether they could explain these differences.

A first glance shows: The majority of the students interviewed (16 of 24) presumed that the interest in the particular areas of application of mathematics varied between the different courses of study and varied between the sexes. It is interesting to note that those interviewed thought it was completely "normal" that those in different courses of studies had different interests. Further, these differences could be explained spontaneously, without any trouble. By contrast, the students interviewed "somehow" perceived the differences between the sexes on these matters and thought that they existed, but they normally could not offer a clear explanation for this. Not infrequently, they pointed to gender-specific socialization or, in exceptional cases, even to a "biological predisposition" – and both women and men did this. A few select quotes ought to elucidate the students' assessments of and explanations for gender-specific or “courses of study-specific” interests for certain areas of application in mathematics:

"I presume that the economic mathematicians are more interested in economic aspects. That's logical. If that weren't the case, they wouldn't be economic mathematicians, but abstract mathematicians or something like that, with a minor in physics or some other natural science.… So, I would say you have to reverse cause and effect. The cause is certainly: ‘I am more interested in biology or physics, and I am interested in mathematics, so I will just do mathematics that goes off in one of these directions.’ It doesn't work the other way around. Now regarding the male and female differences: Hmm, I don't know." [male, abstract math].

"Well, I think it's relatively clear that those who are interested in mathematic research or in the scientific facets tend to decide to do abstract mathematics and those who know from the outset – we're interested in finances or the stock exchange – that they certainly tend towards economic math.... Why is it men that tend to choose to go into the harder natural sciences and women who choose to go into biology...? I mean,... I can fully confirm this result, because that's what people are familiar with or what people know from their environments. But why women are more interested in biology and medicine than men, I don't know. I know that those,... for example, who do mathematics education tend to be more interested in sociology or education,... that they aren't just interested in mathematics, but also in education and didactics, in how to teach people that. But, with men and women, well, I can't offer a real explanation for that." [female, abstract math].

"Well, I think it's relatively clear along the lines of the courses of study.… Thus, that students of mathematics education are interested in mathematics as a teaching subject is obvious, I think. And that abstract mathematicians tend to focus on research tasks, on the teaching and research areas of mathematics; and the mathematical economists, toward the applications in the economy. Along gender lines, I don't know exactly how I should judge that. You could say, it is just traditional, for whatever reason, that men tend to be interested in such hard subjects and women in the 'softer' ones,... biology, medicine. I can't say for sure why that's the case. But it's certainly typical, I think." [male, mathematics education].

"The reason that girls are more interested in psychology and these things, the soft natural sciences, certainly is connected to some extent to the schools. In school girls always chose biology more often than physics.… Whether that's connected to logical thinking – it is always said that, on average, the language centre of the brain is more developed in women than in men and that logical thinking is more developed in men, and such things. It doesn't apply to me, but it does to most girls." [female, mathematics education].

"I think that it is simply predisposition or talent. Because you find...if you want to be a teacher, you don't become a teacher because you do math, but because of the teaching, and to work with children at school.... There, being a teacher is in the foreground, and then you plan your courses according to your talents – so, for example, math.... And, if you choose abstract math, then you're choosing mathematics as a science as such. You want to learn about this science, to expand your horizons. As for mathematical economists, it's a little different: you study mathematics...really as a prerequisite for other things, which are built upon it – for example, for economic matters or computer science...but as a basis and not to deeply get into mathematics.... And that there are differences between men and women is because, I think,... for men, first, the interest and somehow also the talent for mathematics is better...and that...guys somehow just get involved in this logical thinking, in recognizing structures. And women, well, I don't know. I'm not a woman, and I can't say anything about that...." [male, econometrics].

"Yea, I think, among the sexes...with the hard natural sciences and information technology, this is something that is really clear at the university – if you look, for example, at how many women start out studying physics or computer science,... or how many women and how few men start out, for example, studying psychology. You can just really clearly see that those probably tend to be the areas of interest for men and women. And maybe that's the same in mathematics." [female, econometrics].

Evaluating teaching and learning methods at university

Some of the questions on the questionnaire aimed at making it possible to achieve some kind of an evaluation of the learning and teaching situation in mathematics at the three universities. In one of these questions, students were presented with 17 different modes of teaching and learning. In order to be able to pursue the question of whether and to what degree males and females differ in their assessment of these modes of teaching and learning, the students were to estimate whether each point given should be given more or less weight in the curriculum, or whether it is presently weighted correctly (see Table 7). For those

cases in which the university did not have the mentioned form of teaching and learning, the students were able to note whether in their view it should be introduced or whether it was not necessary for their education. For the analysis, on the one hand, the answers "weight more heavily" and "should be introduced" were drawn up, on the other, the answers "give less weight" and "is not necessary". The results showed that 10 of 17 modes of teaching and learning were not weighted significantly differently by males and females. For seven modes, however, significant differences were apparent. Significantly more often than the male students, the females wanted the following to be given more weight in their curriculum or wanted these modes of teaching and learning be introduced to their university if they did not exist there: they wanted more teaching to be done by those who have experience in practical fields of mathematics (e.g. from those who had worked in the business community or in research institutes), internships outside of the university, courses for women only and courses from women professors, practically oriented seminars, for example, in cooperation with companies or institutions from a specific application area of mathematics, and practical educational courses. The only issue that male students wanted to see weighted more than female students concerned self-study. Male students wished for more weight to be given to independent study than female students did.

Knowledge or skills other than expert knowledge to be communicated during studies in mathematics

The students were asked to mark how important they considered the communication of capacities or qualifications other than those specific to the subject ("very important", "rather important", "less important", "not important at all", see Table 8). Cognitive abilities – such as creativity or the ability to solve problems – are of very high importance for both gender groups. As we said above, women more often indicated that the "narrowness" of the field of study was a reason for considering a change of direction. It is therefore understandable that, in addition to the communication of expert knowledge, women rate the transferal of social abilities, as well as rhetoric and presentation techniques, significantly higher than men do (see Figure 5).

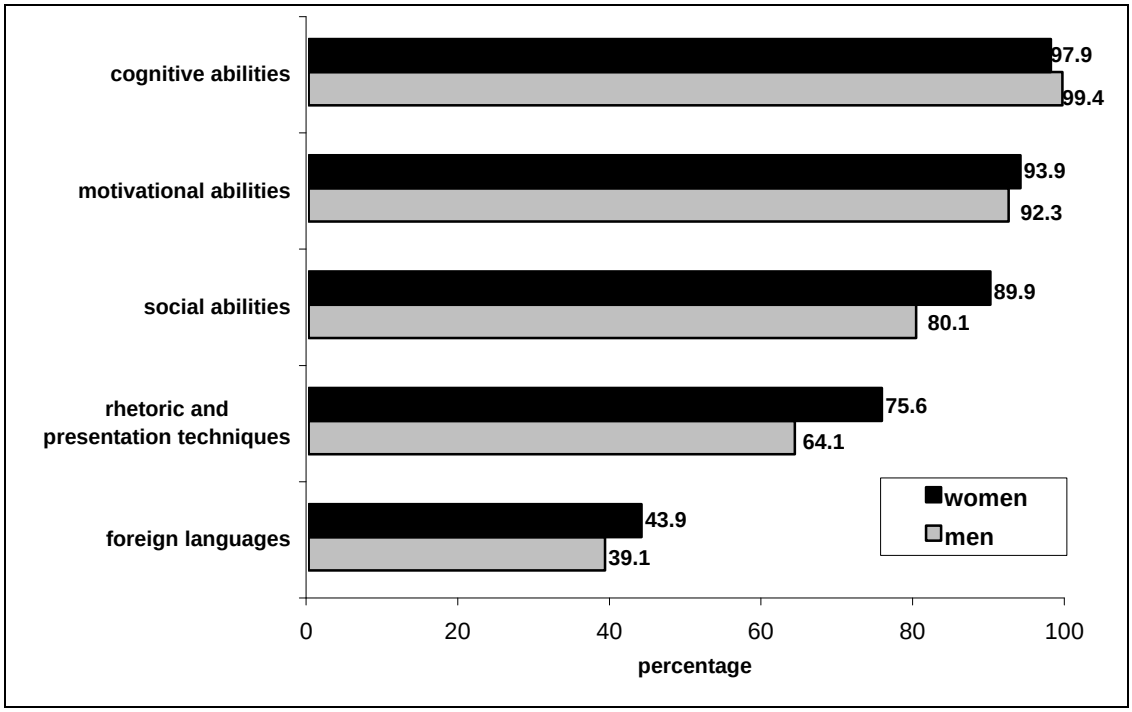

Figure 5: Importance of qualifications other than expert knowledge (gender ratio; those who answered "very important" or "rather important" in %)

5.5 Perception of the culture of interaction in mathematics and at the university

How do students of mathematics experience their interaction with their professors or instructors? Do they get feedback on their achievements? Do women and men experience differences that might arise from different expectations that professors have regarding their achievements? In this section we will try to ascertain whether, in line with our assumptions, the growing participation of women in mathematics is accompanied by a process of growing equality at the interaction level, and whether this is also perceived to be the case by the individuals involved. Have women students become a "normal" phenomenon in this seemingly male-dominated world?

Expectations of performance towards male and female students of mathematics

In order to find out about gender-specific performance expectancies of university professors, the students were asked if they had ever personally experienced such differences. Most of the students (89.2% of men and 83.8% of women) said that they had not. Very few men said categorically that they felt

there was no difference in expectations, but that women are more ambitious (2.5%; 4.1% of women), or that less is expected of women than of men (4.5%; 2.7% of women). Only a few female students (6.1%; 1.3% of men) think the same level of performance is demanded from women and men, but that women put more pressure on themselves, because, in contrast to the men, women studying mathematics were in the spotlight (see Table 9).

Situations in studies experienced by male and female students of mathematics

There were no (or only very slight) differences in the expectations of the levels of performance: Does this mean that discrimination against women in this discipline has disappeared? In order to answer this question, we "constructed" thirteen situational examples of gender-specific positive or negative discrimination and asked the students how consistent they were with their own experiences ("is absolutely the case", "is more the case", "is less the case", "is not at all the case"; see Figure 6 & Table 10).

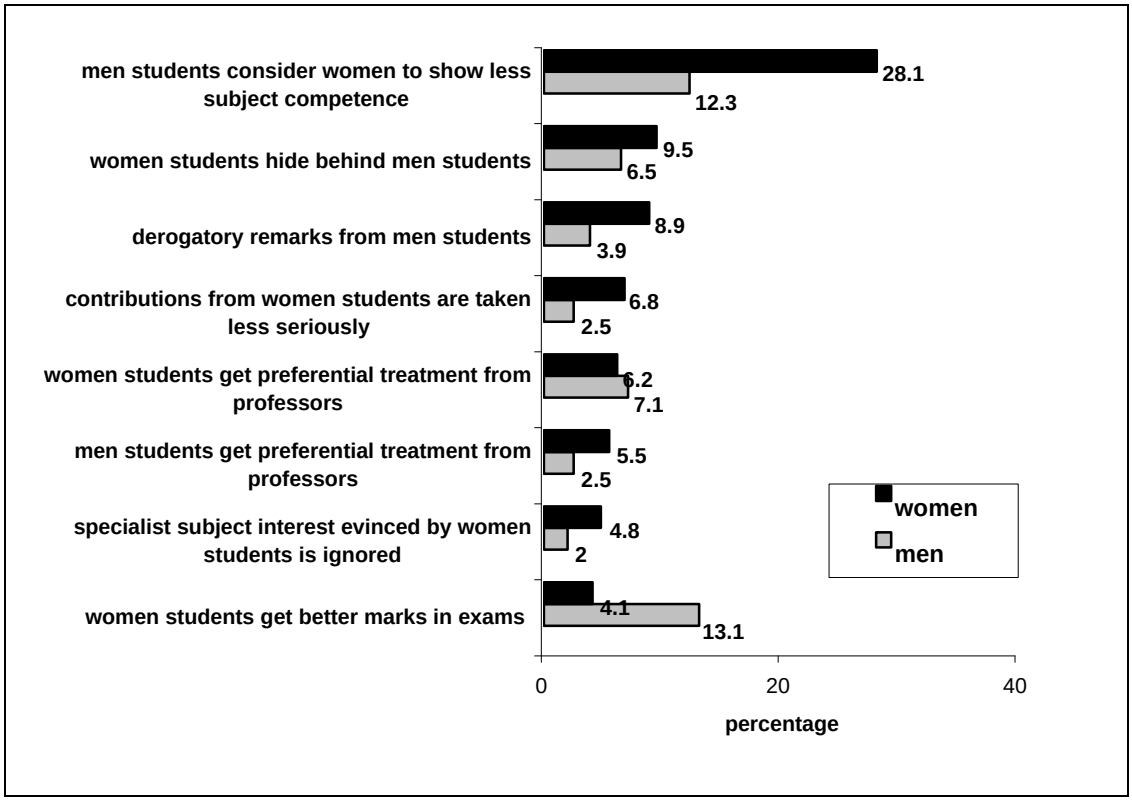

Figure 6: Experiences during studies (selected examples; gender ratio; those who answered "is absolutely the case" and "is more or less the case" in %)

The first conclusion we can draw from the students' responses is that men and women have similar experiences regarding most of the examples. We did not find significant differences in their views about the interaction between the sexes either; e.g. women's reports of men speaking of women in a derogatory way were no higher than the men's reports of such things. Nor did we find differences in their experiences regarding whether contributions from women students are taken less seriously. Significant differences, however, can be identified in two situations. More men than women think that women get better marks than men in examinations, i.e., men perceive positive discrimination towards women (13.1% vs. 4.1%). The somewhat critical question here would be whether men assume that women are not as good as men in mathematics but get better marks anyway. This question can be at least partly answered by the next result: Women experience – to a far higher degree than men (28.1.4% vs. 12.3%) – that the male students consider women to show less subject competence than them.

Experiences with professors and fellow students

In the interviews with students of mathematics, the patterns of interaction during their studies, and their experience with professors and fellow students received especial attention. The results of the quantitative survey remain unsatisfactory in this regard and only showed that, in women's own experience, there was negative discrimination from their fellow students. By contrast, male students thought that women experience positive discrimination regarding the instructors' grading. The quantitative data cannot elucidate how this presumed positive or negative discrimination occurs or what stereotypes are at work, what effects this has on the interaction between the students or between the students and the instructors, or even what this means for the context in which women study. Here, the limits of a standard questionnaire manifest themselves. In this respect, it proved to be a decisive advantage that qualitative interviews were carried out after the quantitative study. They made it possible to question students concretely about their own experience and their perceptions of patterns of interaction in the course of their studies, and to present more details about these things. Besides this, the students were asked whether they themselves had experienced or seen either positive or negative discrimination, and how they would describe the relationship with their fellow students and with the instructors.

When introducing this topic, the students were asked whether they collaborate more with male or female students, whether they meet in single-gender groups or mixed groups. Two students said that they never work in groups, but always alone. Of the remaining 22 students, three (two women, one men) work with

women more often, and seven (four women, 3 men) work with men more often. On woman had only worked with men. Only three students actually only worked in "mixed" groups, and eight of them (three women, five men) worked in various constellations – i.e. alternatively in homogenous and in heterogeneous groups. From the students' explanations of why this is the case, it is clear that the primary group structure that they named was by no means always voluntarily chosen or aligned with their desires. Instead, it was often blamed on a "lack of alternatives". This was especially true for those – and this was true for both sexes – who noted that they primarily worked together with men. Besides that, the fact that they were in "mixed groups" did not mean, or only rarely meant, that a "balanced" gender ratio was found. "Mixed" groups usually consisted of a majority of men, with one or two additional women. The following quotes out to clarify this:

"Usually with male students. But in principle,... that pretty much corresponds to the numerical ratios. I mean, there are fewer female students... But now and then, also with women students. So, I wouldn't say that it is exclusively the case that men and women work separately, but it's more often the case. There are other cases.... In our group we have just worked more often with four males and one female...." [male, abstract math].

"...Well, in the first two semesters it was relatively balanced.... There were three women and three men who meet together. But...after a while, because two women students left, for whatever reasons – for example, for a year abroad, or another major or a different university. They're not here now. So that's why, over the course of time, I met and learned more and more often with male students." [female, abstract math] .

"In my mathematics studies I had ...an exercise work group, which was stable for four or five semesters: There were only men in it.… In the last two semesters I have worked together with a mixed group.... But it was predominantly just a men's group. That's because more men were always there..." [male, mathematics education].

"More with men.... Because there just aren't so many women who are doing the same thing in math. Just look at the beginning: mathematics and chemistry. There were three of us who started. Me a guy and another woman. But then she broke off her mathematics studies." [female, mathematics education].

"Yea, of necessity more men, because there are simply more of them." [female, mathematics education].

"...well, in my studies, there were more men, because there simply aren't so many women. In my semester, I think there are just three." [female, mathematics education].

"At the beginning I worked more with men, later with women. It just worked out that way. Now I'm working with a guy again. So at the beginning, more with men,... then there was group with women only, with me...and four women, and recently I was in a group that was mixed: one woman and three men." [male, econometrics].

The large majority of the interviewed students (18 of 24) described the relationship between women and men students as good to very good, and even more women did so than men (10 to 8). Most of the students did not see any problem or even signs of a "struggle among the sexes". The relationships were mainly characterized as "normal" and "relaxed", or "equal". Or it was said that "they understand each other and work well together." Three students (2 men, 1 woman) viewed the relationship as ambivalent: "sometimes one way, sometimes another." Only 2 students (1 man and 1 woman) were critical of the relationship, but they either explained this in connection with the "special position" of women, which shall be explained, or with the tendency of women to "encapsulate themselves in their own group". This initial largely positive reaction, of course, stands in clear contradiction to the quantitative results. Because it is to be viewed as relatively improbable, especially in the interview groups, that the experience between the male and female students is nearly exclusively "good", the students were again asked if they had themselves heard, or heard of, "denials of [women's] competence of the subject" or "derogatory remarks" about women's lack of competence in the subject. Half of the group denied having heard of such incidents; six students (4 men, 2 women) said they hadn't heard such remarks themselves, but they had heard about them; and five of them (3 women, 2 men) could remember hearing "something like that". It is striking that the students – for one reason or another – did not (want to) perceive these experiences as discriminatory, but that they, for example, redefined them as jokes, or relativized or excused them in some other way. This applies, as the following quotes show, for women and for men:

"OK,... now and then there was some remark, but nothing really problematic.... That was virtually always really understood as a joke – that is, if women were even there." [male, abstract math].

"...I never really heard derogatory remarks. Maybe at one time or another somebody doesn't think that you can handle it. But, then, it's possible to disprove that by convincing the person that you really are somehow qualified...." [female, econometrics].

"No – if, then as a joke, nothing that was meant to be taken seriously.... So, I don't take it personally. I don't know, maybe I only always thought that it was meant as a joke, but it was serious. That could be. But it never struck me as negative." [female, econometrics].

"About the derogatory comments,... sometimes it comes up. But that is, well, I know this sounds shitty, but it's not serious, but it's just meant as a joke or something." [male, econometrics].

In the interviews, a further aspect related to this was evident, indicating that the relationship between the male and female students may not be as completely "good" as the majority of the students think or would like to think. The extent to which these were isolated events is undecided. In any case: some of the

women's answers to the questions as to how they would explain the quantitative results – that the men considerably more often think that women's tests are (unfairly) graded higher than men's – indicate that they do in fact presume that the male students have "old male prejudices" or "typical views and stereotypes of women", and that these are still obvious in their dealings with one another. Three examples ought to illustrate this:

"...purely intuitively, men do have the tendency to say, 'well, you've got the "girly bonus".' As dumb as that might sound, you hear students say that – right around exam time: 'yea, well, you know, she's a woman.'... Especially around the oral tests...you often hear this expression 'girly bonus'...and if you're good looking, 'Well, be sure to wink at the professor during the tests.' Whether that's true is another matter…. I wouldn't make any rigid generalizations, but there are male mathematics students who do say that, even if they do have grins on their faces." [female, mathematics education].

"Well, the men always make remarks like: 'Yea, if she puts on a short skirt, she'll be sure to get a better grade', and maybe some of them really do believe something like that." [female, mathematics education].

"There are a few people who think that because they are good...they have to let everybody know. And then you do get the feeling that that really is more of a male air,... male bragging –that they have the feeling that they now really want to be admired.... Well, I can imagine that some male students think that a man tends to be better at mathematics than a woman, and if a woman then gets good grades, they try to somehow make her look bad." [female, econometrics}.

The majority of those interviewed (14 of 24) – and both men and women (7 to 7) – also described the relationship between the students and the instructors as good to very good. Most of the students did not see any problems at all; they characterized the instructors as fair and willing to help. They denied that there was any form of unequal treatment between men and women and described the relationship as "relaxed" and "cooperative". Six students (3 men, 3 women) held the relationship to be ambivalent, and they justified this saying that "it was largely dependent on the individual person". Only three students (2 men, 1 woman) were critical of the relationship, but they primarily brought this into connection with the "general disinterest of the instructors for the students" or "arrogant behavior". Despite the generally positive assessment of the relationship between the students and the instructors, there appear to be views and stereotypes among the teaching staff that make it possible to conclude that not all male instructors view the sexes as equal and approach women students of mathematics with an attitude free of prejudice. Here, too, this may of course only occur in isolated cases; nevertheless, these are also at least problematic. The following quotes of the students ought to offer an exemplary description of these attitudes, views and patterns of behavior:

"Well, I know that there are instructors who do not have any faith in women's abilities.… I know of one case, when in a test, the comment was made: 'Yea, for a woman it wasn't bad at all. We'll give this one a three instead of a four this time."... But I think that tends to be rare." [male, mathematics education].

"Well, where I have noticed it is with the instructors. I think there are several who think that men have more knowledge of mathematics than women. I think that is really a big problem, because there are still more male instructors than female ones." [female, econometrics].

"...I think, from the way professors act towards women who are employed at the university, you can draw a conclusion about how they act towards female students.... But I would like to be more concrete.... I would point out some people with conservative values, who I have partially noticed or who I could imagine have very chauvinistic views or values, and who are to some extent certainly misogynist, but who have no problem working together with women as long as women do their work very well." [male, mathematics education].

"Oh, once, just as I was starting my studies, when I went to visit the professor...his intentions weren't bad or anything, but in any case, I didn't always feel comfortable enough to go visit him during office hours or make appointments.... Anyway, at some point I asked him when we could have the next appointment or something. And then, well, he said, really dumb: 'Oh God, you poor thing.' I then just looked at him...and didn't say anything. I mean,... no man would probably experience this sort of coddling." [female, abstract math].

Assessment of selected conditions of studies

We also wanted to know how men and women perceive and assess certain teaching conditions. They were asked to evaluate eighteen aspects of university life and of their courses of studies and to assign values from very good (1) to very bad (6). Nine of the selected conditions dealt with more or less "objective" aspects, such as the availability of specialist literature in the library, the breadth of courses or the access to and quality of computer equipment. Strictly speaking, these issues were not a component of our research. Nine further conditions, however, were again targeted to ascertain the level and quality of interaction structures; they will be looked at more closely here in order to allow us to evaluate whether the assessment of women and men students differs in these points. Six of the nine interaction situations were evaluated nearly identically among the two groups, like the possibilities for contacting the teaching staff (Median for women 2.19; for men 2.18), or the commitment of the teaching staff (median for women 2.61; for men 2.44). Nevertheless, we find the following statistically significant differences: women are more critical than their male colleagues of the possibility students have to participate in the planning and carrying out of courses (median for women 4.37; for men 3.66). This could be an indication that male students are more integrated into the faculty and that their incorporation into the discipline or into the profession is more firmly fixed, while female students of mathematics are still viewed as exotic deviants (see also Engler 1999). A further point dealt with the preparation for future professional

practice. As we saw earlier, students in general are very critical on this point. This is even truer for women than for men (median for women 4.76; for men 4.15). This result can be taken as confirming that women more strongly desire that practical concerns be addressed in their studies. Finally, women are more critical than men about the possibilities for autonomously determining the structure of their studies (median for women 2.98; for men 2.38).

5.6 Mental (re)production of mathematics as discipline and of the university as an organization

It will now be interesting to examine the extent to which the processes so far revealed are accompanied by mental or cognitive inequalities that hinder women from openly expressing themselves in this subject area. We formulated six questions concerning attitudes to and perceptions of the relationships between women and men and mathematics, and with regard to the individuals' self-perception and the perception of the achievement [of women] in mathematics by others. Finally, we asked the women only what problems they expected to encounter in the future as women in mathematics.

Attitudes about women and mathematics

In order to illuminate existent prejudices or gender stereotypical assignments of attitudes about women and mathematics, participants were confronted with ten statements that consisted, in the main, of everyday life views of the persisting imbalance in the number of men and women interested in studying mathematics. They were asked to assess all the statements and mark them with "fully agree", "more or less agree", "more or less disagree" or "do not agree at all" (see Table 11). The statistical analysis shows that latent gender stereotypes persist above all in the minds of young men. To a statistically significant higher degree than their female colleagues, they believe that women are not very interested in mathematics and that women are more interested in languages, that men in general are more talented in mathematics, that women do not want to study a subject where they are a minority and that women have a lower aptitude for analytical thinking (see Figure 7).

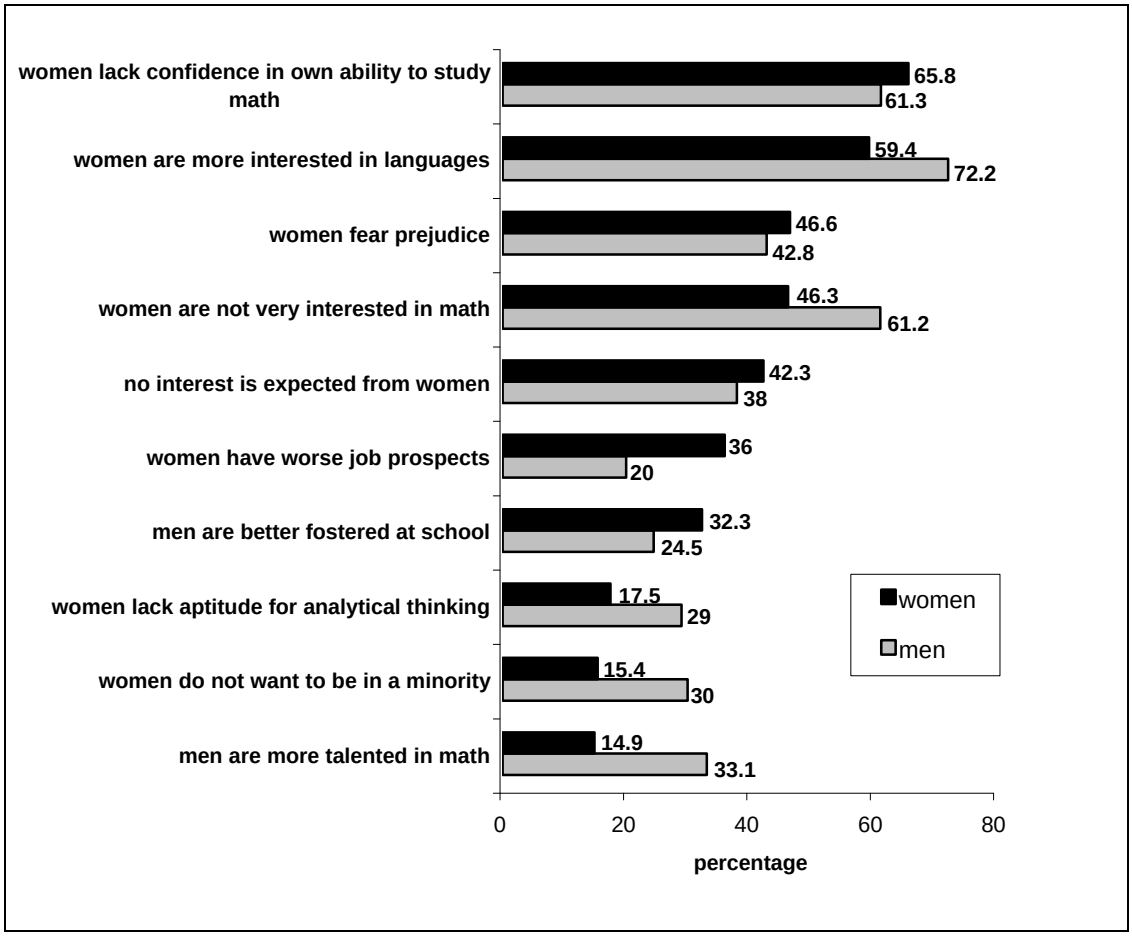

Figure 7: More men than women study mathematics. Why is this so? (gender ratio; those who answered "fully agree" and "more or less agree" in %)

The reasons for most of these differences are still attributed to female personality rather than structural or cultural barriers. There is only one statement where the agreement of women is significantly higher, namely that women have worse job prospects than men – a finding that is coherent with the results referred to above. It is not for the good job opportunities that women choose this subject. This is most true for women studying econometrics, followed by those preparing for a teaching career (somewhat surprisingly) and women studying abstract mathematics.

Mathematics – still a man's domain?

The issue areas "men, women and mathematics" and "mathematics as a man's domain" were given special emphasis in the qualitative interviews. Here too, it proved to be advantageous that the qualitative interviews were conducted after

the quantitative investigation. Because of that, it was possible, for one thing, to integrate important thematic facets into the conversation from the theoretical presuppositions acquired from the quantitative study. For another, it was possible to specify certain facets or thematize them differently. These were facets that once again demonstrate the limits of a standardized investigative model – namely, facets that transcend "questions of attitudes" and move into the area of one's experiences and perceptions. So, on the one hand, students were confronted with the quantitative results regarding the question of why men still study mathematics more often than women, a question where a significant difference between the answers of men and women was apparent. On the other hand, the students were asked whether mathematics is still a man's domain, as was long maintained, and how they perceive this in their everyday experience.

In respect to the question of why more men study mathematics than women, the quantitative results showed that students are still "haunted" by numerous prejudices or views of gender stereotypes. That is primarily evident in the fact that males, with a significantly higher frequency than females, subscribed to the views that men were generally more talented in mathematics, that women are not inclined towards analytic thinking, and that women are not as interested in math, but are more interested in languages. When the students were confronted with these results in the interviews, and were asked to assess or explain the statements, it was interesting to note the following: The majority of male students (9 to 3) at least partially agreed with these results and thus confirmed or reproduced the views and stereotypes that underlie these results. The majority of female students, by contrast (8 to 2), were initially fairly surprised about the results, and rejected the stereotypes connected with them by attempting to find other explanations for these facts or attitudes. Select quotes ought to illustrate these reactions and attitudes, first of men, then of women:

"Yea, I do find...that guys are more interested in mathematics, that maybe also they're a little more talented.... But like I said, well, in the study of mathematics I don't have any prejudices against my women – oh...against women in my studies.… OK, I maybe justify my prejudices by saying, guys have a greater interest in math, and maybe they tend more towards logical thinking. But as soon as – well, if a girl enrolls in math, the differences disappear.... They can be just as good, or girls can even be better. I don't think that there's a difference any more." [male, econometrics].

"Yea, there are certainly some stereotypes. Well, I don't know how deep seated that is or how concrete the stereotypes are, but I think that this isn't just the case at the university. But it is also related to how women are perceived in general, at grade school. If there are lessons in handcrafts, that then is the domain for women, and they have got to be very good,... whereas, if there is an elementary science lesson, the boys are questioned. So, by doing this, in grade school certain views of gender are promoted, and they just stick in your head." [male, mathematics education].

"Hasn't that been proven in some ways, that men, generally speaking, are a bit more skilled than women in these analytic matters, and women in the creative, communicative and so on?... I don't know, but, even if it's minimal,... you hear it at some point and think: Men are just better in math, in physics and the like.... It's clear. If they are differently disposed genetically, then they ought to study that, and women ought to study languages. I could imagine that that somehow sticks. And...if the difference is even minimal, it then just somehow gets exaggerated." [male, abstract math].

"I tend to think that that isn't the case. I think that this ability for analytical thinking is the same from the outset. It's just that the interests differ – that girls, or women, that they don't make demands on themselves in these matters, because maybe they're not so interested. But that they can surely think as mathematically – I certainly believe that. And the ability to think logically and to abstract, that is an ability that really must be encouraged – which is strongly dependent on how it is encouraged, and that maybe it isn't [encouraged] as much in girls." [female, mathematics education].

"The male perspective is definitely very strongly based on the societal view.… So, I find it extremely difficult to explain that...this societal view, what underlies it, that women are better at languages and aren't disposed towards analytical thinking as much and so on. That is really everything that you know from the general discussion, which then comes up again and again, in some newspapers and articles." [female, mathematics education].

"I don't think any woman would say I'm not as good at analytical thinking, and that's why I don't study mathematics. It's clear that it's men who say that.... Yea, I've heard it, of course. But I think it's nonsense.... There are of course women who can do that as good or better than men. And I think there are men who have no understanding of mathematics at all, but are then good at languages.... There are always different sorts. I, of course, don't know whether you can say generally that women are more interested in languages and men more interested in the natural sciences. But I think it is, of course, based on people's upbringings. For, like I said, the boys are still given an encyclopedia or a telescope, and people try to set them off in the direction of the natural sciences, and girls tend to get dolls and similar crap." [female, econometrics].

"I think that the interests are the reason that men are more interested in mathematics than women. I think, maybe it's also partially due to the fact that the interests tend to be roused in men more. I don't know, maybe by the teachers, and so on, but I can't explain it exactly.… I would deny from the outset that women are not as capable of analytic thinking and have less talent in this area. Because in my class and others that I know, women always had better grades in mathematics than men.... And the interest, I think you get that partially from home. That mathematics and technical understanding still tends to be classified as for boys – I think that is still a big problem." [female, econometrics].

Do the students of mathematics still see mathematics as a man's domain, and if so, what do they base this characterization on? The answers that the students gave in the interviews show several dimensions of perception. First, it is to be kept in mind that only three students categorically rejected the description of mathematics as a man's domain. They indicated that this perhaps used to be the case, but that today many women successfully study mathematics. Also,

whereas the ratio of women in abstract mathematics is lower than men, in the other areas of math, there was nearly a balance in the ratio of men and women.

Three female students and two male students, by contrast, were of the view that mathematics remains a man's domain. The rising percentage of women studying mathematics has done nothing to change this. To support this assessment, they indicate, for example, that publications are still nearly all from men – precisely because there were no women mathematicians. In addition, while more women than ever now begin studies in mathematics, they still break off their studies more often or change majors, so that in the upper semesters, there are hardly any women to be found. And, of course, at the higher status level of the university, as well as in the business world, there are hardly any women mathematicians to be found.

The majority of the students, seven men and nine women, find that today mathematics must still be viewed, at least partially, as a man's domain. This characterization is not just based on the "abstract" numerical relation between men and women in mathematics, but also on the related views or stereotypes of women in mathematics or the reification and tendency for exclusion of the male majority, which has preserved the power to define the issues. Nevertheless, they also perceive more or less clear changes, or tendencies of the field opening up, and they are of the view that the era of mathematics as a man's domain is slowly but surely coming to an end. The following quotes ought to illustrate this:

"If you look at the instructors, yea. But among the students, I would say, there it looks like this is no longer the case, because there are now just a lot more women who do this.... So I think that probably the fact that there are now more students of mathematics, more women students, the next generation will be taught completely differently,... no longer with these old prejudices. And because of that, the views of the next generation of students will be different." [female, econometrics].

"I think so, yea.... I mean, you see that just by looking at the university – that there are hardly any women.... There are now female assistants or lecturers, but they tend to be young women.... So I think that it is slowly changing...that more women study, that more women, then also continue. So, I think there is a little bit of a transition process. But at the moment, I would still say that it's a man's domain." [female, econometrics].

"Looking at the numbers, it is simply clear that there are more men there, and that it also probably will be a man's domain.... Given that there are few women, it is something special if a woman is there.... Well, say there are twenty men who have done it, and one woman, and because of that she has a special position.... So, it's not really normal.... I don't know whether there are active people who want to prevent women from being professors. I can't judge that. I can't imagine it, but the numbers seem to indicate it. I think that it's more of a behavioral scheme: as soon as there is minority, people try to exclude them. I think that it's more of a mechanism that catches hold of the group.... Well I think those who are there have to assert themselves much more – even today. But I

also think that this will change. I'm convinced of it. There are just more women, above all, among the students." [male, abstract math].

"I can imagine so. Well, especially when I look at the tradition of the field of mathematics, which professorships there are, [how the staffs] regularly see to it that only a token female is invited for interviews. Well, I have seen that myself – I was...on the commission, which supervised the processes – that a woman was regularly invited as a token, who by chance though did not fit the very precise job description. And so she unfortunately couldn't be hired. And so they simply continue the process, and nothing is said openly.... But such an understanding of course affects the climate of the lectures and seminars.... As I mentioned, if I just take a look at the instructors, definitely. Among the students there are now, for the first time, more women enrolled than men. As a whole, if you look at the faculty, there are clearly more men than women. But the increasing penetration of women in mathematics shows that it is not specifically male." [male, mathematics education].

"Well, it's simply because of the quantitative difference that there are now more men who finish their studies in mathematics than women. At the beginning, it was about balanced...but at the end, it seems to me it's male dominated. But for mathematics education, that's different. And you see this in the professors. You see it, for one, that there are just more male students and that just about all the professors are men. And all the instructors, too. You just notice it a lot. I know only one female professor here." [female, abstract math].

"The percentage of women, especially at the university level, is really really small, and I think that there is still more reservation and more prejudices there than among the students.... But I think that most of them don't speak openly about these reservations. So, on the mathematics faculty there is one woman professor, but she is responsible for didactics. So, for the students of abstract math, there are only male professors. And the instructors are also used to discussing mathematics among men.... It is a creeping process, I think, and it will first really change when there are more women in abstract mathematics and as professors. [male, mathematics education].

At another point in the interview a further issue was addressed, more fitting for our purposes. The students were asked to name two people, who in their opinion had done much for or accomplished much in the history of mathematics. If only men were named here, then the students were explicitly asked whether they could also name a woman. This was meant to indirectly illustrate whether the students were even aware of a woman mathematician of relevant significance and whether, for example, reference is made to them or their work in teaching.

In regard to "famous" mathematicians, it is to be noted: 22 of 24 students were able to spontaneously name individuals who they thought had made excellent contributions to mathematics. One male and one female student each spontaneously named a male mathematician and the female mathematician, Emmy Noether; one female student namely only Emmy Noether. But the majority of the students, men and women, could only spontaneously think of male representatives of their discipline. Nine students were able to think of two male

mathematicians; five could even think of more than two; and another five were able to name at least one. Of these 19 students, nine could not think of a female mathematician, even after we asked them. Surprisingly, seven of these nine were female students. In other words, even women who now are studying mathematics have hardly any knowledge of the role of women in the history of mathematics. When asked, ten students mentioned the name of "generally well-known" female natural scientists, whereby only six clearly named a female mathematician – namely Emmy Noether, and in one case, Harriet Griffin. The other, though, referred to people, such as Marie Curie, who were not mathematicians in a strict sense. Perhaps the most dismal result is that, of all the female mathematicians in the history of math, only Emmy Noether was known and was attributed with being very important for the development of the discipline. In some interviews, it was mentioned that they had heard this name, but they didn't know what she had done, and that the history of mathematics in general, especially that of women's role in math, was a not a subject of their studies. This may certainly be the case. It is only noteworthy that in respect of the historical perspective, mathematics seems to have been clearly perceived as a man's domain.

Assessment of male and female performance in mathematics

A somewhat different picture emerges when men and women are asked about the respective performance of the sexes in mathematics. The majority of men and women (about 70%) see hardly any difference in the performance of men and women in mathematics. The opposite statement, that men are better than women in mathematics, was given by 13.5% of men and 11.4% of women.

Level of satisfaction with and ranking of own performance in mathematics

When asked whether they were satisfied with their own performance in mathematics, most of the participants answered "partially" (53.5% men and 66.2% women). Significantly fewer women (20.3%) than men (36.9%) said they were satisfied with their performance in mathematics, while the situation is reversed in reference to the percentage of "not satisfied" students (women 13.5% and men 9.6%). If we look at the self-ranking of mathematical competencies, differences become more significant (see Figure 8). Male students rank themselves significantly higher than women do.

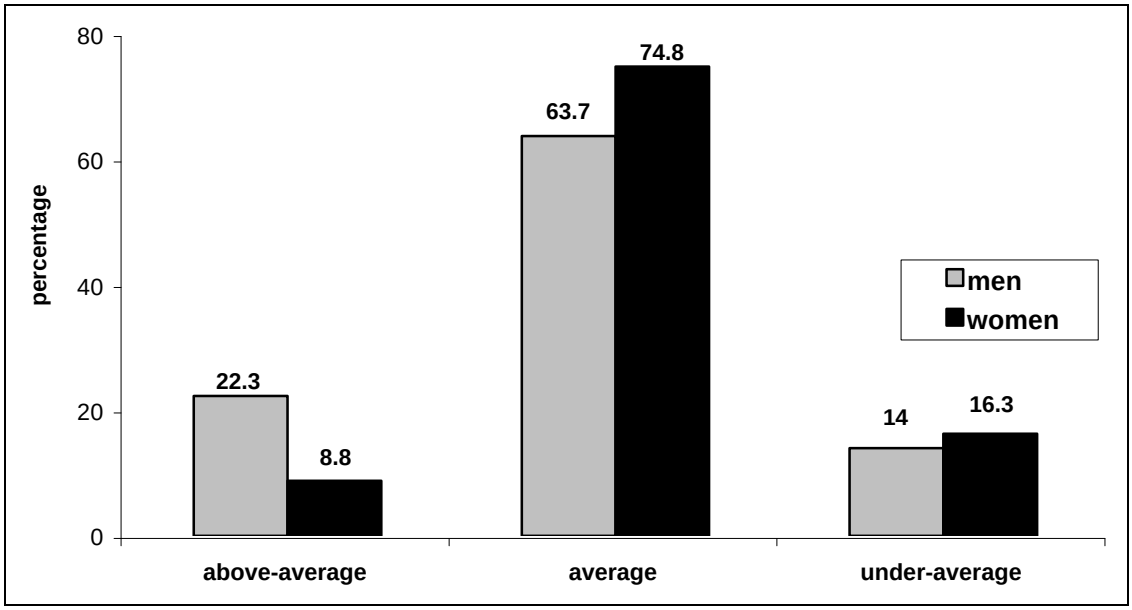

Figure 8: Ranking of own achievement in mathematics (gender ratio in %)

To sum up these results, we could say that the most meaningful differences between men and women are not to be found at the symbolic level and the level of interaction, but at the cognitive level, in the "mental maps" of the students of mathematics. Men still believe that mathematics is not really a "suitable" subject for women; and women rate their own performance significantly worse than men rate theirs. Nevertheless, in general, neither men nor women perceive great differences in the performance levels of women and men. Clearly, women are still confronted with the idea that they have no appropriate place in mathematics, and this may help to explain why they would believe that they will not be very good at it.

Explanation of the gender specific assessment of performance

There was a contradiction evident in the quantitative investigation regarding student performance: on the one hand, both the majority of men and the majority of women were of the view that there was no difference in the performance of the two sexes; on the other hand, women were less satisfied with their performance, and they judged their performance as significantly worse than the men judged their own. In order to try to determine the reason for this contradiction, in the qualitative interviews the students were asked to try explaining this result. Here, it was first confirmed that, based on their own experience, none of the students interviewed were able to determine actual general gender-specific differences in performance. Both sexes explained the fact that women obviously tend to judge their own performance as worse than men's in reference to the

fact that men have a tendency to over-estimate themselves, whereas women have a tendency to under-estimate themselves or "sell themselves under their value"; that women, perhaps because of their minority position, are more self-critical, and that women and men unconsciously internally reproduced views and prejudices about themselves. The following quotations ought to offer an exemplary illustration of this explanatory pattern:

"That would, I guess, fit the prevalent prejudices pretty well. Well, if, for example, the teacher always says anyway: 'Women aren't so good at it', then you believe it in the end. And then maybe you believe later that you're worse, although you're really not worse...." [female, mathematics education].

"Well, I think many women sell themselves below their worth. And men over-estimate themselves more often." [female, econometrics].

"Yea, maybe men are just generally a bit more self-assured. They think: 'Oh, what I'm doing isn't so bad.' And women are a little more reserved or critical." [male, abstract math].

"Well, maybe because women are in the minority, they just tend to presume that they've got a harder standard. And then they're more self-critical." [male, mathematics education].

"I could simply...imagine that this...opinion is so dominant – that men are just better, and that women aren't so good – that men just have more confidence in themselves and think they can do it better, and the women then just tend to be more reserved, because it's so embedded in their minds." [female, abstract math].

"Maybe men tend to over-estimate themselves, so assess their own ability as better than it is. Maybe women just see that more critically." [male, mathematics education].

"I think that its because women tend to hide their light under a bushel basket, and so they say: 'Yea, I'm not so good.' And men tend to be different, so they say: 'Yea, great, I can do that. I'm your guy.' I think that it's just a difference between men and women." [female, econometrics].

5.7 Job opportunities, career chances and problems at the job

Exploring students' expectations concerning their job opportunities after the completion of their studies (see Figure 9), we find significant differences between the sexes.

82% of the male students anticipate good or very good job opportunities, while only 61.1% of the female students do so. If we consider the different courses of study (in theoretical mathematics, econometrics, or mathematics education), we find statistically significant differences among the group of women. Women studying mathematics education believe significantly more often than women studying theoretical mathematics or econometrics that they will have good to very good job opportunities.

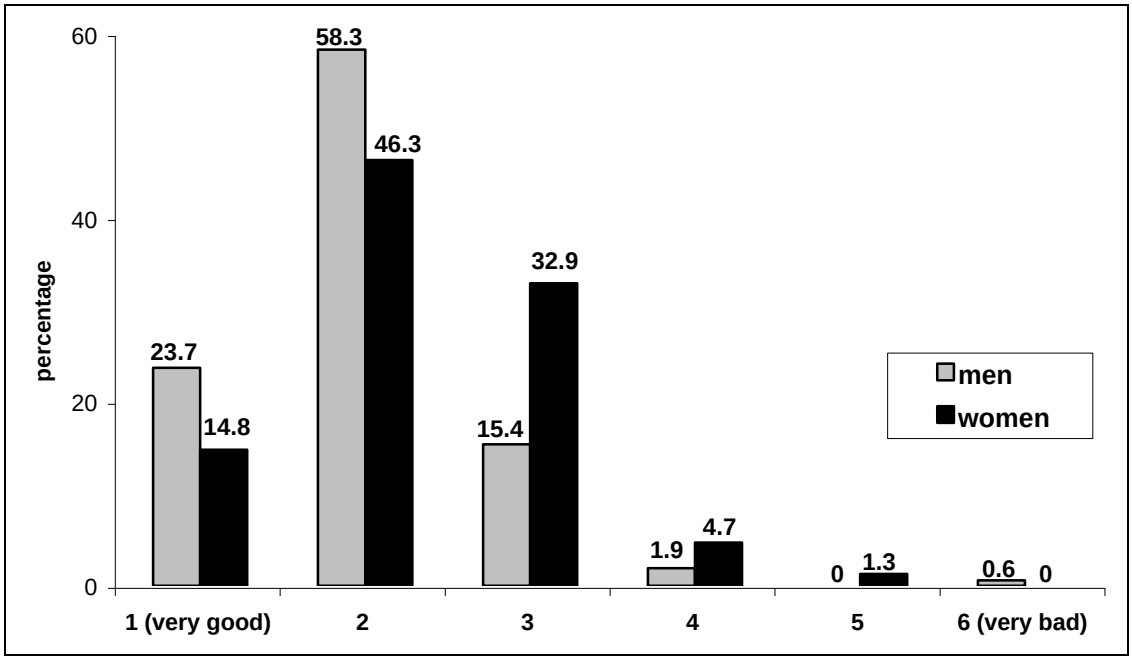

Figure 9: Anticipation of job opportunities (gender ratio in %)

In the qualitative interviews, the issue of the students' assessment of their career chances was once again taken up, and, in pursuing this matter in more detail, the reasons were sought for why they viewed them to be good or not so good. Here, the results known from the quantitative data were confirmed, namely that the majority of the mathematics students (19 of 24) judged their career chances to be good to very good. However, other results from the quantitative study – i.e. that significantly more men than women presume that they have good to very good career chances – could not be confirmed in this group. Among the interviewed students, the relationship among women and men was virtually the same: nine women and ten men viewed their career chances as good; only two students viewed them as not so good (one man and one woman). And two women viewed their career chances as ambivalent. In contrast to the quantitative results, here no great difference was evident in the group of women. The nine women who viewed their career chances as good were spread out evenly among the majors, with three in each of the three major areas of concentration in mathematics. The econometrics students obviously tended to be more skeptical about their career chances than their classmates majoring in the other areas. Two of the three women who viewed their career chances as not so good or as ambivalent studied econometrics. The following quotes ought to provide a general idea of the students' assessments of their career chances and show the reasons for these assessments:

“Well, since I started my studies, my views about the chances have increased. Since I have seen that I’ve now gotten the highest notes on my tests and that I got straight A’s on everything and that I really know how to handle the material, I think that I really do have realistic chances to do what I set out to do. That doesn’t mean that it will work out, but I think … I certainly have a chance to do something at the university. Whether I will become a professor or something is another question, but to research or teach somewhere.” [male, theoretical mathematics].

“I think that as a mathematician … you can make pretty good money. And that I can … also get a position where I can make certain decisions and I somehow plan that or something. But whether that is in my area of focus or the area that I am working in, whether its what interests me – I don’t know that yet…. But I think … if you prepare yourself, see what jobs there are – you can certainly find something interesting that you are later happy with….”[female, theoretical mathematics].

“The job market looks relatively good for mathematics teachers, at least for a few years still. So I think my chances are pretty good.” [male, mathematics education].

“Good…. Mathematics is one of the areas where there is a lack of teachers. And so, I’m not worried about it. I think that if you get relatively good grades, then there ought to be good chances, maybe better than in a lot of other careers.” [male, mathematics education].

“I think that my chances aren’t bad as a sports and mathematics teacher, because both of those subjects are pretty much sought after, and especially women…. Especially in math, they’re looking there a bit, at least … at the moment.” [female, mathematics education]

“Yea, I don’t think they’re so great. Well, I imagine that I’ll get a job, I hope so. I’m relatively optimistic about that.” [male, econometrics].

“I don’t think there are a lot of problems there, and I think that mathematical economists have partially better chances than business students, for example. Because there are just too many of them…. But I think what one problem is … I will be finished in one and a half years. Then I will be 27, and then of course it can be decisive if a man applies with the same qualifications, that he gets precedence because everybody thinks: in two or three years, you’re going to have kids. Then we can look for somebody else.” [female, econometrics].

“Still pretty good. I think they’re not as good as maybe two or three years ago, when … things were better for the banks and insurance companies. But I think that the prospects are pretty good anyway.“ [female, econometrics].

Anticipation of problems as a woman in mathematics

Concerning the anticipation of problems as a woman in mathematics, we had some questions for women only, one of which was the following: "Before you decided to study mathematics, did you foresee any problems that might arise from belonging to a minority?" A second question addressed to the women was "Do you foresee any problems in the labour market after graduation because most mathematically related jobs are still 'male dominated'?" Approximately 90% answered both questions. In answer to the first question, 75% of the women said they had not foreseen any problems; nor had they encountered any to date. 15.5% said they had expected problems but not encountered any so far. 5.4% said they had expected problems and encountered them; while 4.1% said they had not expected to encounter certain problems that they had in fact encountered. Some of the problems cited by the young women fit into the following categories: "as a woman you always have to be better than a man to get the same recognition", or "the professor regards those who do mathematics education and, even more, women in the courses of mathematics education, as inferior". Other problems that cropped up were related to the fact that there are fewer women studying mathematics or that women appear less motivated because of a perceived lack of relevance to the task of teaching in the future.

The assumption, deduced from the results so far, that women studying mathematics education would have expected to encounter fewer problems than those studying theoretical mathematics was not confirmed. We did, however, find significant differences regarding the expectations of having problems in the labour market (see Figure 10). 36.1% of all women anticipate partial problems because they are women, and 5.4% anticipate problems. This means that, again, the majority (58.5%) foresees no problems.

Analysing the role of the course of studies, we come to the following, significant conclusion (see Figure 10): mainly those women who intend to become teachers do not anticipate that being a woman will pose problems in the labour market (78.9%). This means they do not foresee problems in becoming a teacher because many teachers of mathematics are women. It has become normal for women to choose careers as mathematics teachers. A further consideration is that schools nowadays deliberately seek out female teachers of mathematics, which means that gender has become an area of positive discrimination as far as women are concerned. By contrast, due to the prejudices of male colleagues or superiors, and due to worse career opportunities for women in the professional fields where men are in the majority, women studying econometrics anticipate problems; those studying theoretical mathematics anticipate somewhat fewer problems than those studying econometrics. Finally, they indicate that reconciling family and work could become a serious problem for them.

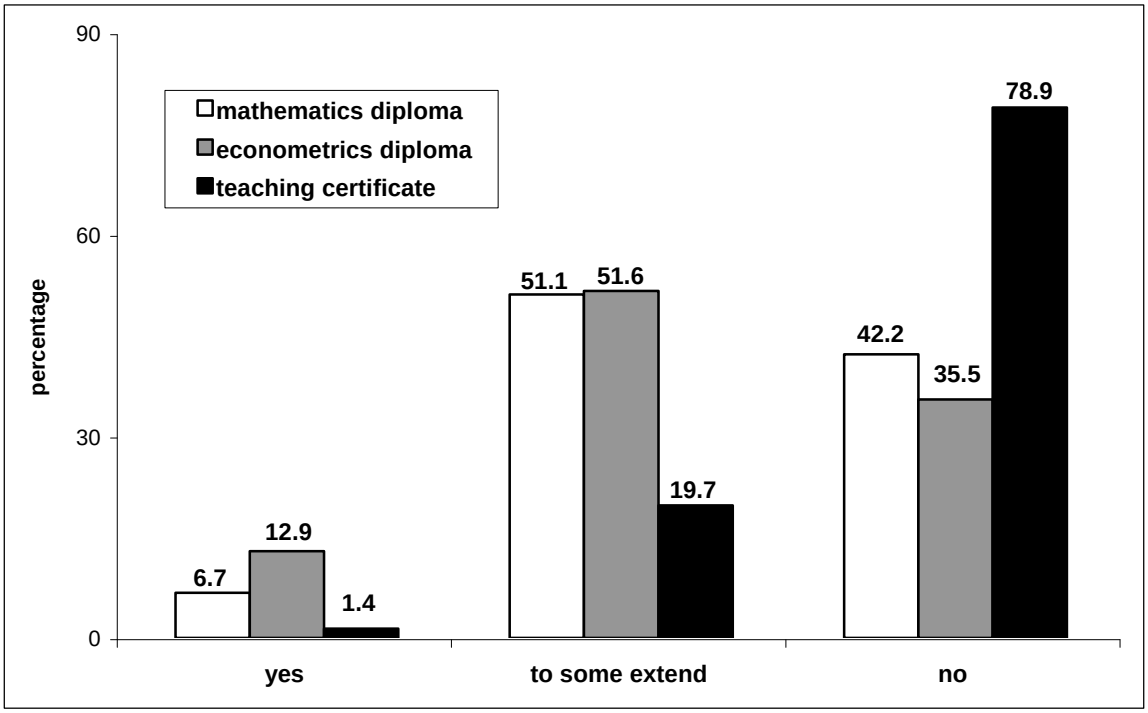

Figure 10: Anticipation of problems as a woman in the mathematics labour market (Differences according to courses of study in %)

5.8 Professional and career orientation

To learn something about the general career orientation of the interviewees, as a "starting question", the students were first presented with 11 characteristics or aspects of employment. They were then to specify how important these aspects were for them on a four-level scale ("very important", "rather important", "less important", "not at all important") (see Figure 11 and Table 12).

Regarding the question of the possible gender-specific differences in the assessment of the importance of aspects or characteristics of employment, there was a very interesting result: There was no difference along gender lines for seven of the 11 specifications; for four of them, however, a very significant difference was evident regarding the importance and thus the career orientation or the views about employment. Diversification in the job tasks was significantly more important for women than for men. The compatibility of a family and a career also still played a significantly larger role for women than for men; it was also rated as significantly more important by female students than by their male classmates. By contrast, for male students, the possibility for job advancement and for a high salary was significantly more important than for the female students. Even if there was little difference along gender lines in the assessment of the importance of most of the aspects of employment presented, those significant differences that are evident demonstrate "classical" gender roles and gender stereotypes.

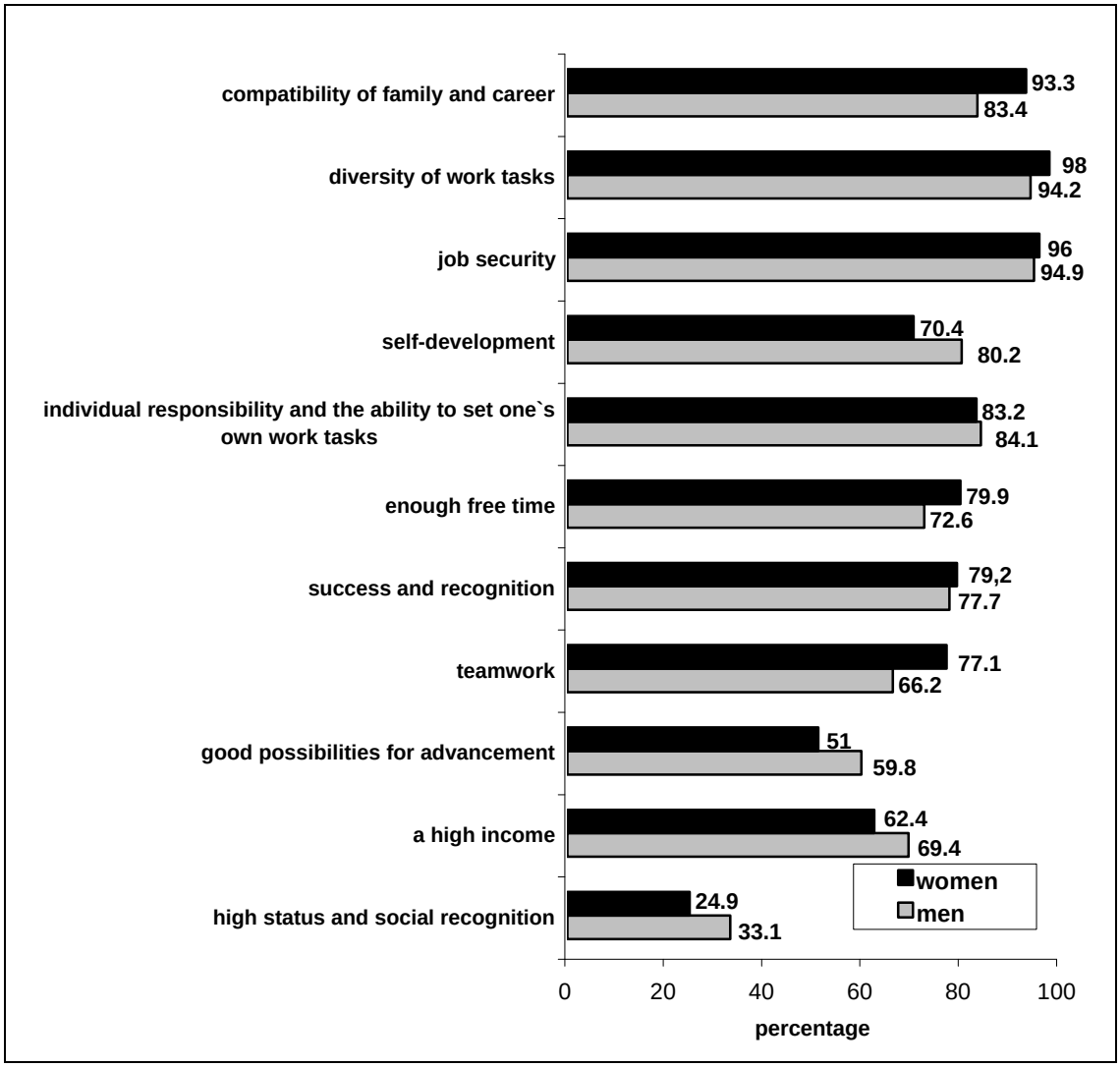

Figure 11: Importance of aspects of the job (gender ratio; those who answered “very important“ and “rather important” in %)

Two question of the quantitative investigation aimed to make it possible to draw some conclusions about the students’ career orientation. On the one hand, they were asked quite generally about “their career desires”; on the other hand, about their willingness to make compromises to achieve these desires.

As an answer to the general question of their career desires, the students were to indicate whether they wanted to pursue a career at all costs, or whether they would try to pursue one at least, but perhaps not do so should it conflict with other desires – i.e. whether their priorities lie elsewhere. Alternatively, the interviewees were able to indicate that they do not yet know. The results show that regarding their career desires and thus regarding their general career orientation, men and women do not differ significantly. A fifth of the women (20.3%) and more than a fourth of the men (29%) definitely want to pursue a career.

Somewhat more than half of the women (54.7%) and two-fifths of the men (43%) want to at least take the initial steps towards pursuing a career.

But to desire a career and to “actively” work to achieve one are possibly two different things. Because certain priorities have to be established at certain times in order to achieve one’s career plans, the students were later asked how willing they would be to make certain sacrifices for their career development and career. For this, 13 points were listed. The interviewees were to indicate on a four-level scale their willingness to accept the noted consequences (“willing at all costs”, “generally willing”, “not so willing” and “not willing at all”).

For 12 of the 13 points no significant difference was evident. For their careers, the male and female students questioned here were willing (or unwilling) to nearly the same degree to make sacrifices in their private life or in their careers: This spanned issues of (at least in part) having less time for themselves, less time for their friends, less time for their partners, less time for their families, less time for their hobbies. It also included their readiness for conflict with their partners, for a move to another city, for greater mobility in general, for work on the weekends, for abstaining from having children or, by contrast, for a lower salary. Women only significantly varied from men in their lack of willingness to accept high competitive pressure (see Table 13).

Family orientation/compatibility of family and career

On the basis of the results concerning the professional and career orientation of the students presented thus far, it is clear that hardly any significant differences between men and women are (now) to be found. This applies to the general view about employment, to their career desires, and obviously also to their willingness to make certain efforts or to set priorities for their careers. These results are, however, at least relativized if one considers the flipside of the coin – namely, family planning. In reference to the importance of certain aspects of employment, the only significant difference in the assessment of men and women was shown to concern the issue of the compatibility of family and career: women still view this as considerably more important than men do.

The vast majority of the students questioned want to have a family with children. Just under 10% denied wanting to have children, 15% were not sure about this. For three-fourths of those questioned – women and men (75% each) – establishing a family seems to be constitutive of the desirable lifestyle model. The succeeding question then was how career and family is thus to be combined, given such prospects. In order to be able to elucidate this issue, which was pursued in more detail in the qualitative interviews, the quantitative inquiry already

asked the students what they thought the ideal family model or partnership model would look like.

Here, the following was indicated: The male and female students questioned here showed hardly any difference in their views about what an ideal family or partnership model should look like. A good third of the men and women have the “traditional” (german) model in mind – that they have children and that one person works full-time and the other part-time or only as much as is possible given the family work and childcare (“bread-winner-model”). For a little more than a third of the interviewees, in their ideal model, both people work full-time, and they take care of their children jointly. The model in which both partners work part-time in order to have enough time for their children and their partnership was only preferred by one-fifth of the women and about one-fourth of the men – which is an interesting result! A minority wanted a partnership, but without children (see Figure 12).

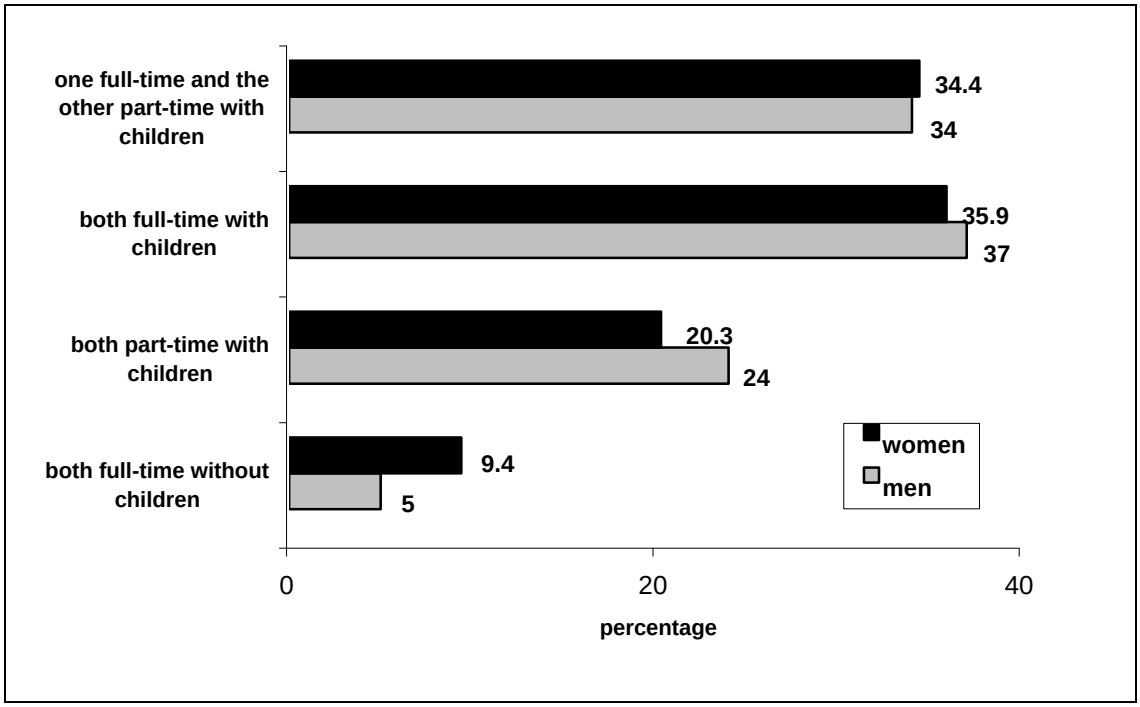

Figure 12: Ideal family model (gender ratio in %)

If those interviewees who prefer the “traditional” family model (namely, in which they have children, and one person works full-time, whereas the other works part-time or as much as is possible given the family work and childcare) are now asked which partner is then to work less, there are significant differences in the answers of men and women. 42.9% of the women, but only 5.9% of the men, indicated that they would work fewer hours in such a scenario. By con-

trast, 47.1% of the men and 19.0% of the women said that their partner ought to work less. 47.1% of the men and 38.1% of the women did not know who should do this.

These results point out that, despite that men and women have nearly the same professional and career orientation, for at least a not inconsiderable percentage of the interviewees, when a family is established, the “traditional” gender roles “break through”, and the women then once again tend to orientate themselves towards the family.

6. Conclusions

Following Acker (1992), in this paper we have assumed that both universities and scientific disciplines are gendered, and consequently that structural, symbolic interaction and mental processes of “doing gender” effect processes that reproduce gender imbalances – also in mathematics. From the hypothesis above, we deduced the following question: What happens if, one or more elements of this “vicious circle” change? In german academia there have been changes at the structural level in the field of mathematics, i.e. an increasing percentage of female students. Has this process been accompanied by processes of de-gendering at the level of symbolic interaction and the mental level as well? If so, we might expect that differences between both gender groups would diminish, and – where still existing – will no longer be statistically significant.

We tried to answer this question, to test this hypothesis, with two studies (a standardized questionnaire among students of mathematics followed by an in-depth survey among the same group). Here are the results:

1. At the undergraduate level, in Germany it has become increasingly common for women to study mathematics. This does not mean, however, that Acker's "vicious circle" of the (re)production of gender imbalance has been broken. Nevertheless, there do seem to be some small cracks in the system. Women and men share similar views about how good their performance in mathematics was in their early schooling, and they have developed an affinity for mathematics for quite similar reasons. Young women students of mathematics show a broader variety of secondary interests than the male students. When it comes to explaining why the students decided to study math, one thing is clear: To a significantly higher degree than men, women chose mathematics because of a preferred choice of a concrete profession. Here we already find some initial evidence of a seemingly systematic difference between men and women. *Much more often than men, women study mathematics with a view to becoming school teachers and with a view to combining mathematics with disciplines outside of the natural sciences*. As a consequence, female students think that mathematics, as it is taught at the university, is too "narrowly" focused. These impressions are distinctly confirmed in the interviews.

2. *Regarding the symbolic level, it can be concluded that, in the german university system, men are more closely linked into theoretical mathematics than women, and, to a significantly higher degree than women, men follow the classical path of mathematics as a basic discipline, with applications in technology*

or engineering. Asked about the reasons for their interest in mathematics, men – to a much higher degree than women – stressed the importance of the intellectual challenge of this subject, its aesthetical structure and its vitality. In the qualitative interviews, men and women expressed about the same degree of fascination for their chosen subject – and for the same reasons. Concerning the fields of application in mathematics, women are more interested than men in mathematics as a school subject, in medicine and biology, in psychology and sociology, whereas men are more interested in the classical fields, such as physics and astronomy, or technology and engineering. Students from the different areas of mathematics had different interests and were interested in different areas of application. When asked if they could offer possible reasons for these differences, both gender groups offered similar arguments: They both noted that different courses of study would - quite obviously – cause different interests in the areas of application. They thought, however, that there would probably be no difference in people's interests based on gender, but that if one did exist, it would stem from socialization processes, mainly at the school. A few individuals thought such a difference might be based in biological differences. *Given all those findings, it is not surprising that women attempt to integrate into a faculty with a higher proportion of women.*

3. At the interaction level, men and women do not feel that they are subject to different performative expectations. Nevertheless, to a significantly higher degree than women, the men students thought that women got better marks than men because of their gender (i.e. that there was “positive discrimination towards women”); and women had experienced situations in which male students had deemed women as less competent in mathematics than themselves (i.e. the ”negative discrimination towards women”). One important finding might be summed up as follows*. Already as students, men are much more integrated into the discipline of mathematics than women are.* In their everyday experiences of studying mathematics at university, men feel more integrated than women do. Gender differences are marked in a few areas: one concerns course participation. Men believe significantly more than women that they can take an active part in class more than women. *Women, and even more women in mathematics education, experience discrimination by their professors.* A further difference concerns the preparation for professional careers. Women are much more critical about this issue than men are. In the interviews, initially both gender groups argued there was no serious discrimination against women by male students, and that if there were derogatory or discriminatory comments, these were meant to be understood as jokes. Nevertheless, when asked more concretely, women indicated that their male colleagues still held many negative stereotypes

about women. Both gender groups indicated that they had experienced discrimination against women by the faculty.

4. The most enduring gender stereotypes are to be found at the cognitive level, above all, among the male students and faculty. *The main reasons provided about why more men than women enter mathematics are related to long-standing social assumptions: assumptions that men are more talented at mathematics, that women have no aptitude for logical thinking, or that women are more interested in languages than in mathematics.* All these assumptions were formulated by men much more often than by women. Yet, no differences along gender lines could be found in the performance level of men and women. Women did, however, rank themselves significantly lower than men rank themselves. In the interviews two main reasons were offered for this: that men are more self-assured; and that women somehow tend to hide their aptitudes.

5. Concerning the students' views about their job prospects and about future problems that the women might confront in mathematics-related professions, we find the following: In contrast to women, men anticipate good to very good job opportunities. Among the women interviewed, students of mathematics education are much more optimistic about their job opportunities than their colleagues from other fields of math. When it comes to the anticipation of problems that women may have in mathematics, we find no differences along gender lines, but, again, women from different areas of mathematics did express different views here. *Female students who are studying mathematics education are much more optimistic about evading such problems than those studying theoretical mathematics or econometrics.*

6. *Men an women in mathematics show quite high interest in a career, with only slight differences between the gender groups*. Each fifth woman and each fourth man are interested to make a career. *But men and women show differences in relation to the reconciliation of family and employment (or a career).* Whereas only a few men expressed a willingness to reduce their workload after becoming a father, more than 40% of the women indicated that they would do that.

In summary, we have to conclude that our initial hypothesis is wrong. The imbalance in mathematics has not disappeared. Remarkable gender differences still reproduce the “vicious circle” of inequality in the field of mathematics. While they are no longer a numeric minority, female students of mathematics are still

discriminated against by male students and the (almost exclusively male) faculty. These acts of discrimination are rarely openly formulated, but they can be deduced from male and female answers to certain questions. When asked if they have experienced problems during their studies stemming from the fact that they are women, most of the women said they had not, even though they had! They do not have the same feeling as the male students that they belong to the faculty; and they feel that the studies are less consistent with their own needs. In the coming years we will see whether more young women will choose to enter mathematics and pursue mathematical careers. In any case, however, as long as gender differences exist in society in general, it will be difficult to reduce them in this male-dominated discipline and in the male-dominated organization that is the german university.

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Appendix: Tables

favorite subject	women (in %)	men (in %)
mathematics	60.4	67.5
natural sciences	12.1	9.6
sports	4.7	7.0
languagues	13.4	10.2
religion/art	9.4	5.7

2nd favorite subject	women (in %)	men (in %)
mathematics	22.8	15.4
natural sciences	20.7	37.8
sports	6.9	18.6
languagues	37.2	23.1
religion/art	12.4	5.1

Table 1: Favorite subjects in school

abitur mark in mathematics	women (in %)	men (in %)
1.0 – 1.9	46.1	49.5
2.0 – 2.9	48.3	37.3
3.0 – 3.9	5.5	13.2

Table 2: Abitur mark in mathematics

reasons	women (in %)					men (in %)				
	very important	important	less important	not at all important	does not apply	very important	important	less important	not at all important	does not apply
aptitude/talent	62.8	32.1	4.4	0.0	0.0	56.6	38.6	4.8	0.7	0.0
interest in maths	27.2	52.9	15.4	2.2	2.2	26.9	55.2	14.5	2.1	1.4
good marks	27.9	45.6	16.2	6.6	3.7	19.4	45.1	25.7	4.9	4.9
good job prospects	19.1	47.1	23.5	10.3	0.0	19.4	43.1	27.8	6.9	2.8
preferred choice of profession	25.5	29.9	21.2	19.0	4.4	19.3	17.9	30.3	20.0	12.4
curiosity	9.5	40.9	32.8	13.9	2.9	13.9	40.3	22.2	13.9	9.7
self-fulfilment	11.8	38.2	31.6	14.0	4.4	13.8	37.2	33.8	11.0	4.1
variety of job possibilities	11.0	35.3	27.2	17.6	8.8	16.0	34.0	22.2	19.4	8.3
career opportunities	7.3	25.5	29.9	26.3	10.9	11.8	27.8	29.2	24.3	6.9
didn’t know what else to do	7.3	16.1	24.1	27.0	25.5	5.5	16.6	24.1	29.7	24.1
family reasons	0.7	7.4	16.9	54.4	20.6	0.7	3.4	14.5	55.2	26.2
parents or relatives work in similar areas	2.2	10.2	10.9	37.2	39.4	1.4	7.6	6.9	33.3	50.7
friends study mathematics	0.0	3.6	4.4	39.4	52.6	1.4	4.9	9.0	33.3	51.4
it wasn’t possible to study in my desired area of concentration	2.9	1.5	2.9	14.6	78.1	1.4	2.1	4.9	16.0	75.7

Table 3: Reasons for choosing a subject area

influence	women (in %)					men (in %)				
	very important	important	less important	not at all important	does not apply	very important	important	less important	not at all important	does not apply
mother	12.1	22.8	26.2	36.9	2.0	2.6	13.5	29.7	52.9	1.3
father	7.4	28.2	26.8	36.2	1.3	4.5	18.1	32.3	43.2	1.9
sister(s)	2.0	8.7	8.7	34.9	45.6	0.6	5.1	8.3	35.7	50.3
brother(s)	2.0	7.4	9.4	41.6	39.6	0.6	6.4	9.0	36.5	47.4
male friend(s)	2.7	14.2	29.7	48.0	5.4	1.9	17.5	26.6	44.8	9.1
female friend(s)	2.7	17.0	31.3	44.9	4.1	1.9	9.0	21.9	52.9	14.2
male partner	5.4	13.5	16.9	28.4	35.8	0.0	0.6	3.9	22.1	73.4
female partner	0.0	0.7	2.8	10.3	86.2	1.3	6.5	12.3	34.4	45.5
male teacher	10.1	26.8	28.2	29.5	5.4	7.1	27.7	25.8	29.7	9.7
female teacher	3.4	16.9	23.0	41.2	15.5	3.2	11.6	21.3	43.2	20.6
women with similar majors	3.4	12.2	9.5	48.3	26.5	0.0	4.5	11.0	45.8	38.7
men with similar majors	0.7	8.8	16.2	47.3	27.0	3.2	9.1	9.7	44.2	33.8
female relatives	0.7	4.1	14.9	71.6	8.8	0.0	1.3	9.0	76.8	12.9
male relatives	1.4	2.0	15.5	69.6	11.5	0.6	1.9	9.0	75.5	12.9
university/career counsellor	2.0	16.2	18.9	46.6	16.2	0.6	10.3	19.4	49.0	20.6

Table 4: People who influenced the choice of a major area of concentration

interesting subject. because	women (in %)				men (in %)			
	very important	important	less important	not at all important	very important	important	less important	not at all important
strictly logical structure	40.1	51.0	8.8	0.0	48.4	42.0	8.9	0.6
clear and unequivocal	37.0	45.9	16.4	0.7	37.6	45.9	15.9	0.6
intellectually challenging	36.2	45.0	14.1	4.7	47.8	42.7	8.3	1.3
many important applications	31.1	50.0	17.6	1.4	35.7	51.6	11.5	1.3
same all over the world	20.3	50.7	25.7	3.4	22.9	41.4	28.0	7.6
value neutral	15.1	38.4	38.4	8.2	20.5	38.5	28.2	12.8
aesthetical satisfying	11.6	21.1	41.5	25.9	19.2	24.4	37.2	19.2
vital, living branch of science	2.7	25.0	50.0	22.3	10.8	30.6	44.6	14.0
optimal combination of science and practice	2.7	23.1	50.3	23.8	4.5	25.5	50.3	19.7

Table 5: Reasons for interest in mathematics

interest in fields of application	women (in %)				men (in %)			
	very deep	deep	weak	very weak	very deep	deep	weak	very weak
physics, astronomy	10.7	23.5	35.6	30.2	19.2	32.7	34.6	13.5
medicine, biology	14.1	23.5	40.9	21.5	6.4	16.6	40.1	36.9
psychology, sociology	8.1	22.3	38.5	31.1	3.2	15.4	31.4	50.0
economics, financial mathematics	18.1	23.5	30.9	27.5	23.7	30.1	26.9	19.2
earth sciences	6.7	32.2	36.2	24.8	3.8	32.1	34.6	29.5
computer science, computer technology	8.8	16.9	43.9	30.4	19.9	34.6	33.3	12.2
engineering technology	12.8	17.4	34.9	34.9	11.7	36.4	38.3	13.6
math as subject of school curriculum	43.6	18.8	15.4	22.1	30.8	12.2	26.9	30.1
math as area of teaching and research	14.1	34.9	34.9	16.1	21.3	31.6	33.5	13.5

Table 6: Interest in fields of application

forms of teaching and learning	women (in %)			men (in %)		
	weight more heavily	remain the same	give less weight	weight more heavily	remain the same	give less weight
lectures	3.4	86.5	10.1	3.8	84.1	12.1
seminars	34.2	59.6	5.5	28.8	66.0	5.1
people from business world and contexts of applied math	74.5	18.6	6.9	56.7	24.2	19.1
Internships outside of the university	69.7	21.4	9.0	49.7	26.8	23.5
interdisciplinary activities	52.8	34.7	12.5	46.1	41.6	12.3
study projects/project work	52.5	25.5	22.0	38.5	39.1	22.4
courses exclusively for women	8.8	16.9	74.3	1.3	8.9	89.8
courses from women lecturers	41.7	36.1	22.2	27.8	45.7	26.5
block courses	24.0	34.2	41.8	19.3	35.3	45.3
research colloquia	34.5	41.0	24.5	32.9	39.6	27.5
international guest lecturers	44.5	39.7	15.8	40.3	39.0	20.8
small group work	44.9	45.6	9.5	36.1	54.8	9.0
tutorials and exercises	35.8	62.8	1.4	28.0	70.1	1.9
seminars oriented towards applications	79.9	13.2	6.9	59.0	23.1	17.9
virtual teaching/learning	30.8	23.3	45.9	27.9	27.3	44.8
self-study/work on one’s own	9.6	65.8	24.7	13.5	71.8	14.7
practical educational activities	60.8	24.5	14.7	41.1	31.1	27.8

Table 7: Evaluation of teaching forms

importance of qualifications	women (in %)				men (in %)			
	very important	important	less important	not at all important	very important	important	less important	not at all important
cognitive abilities	75.5	22.4	2.0	0.0	74.4	25.0	0.6	0.0
motivational abilities	45.3	48.6	5.4	0.7	38.5	53.8	7.1	0.6
social abilities	51.4	38.5	9.5	0.7	29.5	50.6	17.9	1.9
rhetoric and presentation techniques	27.0	48.6	21.6	2.7	14.7	49.4	30.8	5.1
foreign languages	10.8	33.1	48.0	8.1	5.8	33.3	55.1	5.8

Table 8: Importance of qualifications

performative expectations	women (in %)	men (in %)
yes, more is expected of female students	1.4	0.6
yes, less is expected of female students	2.7	4.5
no, there is no difference in the expectations	83.8	89.2
no, but women students put more pressure on themselves	6.1	1.3
no, but male students are more ambitious	2.0	1.9
no, but female students are more ambitious	4.1	2.5

Table 9: Are there different performative expectations for male and female students?

experiences during studies	women (in %)				men (in %)			
	is absolutely the case	is more the case	is less the case	is not at all the case	is absolutely the case	is more the case	is less the case	is not at all the case
contributions from female students are taken less seriously	0.0	6.8	34.0	59.2	0.6	1.9	29.7	67.7
female students get preferential treatment from professors	0.0	6.2	41.1	52.7	2.6	4.5	41.3	51.6
female students get better marks in exams	0.0	4.1	34.5	61.4	2.6	10.5	36.8	50.0
student assistant jobs are more frequently offered to females	0.0	3.5	34.8	61.7	1.3	4.6	35.5	58.6
specialist subject interest evinced by female students is ignored	0.0	4.8	39.3	55.9	0.0	2.0	34.0	64.1
male students consider females to show less subject competence	3.4	24.7	39.7	32.2	0.6	11.7	42.9	44.8
derogatory remarks from male students	0.7	8.2	25.2	66.0	0.0	3.9	29.7	66.5
female students get more assistance from the instructors than males	0.0	3.4	41.1	55.5	2.6	7.2	37.9	52.3
student assistant jobs are more frequently offered to males	2.1	5.6	37.3	54.9	0.0	5.9	30.1	64.1
male students get preferential treatment from professors	0.0	5.5	37.0	57.5	0.0	2.6	30.5	66.9
female students dissociate themselves from their classmates and want to remain among themselves	0.0	2.0	26.5	71.4	0.0	4.5	31.2	64.3
male students get better marks in exams	0.0	1.4	34.9	63.7	0.7	2.6	24.8	71.9
female students hide behind male students	0.0	9.5	33.3	57.1	0.0	6.5	31.8	61.7

Table 10: Situations in studies, experienced by male and female students of mathematics

reasons	women (in %)				men (in %)			
	totally agree	more or less agree	more or less disagree	do not agree at all	totally agree	more or less agree	more or less disagree	do not agree at all
women are not very interested in math	4.7	41.6	37.6	16.1	13.5	47.7	30.3	8.4
men are better fostered at school	12.8	19.5	39.6	28.2	4.5	20.0	41.3	34.2
men are more talented in math	0.7	14.2	29.7	55.4	7.1	26.0	36.4	30.5
women don’t believe themselves to be capable of studying mathematics	12.8	53.0	21.5	12.8	12.9	48.4	30.3	8.4
women do not want to be in a minority	1.3	14.1	49.7	34.9	2.7	27.3	50.7	19.3
women lack aptitude for analytical thinking	0.7	16.8	40.3	42.3	5.3	23.7	45.4	25.7
women are more interested in languages	4.7	54.7	26.4	14.2	14.8	57.4	21.9	5.8
women fear prejudice	11.5	35.1	34.5	18.9	4.5	38.3	41.6	15.6
no interest is expected from women	9.4	32.9	28.9	28.9	7.7	30.3	35.5	26.5
women have worse job prospects	6.1	29.9	46.3	17.7	0.6	19.4	52.3	27.7

Tabelle 11: More men than women study mathematics. Why is this so?

aspects of the career	women (in %)				men (in %)			
	very important	important	less important	not at all important	very important	important	less important	not at all important
job security	53.0	43.0	4.0	0.0	49.0	45.9	4.5	0.6
high income	9.4	53.0	36.2	1.3	20.4	49.0	28.7	1.9
good possibilities for advancement	10.1	40.9	45.0	4.0	17.8	42.0	38.2	1.9
diverse workload	61.1	36.9	2.0	0.0	50.3	43.9	5.7	0.0
teamwork	22.1	55.0	22.1	0.7	19.1	47.1	29.9	3.8
compatibility of family and career	64.4	28.9	5.4	1.3	41.4	42.0	14.0	2.5
self-development	34.2	36.2	26.8	2.7	36.9	43.3	17.2	2.5
personal responsibility	32.2	51.0	16.8	0.0	37.6	46.5	14.6	1.3
success and recognition	24.2	55.0	20.8	0.0	29.9	47.8	20.4	1.9
enough free time	30.9	49.0	20.1	0.0	29.9	42.7	23.6	3.8
social status	3.4	21.5	61.1	14.1	8.9	24.2	52.9	14.0

Table 12: Importance of diverse aspects of a career

Willingness to accept	women (in %)				men (in %)			
	willing at all costs	generally willing	not so willing	not willing at all	willing at all costs	generally willing	not so willing	not willing at all
less time for oneself	10.1	48.3	39.6	2.0	19.7	47.1	28.7	4.5
lower salary	11.5	62.8	22.3	3.4	12.1	51.6	32.5	3.8
health problems	1.3	1.3	26.2	71.1	1.3	5.7	38.2	54.8
high competitive pressure	3.4	25.5	56.4	14.8	5.7	42.0	46.5	5.7
to move to another city	21.5	53.7	19.5	5.4	29.3	51.0	18.5	0.6
less time for hobbies	6.0	53.0	38.3	2.7	13.4	47.8	34.4	4.5
conflicts with partner	1.3	9.4	43.0	46.3	2.5	15.3	44.6	37.6
work on weekends	10.1	46.6	37.2	6.1	17.8	45.9	28.0	8.3
greater mobility	13.4	37.6	40.9	8.1	19.1	37.6	38.2	5.1
less time for friends	0.7	33.1	59.5	6.8	3.2	35.3	54.5	7.1
less time for partner	0.7	10.8	56.1	32.4	2.6	12.8	52.6	32.1
to abstain from having children	5.4	4.7	18.8	71.1	3.9	11.6	30.3	54.2
less time for family	2.0	10.8	47.3	39.9	1.9	12.8	53.8	31.4

Table 13: Willingness to accept making sacrifices

• If we believe in mainstream publications on the history of mathematics, scientific progress in this discipline has been made more or less exclusively by male scientists. Female mathematicians, who existed in all stages of the development of this discipline, are not part of the discipline's self-description: the women in this discipline have been forgotten, labeled as "strangers" or "deviants", or they have been actively excluded. Focusing on the situation today, on first glance, the discipline still seems to be "male", at least in Germany. Less than 5% of all professors in this discipline are female. But, on second glance, we can observe that mathematics seems to be becoming more and more interesting for female students. Are we now participating in a process where gender relations are becoming more equal in mathematics? Are women slowly but surely (re-)gaining a place in this discipline? Or: Do we still identify gender differences – does "doing gender" (still) take place in mathematics? In order to give answers to these questions, the authors conducted a survey among students of mathematics and followed it up with in-depth interviews with students of mathematics in three German universities. The main results of this study are presented in this paper.

ISBN 3-932869-16-8