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RESEARCH

Paths to Career and Success for Women in Science

Findings from International Research

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With a foreword by Prof. Dr. Johanna Wanka,
German Federal Minister of Education and Research

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Foreword

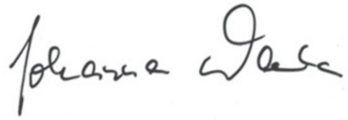
Germany and South Africa have cooperated closely on science and technology for almost 20 years. We have recognized this excellent cooperation and jointly publicized results and perspectives for the future in the course of the German-South African Year of Science. One important topic has been the role of women in science in both countries coupled with the issue of greater gender equality. This topic was discussed in detail at the Women in Science conference held at the Kiel University of Applied Sciences. This volume sets out the results of the conference.

A great deal has been done over the last twenty years to enhance equal opportunities in education and research. Women today have outstanding qualifications and almost half of all doctorates awarded in Germany and South Africa are granted to women. The proportion of women holding professorships has risen continuously over the past ten years, and in Germany their share has even doubled. And yet women in both countries continue to be underrepresented at the very top of the science system.

For this reason, Germany and South Africa have both launched numerous initiatives to enable more women to enter top positions in science. We cannot afford to do without women's talents. Gender equality must be an integral part of education and research policy. In particular, the Programme for Women Professors, which is jointly funded by the Federal Government and the *Länder*, has helped German universities to make a breakthrough in this area, and is making a considerable contribution to developing the profile of German universities.

I very much welcome the fact that these conference proceedings not only present the latest empirical findings about women in science but combine these with discussion of recommendations on the approaches that can be taken by young female scientists. This book is therefore aimed not only at a specialist scientific audience but in particular also at young women scientists in Germany and South Africa.

I would be very happy if many young women made use of these gender research findings to shape their own successful careers in science.



Prof. Dr. Johanna Wanka
Federal Minister of Education and Science

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Introduction

Britta Thege, Silvester Popescu-Willigmann, Roswitha Pioch, and Sabah Badri-Höher[1]

Science and its cultures are generally associated with male efforts, male responsibility and male success. Traditionally, men have always dominated science and determined the frameworks of scientific practice – the questions that are asked and the answers that are given. Despite the fact that there are numerous examples of outstanding women scientists in the past and in the present, whose works and discoveries have advanced knowledge and innovation through the centuries, women in general have been discouraged and dissuaded from science. In both Germany and South Africa, changes in persisting cultures and structures have been achieved only gradually.

Today, a lack of women in top positions in the fields of science and in Science, Engineering and Technology (the so-called SET field) in particular constitutes a significant gender gap. The obstacles women face have been well researched over the last decade. Gender stereotyped notions of femininity and masculinity continue to shape the dynamic organisational processes in the science system, whereas gender inclusive cultures are more of a rhetorical nature than of real practice, thus allowing space for gender discriminating practices to the disadvantage of female scientists. The loss of women's human capital means a significant loss of talents and potential in terms of new ideas and more holistic knowledge production.

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Human capital development was chosen as one of the top themes for the German–South African Year of Science, which took place from April 2012 to April 2013 and included numerous activities. Societies increasingly depend on capacity building, knowledge development and scientific knowledge production. The goal of the equal participation of women in this respect is uncontested, yet unrealised. Gender equality in science is a major challenge for the higher education systems in both countries, South Africa and Germany, which are facing several constraints. Under the auspices of the Year of Science, the Institute for Interdisciplinary Gender Research and Diversity (IGD) of the Kiel University of Applied Sciences and the Institute for Women's and Gender Studies (IWGS) of the University of Pretoria jointly organised a bi-national conference titled Women in Science – Promoting Excellence and Innovation for Future Development. The two institutes have a long-standing partnership dating back to 2001. The collaboration started when the University of Pretoria and the Kiel University of Applied Sciences, financially supported by the German Academic Exchange Service (DAAD), jointly established the Institute for Women's and Gender Studies at the University of Pretoria. Since then the two institutes have cooperated successfully over a period of more than ten years in research projects, seminars, conferences, publications and other project activities.

The conference held in Kiel from 21 – 23 March 2013 was geared to scientists from South Africa and Germany, (post)graduate students and young scientists, and centred on three themes: 'Gendered Cultures in Science & Research'; 'Female Career Paths in Science, Engineering and Technology'; and 'Global, Social & Political Change Research'.

The research presented at the conference looked at specific exclusion mechanisms and career obstacles operating in the German and South African university and research systems. Some of the questions discussed at the conference included the following: How do cultures in science and research produce gender inequality? How do traditional role images and working cultures impact on women's career development in academia? How can sustainable changes be accomplished in established structures and cultures? How and why do female and male careers differ? What are the obstacles and opportunities women encounter in Science, Engineering and Technology (SET)?

This book is the outcome of the conference. The volume is divided into two sections. The first section deals with the question of how cultures in science and research (re)produce gender (in)equality, while the second part considers the career paths of women in science and technology as well as other related topics.

Furthermore, each article in the book includes a final paragraph on ‘lessons to learn‘, suggesting ways in which female scientists can use the study findings presented for their own scientific career development.

Roswitha Pioch opens this book by focusing on the political structures of advanced European welfare states, which provide the framework for women’s labour market participation and, eventually, for women’s professional careers. She suggests a multi-level gender perspective which includes the political and social structures on the macro-level, the science institutions on the meso-level and the individual biographies and careers on the micro-level, in order to understand and analyse both the incentives for and barriers to women’s advancement in the science system.

How do cultures in science and research (re)produce gender (in)equality?

In view of the structural and personnel conditions that prevail, careers in science and research are deemed to be insecure for both women and men. Nevertheless, although their proportion is constantly increasing on all qualification levels, women still reach rarely top positions on the career ladder at universities and research institutions in comparison to men. Hence, the proportion of women in top positions in science is still relatively low or often restricted to the traditionally more ‘feminised‘ subject fields. The underrepresentation of women in top positions is known as the ‘leaky pipeline‘. Three contributions in the volume grapple with this phenomenon.

Heike Kahlert conducted a qualitative study in which 17 male and female professors in two disciplines, Political Science and Chemistry, were interviewed, asking the question of how they explain the ‘leaky pipeline‘ in the higher echelons of German science institutions and academia. In consideration of Acker’s idea of ‘inequality regimes’ in organisations, Kahlert investigates the professional practices of male and female professors in supervising and promoting doctoral students in the transition phase from the dissertation to the postdoc level. Since Kahlert views professors as the ‘gatekeepers’ of their doctoral students when it comes to entry to and advancement in the science system, the analysis of their personal gender concepts as well as their ideas on gender equality are explored.

Tendani Mawela carried out a small qualitative study exploring the journey of South African female academics towards associate and full professorship positions in the SET field. She conducted 12 semi-structured interviews with female academics in Gauteng, probing the issue of why females seem to disappear before they reach the senior academic echelons. Mawela seeks to specifically analyse so-called 'black boxes', that is, ideas that are accepted because this is 'just the way things are'. Seeing black boxes manifested and represented in female academics in senior positions such as associate professors or professors, Mawela's exploration of black boxes focuses on three areas: firstly, respondents' attitudes towards gender diversity in academia, secondly, the desirability of the goal of becoming a professor, and thirdly, perceived barriers and enablers for obtaining professorship. Through the voices of the interviewees Mawela aims at deducing what society as a whole has accepted as the reality of female careers in academia and to identify challenges faced by women in attaining academic success.

Josephine Lühe explores the underrepresentation of women in science and especially in the top positions of science by looking at the science sector as an organisation. Accordingly, she applies established concepts and theories explaining those mechanisms and barriers within the organisations of science that produce and reproduce gender inequalities and, as a consequence, hinder qualified and motivated women from progressing in academia. Such concepts include the important role played by gender stereotypes in social interactions, Kanter's concept of tokenism and Acker's concept of gendered institutions. Exemplarily, Lühe fuses her conceptual accounts firstly by referring to the exclusion of women from (informal) networks of professional contacts. Secondly, she addresses a relatively novel gender differentiating phenomenon, namely, the increasing importance of international mobility, as both a means of gender distinction and an indicator of gendered organisations.

The increased participation of women in science has been a challenge both in Europe and on the African continent. Both countries, South Africa and Germany, have been promoting women in science and technology through a wide range of programmes and initiatives, and have encouraged women's access to scientific research and technological engineering. Although structural changes are underway, the progress is not yet as fast as desired, despite the implementation of a number of projects and programmes funding and targeting women (see also Salo et al. below). This indicates that the effective attraction and retention of women is more complex than initially thought. Three articles look at strategies and interventions for gender equity that are in place at universities in Germany.

Bettina Schmidt starts from a rather pessimistic point of view, namely, that with decades of committed work on equal opportunity and equity in academia only limited tangible results and effects have been achieved. Schmidt perceives the gender gap in academia as manifest and therefore she argues that only a crisis can bring about change. She discusses several critical issues and challenges which if accumulated may in fact suggest a crisis in higher education institutions. She firstly presents various facts and figures in order to show where Germany and Europe stand on the issue of gender (in)equality and discrimination against women in academia, and secondly aims to identify and outline some of the successful activities and interventions in place in Germany and the European Union (EU) targeted at overcoming gender bias and ensuring gender equality in science. She finally elaborates on two instruments that have been implemented in Germany to measure and assess the performance of universities on gender equality, namely, the 'CEWS-Ranking on Gender Equality' of the Center of Excellence Women and Science and the 'Research-Oriented Standards on Gender Equality' of the German Research Foundation DFG.

Britta Thege presents findings from a student survey conducted in three cross-disciplinary study programmes at the Kiel University of Applied Sciences combining business and engineering, namely, Business Information Systems, Technology Management and Marketing, and International Sales and Purchase Engineering, which attract more women than so-called hard-core engineering courses. In view of rather gender-specific study choices in Germany in general and the imbalanced gender composition of the social and engineering study programmes at the Kiel University of Applied Sciences in particular, the investigation seeks to explore reasons for subject choices, educational background, study satisfaction, study successes, and study difficulties and demands that could possibly interfere with study success or even lead to students dropping out. The major interest of the survey was the investigation of possible gender differences and, more generally, for improving the study situation with regard to difficulties and demands.

Michael Mitchley, **Yasmine Dominguez-Whitehead** and **Sabrina Liccardo** examined discrepancies between women and men studying computer science at a South African university. In order to explore whether pair programming is a helpful teaching–learning strategy for women, students in a first-year computational mathematics course were given six weeks of assessed programming work, with the option to complete each task in pairs. The researchers present the findings of this survey, which suggest that teaching and learning arrangements at universities need to undergo change if more women are to be integrated in male-dominated subjects.

Sabah Badri-Höher looks at the culture of engineering from a personal perspective as a professor of Electrical Engineering. The article discusses the relative lack of success of policy programmes and initiatives encouraging females to take up academic studies in engineering and the reasons for studying Electrical Engineering. It also addresses specific issues in the culture of Electrical Engineering as well as issues of female career development in the field. In terms of career development, Badri-Höher perceives a clear distinction between male and female PhD students when women start a family – as mothers they see themselves confronted with big challenges in terms of reconciling their research work and their family responsibilities. In this highly technological field of expertise break in work means a career break. However, and despite all government support programmes, if women do manage to reconcile work and family life it is as a result of their own individual efforts and success. For Badri-Höher the present career obstacles for women and the negative image of female engineers with children are still a reflection of the male-dominated culture in Electrical Engineering and, consequently, she maintains that the technical work environment should be changed.

Career paths of women in science and technology

In total, women's representation remains low across the SET occupations and SET industries. Gender differences in academic choice and career patterns continue to exist since they are imbedded in an interplay of social structures, institutional contexts and subject-related factors. Research has shown that although women and men are similarly upward and career oriented, career choices are still to a large extent determined by gender, for instance there are gender-specific attributions of competence. In general, career paths for women in SET tend to be problematic, encompassing a range of stumbling blocks that impedes women's career advancement. Therefore, more gender-inclusive dynamics in the engineering work environments would be desirable.

Embedded in this context is the contribution of **Elaine Salo**, **Felix Liersch**, **Lieketseng Mohlakoana-Motopi** and **Marinda Maree**, who present findings from a study carried out in three South African provinces on incentives to attract and retain women in SET. The research is based on qualitative interviews with 45 informants working at universities, ministries, parastatals or private corporations. Against the background of the apartheid legacy and transition to democracy, South Africa's pronounced gender equity policy aims at increasing gendered and racial diversity in the academic and corporate world. Yet, in the SET field and also in the institutions under investigation equal representation of women, and in particular black women, has not been achieved. The authors identify key incentives in the academic environment as well as in private companies appropriate for retaining women in the workplace and, moreover, stress the importance of both direct and indirect incentives.

Differences exist between SET sectors and occupations, with some industries having greater numbers of women than others. Five contributions shed light on specific SET subject fields in Austria, South Africa and Germany, giving detailed insights through their research on how and why female and male careers differ, why women are underrepresented at senior levels, what obstacles and opportunities women encounter in the STEM/SET, and how barriers can be possibly overcome.

Heidi Siller, **Angelika Bader**, **Barbara Waldenberger-Steidl** and **Margarethe Hochleitner** investigated factors that hinder the advancement of female physicians in academic medicine. Despite increasing numbers of women studying medicine, women are still underrepresented in the higher ranks. In this study, the researchers compare the findings from an older survey conducted in 2002 and a recent study carried out in 2012 at Innsbruck Medical University. While the 2002 study considered only the situation of female physicians, the 2012 study looked at both female and male physicians in terms of their academic achievements and conditions in their private environments. The authors analyse factors causing women's delay in postdoctoral academic qualifications and scrutinise in particular the (in)compatibility of having a family and a career beyond the PhD. Results are discussed with regard to the changes that need to be made to the working environment, as well as the development of more possibilities for women to combine their desire to start a family with the pursuit of their career.

Sminny Jonas, **Vhonani Netshandama** and **Makondelela Mudau** examined a very male-dominated industry of economic growth in the new South African democracy, namely, the construction industry. The researchers investigated reasons why women-owned construction enterprises in South Africa are very often not sustainable, struggling to sustain themselves and lagging behind in terms of business growth and advancement. Data was collected by conducting qualitative interviews with key informants in the industry, who disclosed the barriers to their competitiveness. The researchers in particular question the achievements of government interventions directed at women's empowerment and development in the construction industry. Emphasis is placed on the necessity of increasing (governmental) efforts to empower rural women contractors through well-structured support programmes.

Bettina Langfeldt reports on crucial findings concerning gender disparities in the careers of mathematicians and physicists in Germany. Crucial research questions concerned whether these disparities are mainly due to gender-related differences in following certain career strategies or whether other factors have a role to play in the career success of men and women at both the individual and the organisational level. Furthermore, the influence of subject-specific distinctions and characteristics of different fields of activity (e.g. academia and industry) in the choice of career strategies are discussed.

Sabrina Weber, **Constantin Wiegel** and **Ulrike Busolt** present findings from a research project analysing female patenting activity and career paths in R&D in the business enterprise sector in Germany. As the European Patent Office (EPO) does not register inventors' gender, the researchers applied elaborated gender assignment procedures to the patent data in order to provide statistics on female researchers and female inventors in Germany. This is complemented by an analysis of R&D staff in five medium-high technology industries. Finally, the research group reports results from a STEM students' online survey about personal job preferences and individual future career plans, both directly after and ten years after graduation, which was undertaken in order to explore possible gender-specific differences in career preferences.

Kgomotso Ramushu approaches the field of Information and Communication Technology (ICT) from a rather uncommon perspective. In understanding blogging as a gateway and development platform to ICT agency, she specifically pays attention to 'natural' hair blogging by African women and the question of how the use of ICT promotes both African women's technical skills and their entrepreneurial activity through blogging in a field perceived as masculine.

The conflict or dichotomy between family and work is a major constraint for women in male-dominated environments and workplace cultures. Across the globe (unpaid) care work is primarily done by and is the responsibility of women. Up to today reconciling work career and family life is a major challenge for women in both Germany and South Africa, and is one of the main causes of women's slower career advancement or even career breaks. Two articles discuss the issue of care work and its effects on careers in science.

Dorian Woods gives an overview of global trends in family policy in the last 20 years, discusses new social risks and examines the implications of changes for women's reconciliation of family life and work in science. She firstly focuses on the comparability of family leave programmes, drawing on global trends in paid maternity, paternity and parental leave; secondly, she broaches the issue of the care of the frail elderly which is by far not as advanced as leave policies for the care of children. Finally, Woods exemplifies family leave policies for Germany, South Africa and the United States.

Karin Bodewits and **Philipp Gramlich** describe the particular situation for women in science in Germany by drawing on their own personal experiences. In contrast with developments in other European countries, for example the Netherlands and Norway, Germany lags behind in many regards; the major missing measures being identified by the authors as workplace flexibility, and (still) insufficient supply of childcare. Furthermore, in Germany societal norms with regard to motherhood are highly traditional compared to the rest of Europe, putting an enormous pressure on working mothers.

Acknowledgements

The editors would like to thank first of all the German Federal Ministry of Education and Research for its support of the German–South African conference and of this publication.

We would also like to thank our South African partners from the University of Pretoria, Prof. Dr. Elaine Salo and Marinda Maree, for their excellent cooperation in making the bi-national conference happen.

We thank all participants of the conference, especially our guests from South Africa, for coming to Kiel and for presenting and discussing papers with us in the midst of snowstorms and fresh winds from the Baltic Sea in springtime.

Furthermore, we would like to thank our wonderful then student assistants Isabel Dräger and Sooke Dittbrenner for their wholehearted commitment during the conference and Juliane Köchling-Farahwaran and Alexa Barnby for their valuable support with regard to the editing of this book.

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Kiel, December 2013

Britta Thege
Silvester Popescu-Willigmann
Roswitha Pioch
Sabah Badri-Höher

Gender Relations and Poverty in Advanced European Welfare States – Lessons to Learn from South Africa

Roswitha Pioch[1]

1 Introduction

In the past two decades South Africa has experienced tremendous social change. The long-lasting fight against the apartheid regime has finally been successful. In 1994, free elections and an equal right to vote as a major path to democracy were introduced and a new government was elected by the people of South Africa. As my colleague Elaine Salo from University of Pretoria, South Africa, has pointed out in her impressive key note address to this conference, the resistance of the African National Congress (ANC) and other social movements in South Africa was carried out to a broad extent by women, who play an important role in political movements in South Africa. The resistance of the people of South Africa against the apartheid regime has not yet, however, resulted in overcoming corruption and the old structures of social inequality. However, the social movements of South Africa have shown that change is possible.

In this article I want to show that the chances of bringing more women into science and especially into the field of the technology, the natural sciences and mathematics are pre-structured by the political and social structure provided in each single nation-state. I suggest that looking at women in science requires a multi-level gender perspective. We have to take into consideration how the political system, the political institutions and the social benefit schemes shape gender relations in a way that supports or prevents women from labour market participation and, in particular, from proceeding in their careers to attain higher positions in science, in private business or in the public sector by setting up both direct incentives as well as barriers for women when they are building their professional careers. The first level of analysis refers to the social and political structures erected in science institutions and within which women and men carry out their

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job orientations and professional careers. Secondly, in order to explain women's participation in science we have to look at the institutional level in the sciences and describe the logic of the rationality of institutions in science. We need to identify institutional barriers for women to access the sciences and we need to analyse factors that promote women's careers in science. On the third level we look at the micro-level in order to shed light on how women develop their job orientations and their personal careers.

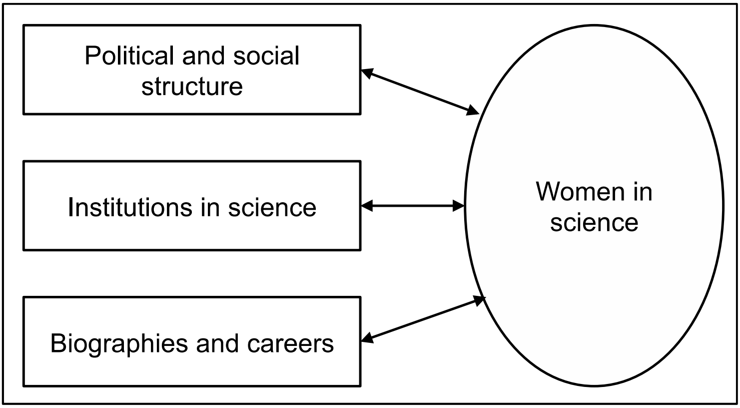

Figure 1: Levels of a multi-level gender perspective on women in science

In this article, on the first level of analysis I focus on the political structure of advanced European welfare states in order to shed light on the interrelation between political structure and women's labour market participation, as well as women in science in particular. The following contributions of the first section in this book are mainly focused on an analysis of the second level, the institutional level, in order to explain improvements as well as the still existing lack of participation of women in science in general and in the field of engineering and technology in particular. The second part of the book gathers contributions which look more closely at women's careers in science and address the third level of gender analysis of women in science. Finally, Dorian Woods and Karin Bodewits/Philipp Gramlich return to the focus on the political structure, namely, the family support for women in science provided or not provided by diverse welfare states.

2 The political structure of the German welfare state – wage centred and marriage oriented

In Germany at the beginning of the 20th century women did not even have the right to vote. Women had to fight for this right, which was only granted in Germany in 1918. The beginning of the 20th century was also a time when German universities slowly opened up to women, although one should not overlook the fact that we do find some women in science in Germany even earlier than that. Today in Germany, if we look at the formal rights bestowed on women, we speak of formal equality between men and women. Formally, men and women have equal rights to vote, equal access to schools and universities, equal rights in the labour market and equal rights to social benefits in the welfare state. However, the way the German welfare state is designed leads to a situation where, in the end, we are still facing factual inequality between men and women in the labour market, as in all earning-related benefits provided by the German welfare state.

This observation can be explained as follows: The German and the Austrian welfare states were among the earliest in Europe. Along with industrialisation around 1870, the workers' movement and its socialist ideas became stronger and stronger in Germany. Bismarck wanted to pacify the workers' movement and, in 1883, introduced compulsory health insurance in Germany. In 1884, statutory accident insurance was introduced, followed in 1889 by a statutory pension scheme. Mandatory unemployment insurance was introduced later in 1927 as a result of long negotiations between employers and unions about financing it. Additionally, a more sophisticated idea of solidarity based on a distinction between the deserving and the undeserving poor delayed the introduction of the unemployment insurance in Germany. In Europe we maintain that, in those countries that introduced social insurance schemes relatively early, such as Germany and Austria, a strongly worker-oriented social security scheme can be observed up to the present day (Kaufmann 2003).

In general, one can say that there is a close connection between labour market participation and the social security system in Germany, which in the main consists of social insurances. Eligibility to benefits in the Germany social insurance scheme is based on three preconditions: firstly, only those who have worked in the labour market are entitled to benefits, secondly, those who receive benefits have to prove that they are willing to re-enter the labour market as soon as possible, and thirdly, the level of someone's prior earnings in the labour market determines the level of benefits in the case of eligibility. These three preconditions lead to a structural priority of the labour market towards the social benefit system as an income resource, and benefit recipients are constantly oriented back towards labour market performance (Vobruba 1990).

The wage-centredness of the German insurance scheme has outlasted the foundation of the German Federal Republic, as well as Germany's reunification. Today the normative idea behind the existing compulsory social insurance scheme relies on an ideal of normal employment in the labour market, which is based on the following assumptions (Mückenberger 1985):

- Regular work in the labour market is dependent on gainful employment.
- Regular work is full-time employment of, nowadays, around 40 hours per week in Germany.
- Regular employment is continuous employment.
- Regular employment is based on an unlimited work contract.
- The worker is the male breadwinner of the family.
- The wage is high enough to sustain a family.
- The worker's life follows the life course of education, labour market performance and retirement.

Up to today, the strength of the German social insurance scheme is the fact that it provides decent social security for those who fulfil these normal assumptions in their work career. The weakness of it is the risk of poverty to all those who do not fulfil these assumptions in their work performance in the labour market. Because of labour market flexibility, we are seeing more and more employment that does not fulfil the assumptions of normal work. Over the last few decades, employment has become less secure and irregular, intermittent work in the low-wage sector has become more and more common (Pioch 2011).

Moreover, looking at these assumptions, it is obvious that female employment and women's work careers have never met these criteria of formal employment within the scope of the national insurance scheme in Germany. The employment rate for women in formal employment has always been lower than for men and the proportion of part-time employment is much higher among women than among men. In addition, the low-wage sector is predominately a female employment segment. Two-thirds of those employed in the low-wage sector of the labour market in Germany are women. In Germany, wages in general measured by real purchasing power have been going down over the past decades. Whether wages are high enough for families to only have one breadwinner greatly depends on the person's position in the labour market. In recent years, irregular work, precarious wages and limited work contracts have been increasing especially for women. For many women continuous employment careers have never been a reality as long as child care and care work is left on the shoulders of women. As long as women are hindered in getting access to better paid jobs in the areas of technology and engineering, where wages are higher, but are forced to remain in the lower paid care and educational sector, female wages will not be high enough to gain enough social benefits in the social insurance scheme to cover living costs independently from their husbands' income.

Nowadays we are faced with a situation where, on the one hand, labour market flexibility has increased, so that employment that does not conform to the normative assumptions still underlying the social insurance scheme has become widespread. On the other hand, the individualisation of society raises the question of whether a flexible, highly individualised labour market can still be embedded in a social security scheme preventing poverty and providing social security to all in need. The question is how to adjust the social security scheme in order to prevent people, especially women, from falling into poverty within the German welfare state.

3 Poverty risk in the German welfare state

If we talk about poverty in advanced welfare states one needs to be aware of different measures for looking at poverty. Firstly, there is the perspective that looks at poverty in terms of extreme poverty. In terms of this view of poverty a threshold is defined as an absolute poverty line. This threshold indicates the minimum level of income someone needs in order to literally survive. The common international poverty line has in the past been roughly $1 a day. In 2008, the World Bank came out with a revised figure of $1.25 at 2005 Purchasing Power Parities. For South Africa in 2009 the Data of the World Bank report a population of 13.8% living on less than $1.25 a day at 2005 international prices. In addition, the percentage of the population in South Africa living on less than $2 a day at 2005 international prices was 31.3% in 2009.[2] A definition of an absolute poverty line is supposed to be an objective measurement. However, one has to keep in mind that an extreme poverty line is always an arbitrary poverty line. As

2 cf. http://data.worldbank.org/indicator/SI.POV.2DAY.

you move it to the top, the percentage of the population below the absolute poverty line increases.

In advanced welfare states like Germany and Austria, the extreme poverty line of the World Bank is not able to indicate poverty in these countries. Therefore much higher levels of absolute income levels are being used here, often related to the level of social assistance. In general, a second perspective for looking at poverty, that is, poverty measured as relative poverty, is much more common in advanced European welfare state. The term 'relative poverty' is taken as an indicator of social inequality. This indicator does not measure wealth or poverty, but low income in comparison to other residents in that country. Therefore, relative poverty does not necessarily imply a low standard of living but rather social inequality in a country. Likewise, in the EU-SILC study, this measure relies on a definition of an at-risk-of-poverty threshold, which is set at 60% of the national median equivalent disposable income after social transfers. In the EU member states the proportion of the population living below the at-risk-of-poverty threshold ranged from 9% in Sweden to 21% in Poland in 2009, while Germany was somewhere at the end of the top third with 13% of the population living at or below the risk-of-poverty threshold (European Commission 2007: 10).

A third way of defining poverty in European welfare states is the measurement of living conditions. Poverty is defined by various dimensions of living conditions, which determine one's life chances, like education, health care, child mortality or political and cultural participation. In recent years this perspective has become famous as the so-called 'capability approach' proposed by Amartya Sen and Martha Nussbaum (1993). This way of looking at poverty overcomes a materialistic interpretation of poverty, but it is less objective and overall it is less useful for the international comparison of poverty rates.

Finally, a fourth way to define a poverty line is by way of self-reflective political poverty definitions. In research I conducted on the images of social justice held by political decision makers in Germany and the Netherlands , it was found that politicians argue strongly for the politically defined poverty line of minimum social assistance. Once this threshold is introduced, it becomes overwhelmingly the reference point for the poverty lines politicians refer to in their daily business of policy making as their ideas of social justice (Pioch 2000).

If we look at poverty in Germany in terms of social inequality we find poverty unequally distributed among population groups and regions. In general, in Germany figures on poverty show a higher at-risk-of-poverty ratio of the population in Eastern than in Western Germany, as well as in the North than in Southern Germany. In 2012 the at-risk-of-poverty ratio, as defined by EU-SILC (see above), of the former German Democratic Republic was 19.8% compared to 14% in Western Germany. In 2012, the poverty risk in Baden-Württemberg was 11.1% and that in Bayern 11.2%, while there was a poverty risk of 23.1% in Bremen and 22.3% in Mecklenburg-Vorpommern (Bundesamt für Statistik 2012). Thus, the poverty risk in Northern Germany is almost twice as high as in the South, and the poverty gap between North and South is remarkably higher than the poverty gap between East and West.

In Germany, the unemployed are identified as vulnerable groups for the living at-risk-of-poverty threshold. Their poverty risk is as high as 70%, while the average poverty risk of unemployment in Europe is only 46%. The poverty risk of unemployed people in Germany is considered to be higher than in other advanced European welfare states, because of the short duration of eligibility for receiving unemployment insurance benefits (Zeit 2012).

The risk of poverty is also relatively high for people with a migrant background in Germany. Among them the poverty risk ratio in 2010 was as high as 26.0%, almost twice as high as for Germans without a migrant background (12%) (Statistisches Bundeamt 2011).

The poverty risk of men and women is slightly higher for women than men in Germany. The poverty risk of women in 2013 is 16.8%, while it is 14.9% for men. In Denmark, however, there is no difference between men and women, with a poverty risk of 13% for both sexes (Eurostat 2013).

However, if you look at those receiving social assistance (Grundsicherung für Arbeitsuchende), in 2012 the proportion was 63% women to 37% men (Statistisches Bundesamt 2013). These figures can be explained by the cumulative poverty risks women are faced with during the course of their lives. Firstly, unemployment and low wages are a significant risk of poverty for women. This is indicated by the fact that there is a higher proportion of women (64.8 %) than men (35.2 %) among those working in the low-wage sector. Secondly, if one looks at single parents the poverty risk is extremely high, reaching as high as 35%. However, one has to keep in mind that around 85% of all single parents are single mothers. Among single parents, single mothers are significantly more often dependent on social assistance (26.3%) than single fathers (6.1%) (Bundesregierung 2004).

In sum, these figures are not intended to give a complete overview of all poverty dimensions in European welfare states, but they do indicate that, in the

German welfare state, social inequality exists and women are faced with an enormous risk of poverty especially if they display such cumulative risk factors as a migrant background, unemployment, single mother, and low wages.

Compared to absolute poverty in South Africa or even other parts of the African continent, the issue of poverty in Germany might seem to be a luxury problem. However, in the following section, I argue that poverty and social inequality in Germany are not just a question of material welfare, but rather are becoming a severe problem for democracy in Europe.

From research conducted by the political scientist Armin Schäfer, we learn that voter turnout correlates negatively with unemployment (Schäfer 2010, 2012). In his empirical research, Schäfer looked at voter turnout in the city of Cologne for all three of the elections we have in Germany: national elections, federal elections, and elections for city councils. As always, the highest voter participation is observed in the national elections and the lowest at the community level. However, Schäfer's figures show striking results; that is, they show a significant correlation between a rising unemployment ratio in different electoral districts and a decrease in voter turnout. Heavy polling can be observed in districts with low unemployment, while low turnout is seen in districts with high unemployment rates. Thus, poverty undermines democratic participation by vulnerable groups.

Furthermore, from Armin Schäfer's research we can learn that democratic participation correlates not only with unemployment but also with the level of education. Schäfer looked at different forms of political action: voter turnout, signing a petition, public debate, citizens' initiatives, membership of a political party, critical consumerism, and rallies and online protests. Voter participation is a form of political action in which more than 80% of both the groups compared participated – those who hold a university degree and those who do not have a high school certificate. All other forms of political protest correlate significantly with the educational level. It is thus most unlikely that people with a low level of education will participate in an online petition or will become a member of a political party or will participate in a citizens' initiative. Signing a petition, participating in public debate and critical consumerism are all forms of political action that are much more likely to be undertaken by people with higher levels of education than with low levels of education. Again for Germany we identify a correlation between democratic participation, various forms of political action and the level of education someone has. Figures for Germany show that lower levels of education correlate with lower income and the risk of poverty. Therefore, I draw the conclusion from this research that increasing poverty in the German welfare state is a threat to democracy. And as much as poverty affects women, the political participation of women in our democracy is likely to decrease.

In contrast to these findings, the complete opposite may be found in social movements and political action directed against the apartheid regime in South Africa, where social movements were driven to a large extent by poor women. In Germany, I argue that poverty undermines democracy and in particular prevents women from taking political action. In a local study conducted by the Institute for Interdisciplinary Gender Research and Diversity, we show that the lowest voter turnout for community elections in Kiel was among poor women with a migrant background (Pioch/ Thege 2011).

4 The gender gap in the labour market as a social security trap in Germany

Poverty and low income among women in the German welfare state is due to the close connection between social insurance benefits and labour market participation. The longer someone has worked and the higher his or her income in the labour market, the greater the benefits one is eligible for. However, if one looks at the German labour market, one observes that it is highly segregated between men and women. Two aspects of gender-specific segregation in the German labour market can be identified. Firstly, there is vertical segregation between higher income levels for men and lower income levels for women. Secondly, there is horizontal segregation between men and women according to the occupational areas that men and women are employed in. While women are overrepresented in the fields of low paid care work, men are more likely to be employed in the better paid technical jobs. In Germany, the gender pay gap, as an indicator of wage differences between men and women, is higher than the European average (Europäische Kommission 2006).

The lower income for women and the fewer chances they have for attaining higher positions in firms in the labour market, also referred to as the ‘glass ceiling’, has a tremendous effect in terms of the pensions women get in the German welfare state. In Germany, pension benefits are calculated on the basis of the duration of employment over the working life and the level of income someone has earned in the labour market. Because women interrupt employment more often than men because of raising children, they far less often fulfil the condition of forty-five years of employment, which is assumed for a standard pension on a standard level, than men. Additionally, women's lower income in the labour market affects their level of pension negatively. This mechanism not only relates to the pension scheme, but also to all monetary benefits of the German compulsory social insurance scheme. Women receive lower benefits from the unemployment insurance than men owing to their lower income in the labour market. In the case of illness, statutory sick pay is also lower for women than men, also related to lower earnings in the labour market. In order to get an idea of the tremendous benefit gap in the German welfare state in this context one only has to look at the pension scheme. In 2012 the average pension of the long-term insured in the Western part of Germany for men was 1.180 euro, while for women it is only 554 euro. In the reunified part of East Germany the average pension of men was 1088 euro, while it is 651 euro for women (Sozialpolitik aktuell 2013). Men's pension is almost twice as much as that of women and women's pension in Eastern Germany is higher than in Western Germany owing to more continuous and better paid employment in the labour market.

5 Gender relations in European welfare states

The way paid work is distributed among men and women is also a question of gender relations in families. These are pre-shaped and influenced by the political structure given by the social security scheme and social legislation in each welfare state. In general, one can roughly differentiate four ideal ways in which gender relations are being shaped in advanced European welfare states (Pfau-Effinger 2000; Lewis 2001, 2004):

I Housewife model	**III** Double income
II Part-time work	**IV** Double care model

Figure 2: Gender relations in European welfare states

In the German welfare state the model underlying the normative ideas when constructing the German social insurance scheme and when continuing with it in the Federal Republic in the 1950s and 1960s for women, was that of a good housewife, while the man was supposed to be the breadwinner of the family. Today, the normative assumptions inherent in the social insurance scheme are to a great extent a result of the reality of the labour market. Labour market performance of women in Western Germany at the beginning of the fifties was lower than 50%. The man was supposed to do the productive paid work outside the home, while women were supposed to do the reproductive unpaid work at home. Men and women were supposed to live together in the form of marriage. The woman was dependent on the earned income of her husband and the benefits he would get from his social insurance.

This normative model is still in people's minds today, even though as a result of the second women's movement in Germany women and men are also looking for new models. However, the pressure on wages in the labour market has forced many couples to adapt to the second model of a fully employed man and a woman contributing to the family income by doing part-time work. However, women can seldom attain an adequate old age pension just by doing part-time work in Germany and certainly not with low-wage employment.

In the Netherlands, part-time work, especially for women, is also very common as a model. However, contrary to the German welfare state, in the Netherlands the negative effects of part-time work have been reduced by decreasing these effects on the level of pension benefits. In this respect the tight relation between benefit and earnings was loosened in the Dutch welfare state at this point (Pioch 2000, Scharpf 2000).

The third model of a double income couple can also be found in Germany, mostly in the higher wage segments. In advanced European welfare states one can distinguish two types of double income models, depending on whether parents have to organise child care in the private sphere as in Germany or whether child care is provided by the public sector as in Sweden or Denmark.

The fourth model is a family model, where both parents share the work of caring for children or elderly relatives, while reducing equally their paid working hours. This model is intended to overcome the male breadwinner model and the gender-specific division of paid male work and unpaid female work.

Ilona Ostner has identified the German welfare state as a strong breadwinner model (1995), as is shown in model 1. In order to understand that there is a very strong marriage orientation in the German welfare state it is worthwhile to look at the legal institutions, which regulate marriage and the labour market participation of women (Brütt 2011). Equal opportunities for women to participate in the labour market have already been declared in German constitutional law (GG Art. 3, Abs. 2). However, it was only in 1957 that a law was passed that formally acknowledged women's right to employment in the labour market. The former right of the husband to decide whether a married women would be allowed to participate in the labour market or had to stay at home and do housework was abolished by that law. However, the right to labour market participation by married women was still subordinated to her duties as a housewife. It took another twenty years to abolish the relegations of women to housework by a law, which became applicable in 1976.

While the one-sided relegation to the realm of reproductive work has been formally abolished by law since 1976, the incentives provided by of the social insurance scheme and the German tax regulations are still shaping gender relations in the German welfare state (Brütt 2011). The social rights of a housewife or of children all depend on the status of the father of the family. For example, the compulsory insurance against ill health that the father of a family takes out to insure the other family members (his wife and children) means that their health insurance is dependent on the status of the husband in the labour market. The statutorily insured family wage of the male breadwinner within the compulsory social insurances determines the possibilities of employment for the women and young people in the family and opens access to irregular employment for them. The wage of the male breadwinner determines the level of pension benefits a housewife or children are eligible for after the death of the family wage earner. Furthermore, by means of the so-called 'Ehegattensplitting', the German tax system provides incentives for marriage and, in addition, for an income gap that is as high as possible between the two partners in a marriage.

6 Reform perspectives for the German welfare state

In Germany one can observe a political debate relating to the problematic wage and marriage centredness of government policies and the disincentives for married women to work. In actual fact, for the past twenty years two important reform steps have been observed which are aimed at changing the unequal treatment of women and care work by the German welfare state. Firstly, in 1992 the conservative-liberal government introduced a new regulation into the pension scheme. This regulation states that for each child one has raised three years are added to the pension calculation as if this person had been employed. This regulation can, at least to some extent, be interpreted as a break in the logic of wage-centredness and as a loosening of the close connection between regular employment and social security in the German welfare state. Secondly, in 2006 another reform introduced the possibility of paid parental leave for both the mother and the father. In addition, incentives for fathers to take parental leave were introduced by the longer duration of parental leave for fathers of at least two months.

Some argue that the wage-centredness of the social insurance scheme should be abolished by a radical reform of the German welfare state by introducing a guaranteed basic income. A basic income, one could argue, would break the tight link between labour market participation and social security. As all citizens or inhabitants of a country receive social security unconditionally, this will bring with it equal opportunities for women and men and give autonomy to women, because they would be no longer dependent on their husbands' income. The idea of an unconditional basic income has been seriously debated during the constitutional process in South Africa, and some actually argue that it is more likely that this will become a reality in countries like South Africa or Brazil than in advanced European welfare states, where we can observe a strong path-dependency in welfare reforms (Pioch 1996, 2000, 2004, 2011, Vobruba 2007).

One could argue that slowly but surely we are on the way to more equal opportunities for women and men in the German welfare state. However, a recently passed regulation to introduce a so-called 'Betreuungsgeld', a child care subsidy to all those who do not send their children to public child care, raises doubts as to whether the current government has the political will to change gender relations in the German welfare state. On the contrary, this new legislation is more likely to enforce traditional women's roles and encourage poor women in particular to stay home to look after their children instead of making use of public child care to take up employment.

7 Conclusion – lessons to learn from South Africa

In terms of the guiding question of this book on how to increase the number of women in science, especially in the field of engineering and technology, my conclusion from this brief look at advanced European welfare states is twofold:

Firstly, if one seeks to increase the participation of women in science, especially in engineering and technology, it is worthwhile to look at the political and social structure of the country we are talking about.

I have tried to point out that Germany is undoubtedly an advanced welfare state providing social security on a high level when compared with absolute poverty figures all over the world. However, the wage-centred structure of the German welfare state only provides a decent level of benefits for those who fulfil the normative assumptions of predominantly male fulltime employment. For all those who do not meet these standards of employment, the wage-centredness of the social insurance scheme becomes problematic. Women in particular, who still carry the burden of care work and reproductive work in families, are disadvantaged by this social security scheme.

Secondly, the wage-centeredness of the social insurance scheme is the reason for poverty risks in the German welfare state. Because of lower labour market participation by women, they are more likely to live in poverty than men. However, poverty is not accompanied by increasing political action for social change. On the contrary, at least for Germany we can see that increasing poverty and lower education go hand in hand with less political action.

If we want to increase social security and the labour market employment of women, in order to have more woman in better positions in the labour market and, finally, increase the number of woman in science, and in engineering and technology in particular, women have to become politically involved to push forward reform in terms of equal opportunities for women and men in the German welfare state.

These political forces for change do not currently seem to be present in Germany, either in parliament or in social movements. However, from South Africa we learn that poverty did not hinder women from engaging in political movements and changing their country. Consequently, if we want to promote women in science wherever we are, it is worthwhile taking political interests and the political and social structures into account.

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How Cultures in Science and Research (Re)Produce Gender (In)Equality

Gender (In)Equality in Academic Career Promotion of Doctoral Students

Heike Kahlert[1]

1 Introduction

Since the beginning of organised gender politics in German science institutions and academia in the 1980s, many measures have been introduced to advance gender changes. In German academia, however, it took a long time to place the issue of gender equality on the political and organisational agenda of the stakeholders in science politics. However, initially it was not democratic factors that opened the minds of political science elites and rectors to this topic, but rather economic reasons. Now, in times when 'excellence' is one of the leading ideas for developing universities to compete in the global knowledge market, gender equality would seem to be important for the future of the (German) university and German research organisations. This is also true in terms of winning 'all talents for an academic career' (Bundesministerium für Bildung und Forschung 2008: 3, translation by the author). Accordingly, producing and enforcing gender equality is an integral part of the science political reform agenda.

But what role do gender and gender equality play in the everyday organisational and professional practices of the professors who supervise and promote the next generation of academics? What do these professors say about the role of gender and gender equality in the professional careers of their doctoral candidates? And how do these professors describe their professional practices in terms of putting gender equality into action while supervising and promoting doctoral candidates? In this article I will present the findings from an empirical study conducted on the supervision and promotion of doctoral students in German science and academia. Particular attention will be given to the question of how female and male professors from different disciplines, fields of expertise and (academic) ages explain the so-called leaky pipeline and how gender is inscribed

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in the views of professors, who in this study are regarded as gatekeepers. The empirical background for this article consists of qualitative interviews that were conducted in a research project on academic careers in political science and chemistry in the transition from the dissertation phase to the postdoctoral phase.[2]

I will start with some reflections on the so-called leaky pipeline in science and academia by giving some statistical data on the overall proportion of women and men according to the qualifications awarded at German universities. The figures make it clear that proportionally more women than men leave academia after finishing their doctorate. Therefore this transition is examined with particular attention in section 2. I will then comment on the gatekeeper role played by professors and, in particular, the importance of gatekeeping for women's academic career development in the postdoctoral phase. In this chapter I will also define what I mean by the supervision and promotion of the next generation of academics (section 3). The methodology of the qualitative study is then introduced in section 4. In the following sections of the article I will present some results on the practices of supervision (section 5) and promotion (section 6) that emerged from the interviews with the gatekeepers. Both chapters show that the interviewees do not present their daily practice as being influenced by gender. Subsequently, five explanations for the so-called leaky pipeline are discussed that may be extrapolated from the interviews with the professors (section 7). The article concludes with a short discussion of the results (section 8), as well as a short section on the question of what women can learn from my research for their career development in the sciences (section 9).

2 A crucial point in academic careers: the transition from doctorate to postdoctoral phase

Science and academia are institutions that are expected by those in politics to actively promote the production of gender equality. Nevertheless, universities and research organisations still contribute to the production and reproduction of inequalities. This is also the case with academic careers. In German universities and research organisations, the doctorate is the formal starting point for an aca-

2 This project, which is under my leadership, is called 'Statuspassage Promotion: Betreuung und Förderung am Beispiel der Fächer Politikwissenschaft und Chemie' (The doctorate as status passage: Supervision and promotion with examples from political science and chemistry). The study has between January 2011 and December 2012 been funded by the German Federal Ministry of Education and Research and the European Social Fund for Germany.

demic career. In recent years, the gender gap in the overall proportion of women and men, according to status group and qualifications at German universities, receiving doctorates has decreased: In 2011, 44.9% of doctoral degrees were earned by women (Federal Statistical Office 2013), so that the numbers of men and women are nearly equal. On attaining a doctoral degree academics reach a crucial point in their careers: The degree is the start of a professional career in the labour market outside academia and also for starting an academic career at German universities and research organisations. Thus, during the doctoral phase courses are set for the further professional development of highly qualified people.

Research results and experiences up to now make it clear that, in the short to medium term, the problem of gender inequality in academic careers will not be solved merely by increasing the proportion of female doctoral students and doctorates attained by women. The reasons for this are as follows: First, there are still large gender differences between the disciplines and only very small changes concerning gender equality are occurring in most of the disciplines. Second, in the next career step in German academia, the postdoctoral lecturing qualification referred to as 'habilitation', very little change has happened in terms of gender equality and male dominance seems to be more or less stable: In 2011, 25.5% of postdoctoral lecturing qualifications were earned by women and 19.9% of professorships were held by women (Federal Statistical Office 2013). Between the doctorate and the postdoctoral lecturing qualification, proportionally more women than men get lost on the academic career path in German universities. This loss of women is a common phenomenon in most academic systems around the world and is described as the 'leaky pipeline' (Berryman 1983; Xie/Shauman 2003). However, one needs to reflect on this metaphor because it suggests that there is a career 'pipeline' in academia. For the German science system this idea of a 'pipeline' is not true: There is nothing like a career 'pipeline' with organised transitions from one career stage to the other and no idea that all well-qualified people in German academia should become professors.

Research results show that a mixture of self- and external selection is responsible for the loss of women on their way to top positions in science and academia. This selection process is a result of the interplay between individual, institutional and structural factors (e.g. Kahlert 2013b). One crucial point for leaving the scientific career path for women seems to be the dissertation phase or, to be more exact, the transition from the dissertation to the postdoctoral phase (Allmendinger et al. 1999; Beaufaÿs 2003; Vogel/Hinz 2004). This is the time in the life course of an academic as a professional in the German science system when they have to decide whether to follow an academic career or not. This decision is important because, apart from professorships, there are no permanent positions in the German system, and in order to obtain a professorship one has to successfully complete the postdoctoral phase with postdoctoral lecturing qualifications (or an equivalent qualification).

The transition period from the dissertation to the postdoctoral phase is usually also the period in the life course when a professional has to decide about starting a family or not. One might suppose that the question of starting a family is a factor that influences the decision for or against an academic career after the dissertation; however, it could be the result of prejudice and gendered stereotypes of life courses and the gendered division of labour. Recent empirical studies show that the proportion of female childless doctoral students and postdoctoral candidates in Germany is proportionally higher than in other professional milieus (Metz-Göckel/Möller/Auferkorte-Michaelis 2009; Lind 2010). This indicates that it is difficult to reconcile the qualification phase of an academic career with the change of lifestyle required by becoming and being mothers.

Apart from these more or less lifestyle-orientated reasons for or against an academic career, one should also look at the influences of scientific and academic organisations on individual career planning and career (im)possibilities. Although Joan Acker does not relate her work on organisational sociology to the particular organisational type of university and research, her approach to work organisations as 'gendered organizations' (Acker 1990) and especially to the idea of 'inequality regimes' (Acker 2006) may be useful for addressing these issues. Acker assumes that all organisations have inequality regimes. She understands these to be loosely coupled practices, processes, activities and meanings, which result from class, gender and race and which keep the inequalities alive. Inequalities in organisations are thereby defined 'as systematic disparities between participants in power and control over goals, resources, and outcomes; workplace decisions such as how to organize work; opportunities for promotion and interesting work; security in employment and benefits; pay and other monetary rewards; respect; and pleasures in work and work relations' (Acker 2006: 443). Thus, inequality regimes also structure professional careers. With regard to the supervision and promotion of the next generation of academics one can argue that the professional tasks of professors are also structured according to inequality regimes and arrangements and structure these as well.

Boris Schmidt and Astrid Richter (2008) consider the supervision of doctoral students to be part of professors' leadership activities. According to Schmidt and Richter, these activities can have emotional effects which in turn affect the work results of doctoral students. Supervision is a key to the successful process and closure of a dissertation, integration into networks and access to further scientific qualifications for the next generation of academics. However, the supervisors perform this function selectively and with varying intensity.

The sex of the doctoral students is one selection criterion (Kahlert 2013b: 179-186, 290-306). Accordingly, it is not surprising that in terms of research results, supervision causes greater dissatisfaction for female doctoral students during the dissertation phase than male doctoral students. The way supervision during the dissertation phase influences the academic career progress of doctoral students is barely considered. Research by Elizabeth Prommer et al. (2006) presents an exception. Based on a study conducted in Germany, Austria and Switzerland with all young academics from the field of communication science, the authors linked interviewees' satisfaction with their professors' supervision to their career planning. The results show that those young academics who did not feel they were adequately supervised also were less likely to plan a career as a professor (Prommer et al. 2006: 82). This result is particularly interesting because, according to the study, women in particular are not satisfied with their supervision: Their main criticisms included that fact that they were not introduced to important people in the scientific community and that they did not feel accepted. In addition, with regard to career planning and networking they complained about a lack of support by their male supervisors (Prommer et al. 2006: 80-82).

Why proportionally more women than men leave the science system after obtaining their doctorate is an issue that has still not been addressed by the German system of sciences and the humanities. Moreover, no comparison has yet been made between the sexes and the disciplines in terms of the processes of career orientation and career planning in this status passage. My research on this topic deals with the perspectives of the next generation of academics as well as their ideas and the social practices they apply in running their professional careers (Kahlert 2012). Additionally, the research analysed the perspectives of both male and female professors on the careers of the next generation of academics and considered their professional practices in supervising and promoting doctoral students. Professors can promote the development of doctoral students' professional identity, open up career paths for them, especially in science and academia, and integrate them into the scientific community. Professors are also important agents of gender equality for the academic career path, especially in the transition from the doctoral phase to the postdoctoral phase – even if this may not be clear to them or may influence their professional activities. The following sections of this article pay attention to these aspects.

3 Professors as gatekeepers: supervision and promotion of the next generation of academics

Compared to professional careers in different types of organisation, one of the characteristics of an academic career lies in the fact that such a career is organised by cooptation. One does not reach the next step on the career ladder when one has fulfilled special requirements and/or qualifications; these requirements and qualifications are merely necessary preconditions for the chance to be coopted. The cooptation process may be described as jumping from one career stage to the next and depends on already established academics. They are the ones who select the academics that are considered to be qualified or fit for the career stage concerned. According to Harriet Zuckerman and Robert K. Merton (1973: 522), these established academics may be regarded as *gatekeepers*.

The gatekeeper role 'is basic to the systems of evaluation and the allocation of roles and resources in science. (…) Variously distributed within the organizations and institutions of science, it involves continuing or intermittent assessment of the performance of scientists at every stage of their career, from the phase of youthful novice to that of ancient veteran and providing or denying access to opportunities' (Zuckerman/Merton 1973: 521-522). Gatekeepers regulate scientific manpower. With regard to the input and distribution of personnel, firstly, they evaluate the promise and limitations of aspirants to new positions, thus affecting both the mobility of individual scientists and, in general, the distribution of personnel throughout the system. Secondly, with regard to the allocation of facilities and rewards, gatekeepers operate largely through broad- or narrow-spectrum 'panels of peers', which recommend and determine the distribution of fellowships, research grants and honorific awards. And thirdly, with regard to the outputs of the variously allocated resources, the gatekeeper role is organised principally into the sub-roles of referees, charged with gauging the validity and worth of manuscripts submitted for publication, and of editors and editorial staff, who make the final determination of what will be published and delivered.

In the context of my research, that is, the career orientation and the career development of the next generation of academics, the gatekeepers decide about the entry and advancement of highly qualified people in the science system. In this respect the supervision and promotion of doctoral candidates are part of the gatekeeper role. Gatekeepers influence the career opportunities and the mobility of postgraduates and postdoctoral candidates and by doing so they also regulate the gender proportion of academic personnel. In order to evaluate the role of gatekeepers from a gender perspective, it is important to discuss who selects, who can be and who is selected, what rules shape the selection process and what criteria are taken into account. Liisa Husu (2004) supposes that at least hidden, but maybe also even unreflected, mental models and attitudes of gatekeepers with respect to the sex of the candidates could play a role in the selection process. According to this one can argue that also the supervision and promotion of the next generation of academics are influenced by gender. Therefore, the analysis of gatekeepers' gender concepts may shed light on the attitudes of gatekeepers with regard to gender (in)equality in science and academia and also the impact they have on putting equal opportunities into action. Thus, it is astonishing that very few and mostly older empirical studies (Anger 1960; Holzbecher 1997; Graf 2011) have been concerned with these questions.

But what is meant by supervision and promotion in this study? The differentiation between these concepts is useful for a methodological investigation of professors' professional activities and the experiences of the next generation of academics with regard to their career paths (Kahlert et al. 2011).

Supervision is understood as support activities by professors and, as the case may be, other persons of relevance for supervision, for example academic assistants and academic leaders of research groups. Supervision is directed at the completion of the dissertation. Accordingly, four aspects of supervision can be differentiated:

- *Ideational-personal supervision* means the process of supervision, the (leadership) style(s) of the supervisor(s) and the forming of a professional relationship between the doctoral student and the supervisor.
- *Technical-functional supervision* consists of the discussion and/or approval of the theme and the synopsis, the exchange of basic knowledge, support in terms of technical-functional and methodological issues, new impulses and the handling of equipment and software.
- *Structural-ideational supervision* includes the structuring and the framework of the dissertation process. It comprises discussions and colloquiums, advisory services according to the form of the dissertation (monograph or

cumulative), joint participation in conferences or lectures, and support for obtaining stipends and certificates for the dissertation. This category is shaped by support activities which provide doctoral students with benefits in addition to a successful closure to the dissertation. These are an integral part of the doctoral education of each doctoral student and for example include integration into the scientific community.

- *Structural-material supervision* covers financial support with respect to participation in conferences, seminars and excursions, insofar as the participation is considered an integral part of the dissertation or common sense. In addition, this aspect of supervision involves offers of stipends or jobs, as well as forms of support that cover the doctoral students' living expenses.

In contrast, *promotion* means support activities for the doctoral students in a broader sense. These support activities exceed the direct success of the dissertation and serve to integrate the doctoral students in the scientific community. They may also be helpful for career advancement but are not an integral part of the doctoral education or common sense. As in the case of supervision, four aspects of promotion are differentiated:

- *Ideational-personal promotion* means motivation and career counselling with regard to a scientific career, for example mobility and publishing, as well as the transmission of implicit knowledge by supervisors. This knowledge mainly includes tips and hints.
- *Technical-functional promotion* involves presentations that assist in the achievement of key competences and the information about these offers. Participation in these presentations and the achievement of the specific competence(s) are of benefit to an academic career, for example academic writing, presenting, university didactics and leadership seminars.
- *Structural-ideational promotion* includes aspects related to professors' activities with respect to the scientific careers of doctoral students. This refers mainly to the active integration of the next generation of academics in the scientific community, for example joint publications, joint participation in conferences and/or lectures, references, joint research proposals, assistance with networking and contact arrangements. Structural-ideational promotion therefore exceeds ideational-personal promotion, which only contains encouragement, tips, hints and counselling.
- *Structural-material promotion* covers the financial resources that the next generation needs to continue their scientific career after having finished the doctorate; for example the financing of travel costs to participate in conferences or to give lectures, further education or job offers.

4 Methodology of the study

The empirical background to this article consists of 17 qualitative interviews with male and female professors from various fields of political science and chemistry in the German system of science and academia. In the comparative context of the study the interviewees were selected by means of theoretical sampling. Besides discipline and gender, selection criteria were orientated to diversity in order to maximise perspectives. The sample of interviewees is composed of four female and five male professors from political science and of four female and four male professors from chemistry.[3] All interviewees represent different disciplinary areas. They work at different German universities in both the Old and the New Laender, are of different academic ages and possess different experiences in supervising and promoting the next generation of academics. Also, the interviewees are differentiated with respect to payment levels and lifestyles (partnership, marriage, single, with or without children).

The interviews focused on the attitudes and experiences of the interviewees with respect to the supervision and promotion of the next generation of academics and therefore they also pay attention to issues of gender. How do gatekeepers of both disciplines organise the supervision and promotion of doctoral students during the dissertation phase and in the transition to the postdoctoral phase? How do they perceive their professional practices according to the development of career orientations and career aims and with regard to the development of the professional identity of doctoral students and postdocs? What do the interviewees see as starting points for improving gender equality? What factors moderate their practices when promoting and coopting the next generation of academics during the dissertation phase and the postdoctoral phase? What role does (the gatekeepers' and the doctoral students') gender play in the process?

In the beginning of the interviews an interest in the production and implementation of gender equality was expressed. This topic was also considered during the interviews by making provision for questions in the last part of the interview guidelines. For example, one question aimed at generating explanations for the decreasing number of women in the postdoctoral phase and in the professoriate. Another question aimed at eliciting suggestions for improving gender equality in science and academia. The interviewees were also asked to

3 The original plan was to interview four professors per discipline and sex. However, during the study I was given the opportunity to interview a fifth professor from political science and this interview was also integrated into the study.

reflect as far as possible on their own experiences as a man or woman in science and academia. In the interview guidelines and instructions the request to reflect questions relating to gender and gender equality was challenged by the methodological problem of taking gender as a social scientific and social structural category into account without affirming gender differences. De facto this resulted in questions directly related to gender and gender equality being asked predominantly in the section of the interview that was planned for these aspects. Apart from that the gatekeepers were reluctant to emphasise gender-related aspects. This could mean that the interviewees do not consciously ascribe any importance to the sex of their doctoral students in their professional practice. One could also assume that in the light of political pressure in science to produce gender equality, the gatekeepers did not want to arouse suspicion that they do not participate in the production of gender equality.

I conducted all 17 interviews, which lasted between 65 and 150 minutes. They were digitally recorded and afterwards transcribed according to special rules. The interpretation of all the interviews is based on qualitative content analysis (cf. Mayring 2008).[4] Because of limited space I will not go further into methodological details here; rather, I will concentrate on some of the results that can be extrapolated from the empirical material.

5 Supervision of doctoral students

The interviewees described the supervision of doctoral students generally as time-consuming and intense. Accordingly, most doctoral students require a large expenditure of time and intensity. All the gatekeepers reflected on the tension between the amount of supervision and the amount of autonomy doctoral students need. The professors resolve this tension in different ways. The scope of supervision seems to extend from tight leadership with clearly structured timeframes and tasks – this model seems to prevail in chemistry – to supervision on demand with flexible structuring of time and open tasks – this model seems to prevail in political science.

With respect to *ideational-personal supervision* the process of supervision consists of three phases: a time-consuming and intense phase in the beginning, a long phase with rather loose supervision in the middle, and an intense phase at the end of the dissertation. Several gatekeepers also hinted at unplanned personal

4 The academic assistants Nadine Frei, Danny Otto and Sabrina Rutter supported this work.

crises during the process of writing the dissertation, which also challenged the supervisors.

The supervision on demand mainly takes place in unstructured and irregular one-on-one interviews. These interviews also serve as conversations on informal issues. Therefore, those doctoral students who do not or do not very often request such interviews may lose out on important information. Additionally, this type of supervisor only recognises the doctoral students' problems if they are obvious to the doctoral candidate and if he or she has the courage to speak about the problems to his or her supervisor.

In this context, the extent to which the supervisors are present in the workplace is important. In chemistry, the professors have a culture of regular attendance. Therefore doctoral students have many opportunities to make use of their supervisor's 'open door' policy. In political science, however, the professors' presence at the university is more erratic. Therefore it is unlikely that doctoral candidates will meet their supervisors by chance.

Only the male political scientists emphasised their function as counsellors and initiators of dissertations and placed the students' autonomy in the foreground. In contrast, a few of the female gatekeepers from both disciplines characterised their manner of supervision as 'caring' and identified differences between the behaviour of male and female supervisors. Both male and female interviewees explicitly mentioned the need to encourage women to start a dissertation and to give them specific counselling.

In the interviews, ideational-personal supervision was closely linked with aspects of *technical-functional supervision*. In political science, the doctoral students usually work on their own research questions. Therefore, the starting phase of the dissertation demands an intense technical-functional discussion on the theme and the synopsis. In the middle of the dissertation process the doctoral students may have technical-functional crises, and in the end they ask again for intensified technical-functional feedback. In chemistry, on the other hand, the themes for dissertations often emerge from the professors' research projects. Therefore there is no need to concentrate the technical-functional supervision on finding and delineating a theme or dealing with a crisis with the material. Instead, technical-functional supervision in chemistry deals with advice on the construction of experiments, discussion on preliminary results, and advice on writing up the results.

The interviewees discussed *structural-ideational supervision* in depth. With respect to the structuring of supervision, remarkable differences were found between both disciplines. These differences emerge from the essentially different construction of the dissertation in political science and chemistry. In chemistry, the dissertation is structured mainly by the work that is done in the laboratory. Not only is the time structure of the dissertation process and the supervision connected with it to a large extent given, but also the exchange with colleagues and the supervisor(s). This structuration of the dissertation is reinforced by the different institutional settings, for example regular research group seminars and colloquiums, where the supervisors organise the technical-functional exchange. The supervisors usually expect the doctoral candidates to be present in these settings and to contribute regularly to the organised exchanges, for example by presenting (preliminary) results. In contrast, in political science, supervision if any, is mainly structural-ideational with colloquiums being arranged at different intervals, for example once a month or once a semester. These include very different groups of students, for example undergraduate students, master's students and/or diploma students, doctoral students and academic assistants of the chair or department. According to the gatekeepers, participation is less binding and there is less active collaboration than in chemistry.

The gatekeepers emphasised gender-related aspects for both disciplines in structural-ideational supervision. These aspects relate to family formation and the reconciliation of family and dissertation. For example, in political science some interviewees organise workshops for their doctoral students that deal with these themes. In chemistry, the gatekeepers mentioned that laws for the protection of pregnant and breastfeeding working women do not allow them to work in the laboratory. In this regard several gatekeepers addressed the practice of supporting those women in their research group with 'laboratory assistants and so on'. In such cases the female chemists do not have to interrupt the research for their dissertation. At the same time the interviewees hinted at the fact that they sometimes have problems with the third-party funding organisations because the supportive work in the laboratory for pregnant and/or breastfeeding scientists has to be paid for separately in order to keep the research project running.

Structural-material supervision was always mentioned in the interviews. In this respect the gatekeepers referred to the allocation of jobs and stipends for writing the dissertation, which is normal in chemistry and an exception in political science. The gatekeepers also placed financial support for participation in conferences and advanced training, which is necessary for the progress of the dissertation, on the record. The costs linked to the dissertation are financed by the chair's or the department's budget resources or by third-party funds, if the supervisors consider these costs necessary. In political science these costs are only financed by the chair or the department now and then and normally in connection with jobs for the doctoral candidates, which are paid from budget resources or third-party funds. These examples make clear how the differences in resources (jobs, money) between disciplines and the particular possibilities for applying for and obtaining third-party funds influence the supervision.

According to the gatekeepers, the gender of the doctoral student and of themselves does not usually play any role in the supervision. The only exception they make concerns the question of becoming and being pregnant and having children. This exception is related to women only on the basis of their (traditional) societal role in bringing up children. Although the interviews show that the gatekeepers make individual differences when supervising doctoral students, they describe their practice of supervision according to scientific standards consistently as more or less gender-neutral.

6 Promoting the next generation of academics

Although the remarks on the supervision of doctoral students took up a lot of space in the interviews, they contain little information about the promotion of the next generation of academics during the dissertation phase and in the transition to the postdoctoral phase.

With regard to *ideational-personal promotion,* most of the gatekeepers mentioned the doctoral candidates' career planning. In this context they consider the decision for or against an academic career and the high requirements, as well as the accompanying problems. Especially those doctoral students who want to stay in science and academia are encouraged to participate in conferences and to write publications.

When the doctoral candidates want to leave university after having completed their doctorate, the gatekeepers send them for career counselling at various places and organisations. This is because the supervisors maintain that they do not feel competent to counsel or promote this group of alumni and that they do not feel to be responsible for their careers but they also question the quality of career counselling for academics with a doctoral degree. It might also be that the gatekeepers do not have much interest in those doctors who leave science and academia. This is because the supervisors make it clear that, for them, their networking and their own reputation in the scientific community is (more) important. Accordingly, their professional activities are also directed at supervising and promoting the next generation towards these interests.

Additionally, some of the professors hinted that they did not want to be involved in their doctoral students' career planning, because career planning is considered to be a 'private affair'. However, in the interviews, the gatekeepers were vague about the line between private affairs and tips or enquiries by the supervisors or discussion about career planning with the candidates and the point at which the gatekeepers find it inconvenient or even convenient to intervene in the private affair of career planning.

Some male and female interviewees spoke about the need to encourage female doctoral students explicitly to continue with a scientific career after having finished their doctorate and to give them special counselling. However, they did not state whose task this should be.

Technical-functional promotion did not play much of a role in the interviews. Only few professors seem to advise their doctoral students to accept offers of continuative technical-functional qualifications and/or to earn key competences. In the interviews with chemists one finds hints that the doctoral students participate in seminars on scientific writing because they do not always learn enough about this during their studies. Apart from that one tends to find the attitude that the doctoral students either have all the necessary qualifications or that they earn them during supervision and/or in the research group.

Examples of *structural-ideational promotion*, such as mutual participation in conferences (where doctoral students or postgraduates are introduced to important people in the field), joint publications, the organisation of joint conferences and/or joint teaching or joint references and telephone calls to colleagues to recommend candidates, were seldom mentioned in the interviews. Surprisingly, only political scientists discussed the purposeful building of networks with the participation of the supervisor(s). This was not mentioned in the interviews with the chemists. This may be because chemists have the possibility of networking in any case because they work organised with research groups. Beyond that, the supervisors probably do not see the need or maybe they do not have the need to structure the building of networks.

The fact that the gatekeepers were so reluctant to tackle structural-ideational promotion may be because the scientific market for people with doctoral degrees is small and only a few have the chance to stay in science or academia after having completed their doctorate. It could also be that these forms of structural-ideational promotion are not spoken about, maybe because the gatekeepers are not aware of them as part of promotion or because these forms of promotion are only selectively practised. Some interviewees estimated their influence or their possibilities to affect the scientific careers of their doctoral students as being very limited. This is because the gatekeepers describe academic careers as ‘filled with imponderables’ and strongly connected with ‘luck’, especially in the case of a call to a professorship at a university. According to the gatekeepers, a scientific career is the result of the individual activities of the candidates and not also the result of professors’ professional leadership with adequate social practices that promote the next generation of academics. An understanding of the gatekeeper role can only be found in a very few of the interviews with professors in this study.

The interviewees were also reluctant to discuss *structural-material promotion*. Only in political science some of the male professors pointed to the promotion of female academics explicitly by offering them a job for the lecturing postdoctoral qualifications and for sharpening their scientific profiles. Two gatekeepers reported that in the meantime some of their former long-time female academic assistants had become professors. In contrast, some of the female interviewees from political science emphasised that their facilities are too small to promote postdoctoral candidates by offering them a budget-funded full-time job. Therefore, they are only able to offer doctoral candidates part-time jobs.

With regard to the structural-material promotion of postdoctoral candidates and assistant professorships all chemists were reluctant to comment. They referred to the fact that in chemistry people with a doctoral degree generally go abroad to work as postdocs and afterwards do not normally come back to the research group where they studied and/or wrote their dissertations. Furthermore, the gatekeepers emphasised that postdoctoral candidates are expected to bring with them their own research funding and research project if they want to affiliate with a professor’s research group. In the interviews these arguments were not linked to gender.

Some female professors from chemistry see the need, not least in the light of their own experiences, to promote female chemists after their dissertations explicitly to stipend or job programmes. However, neither male nor female gatekeepers from chemistry have experience in promoting female chemists after the dissertation. The reason given for this is that they did not have any postdoctoral candidate(s) who seemed fit to be promoted or who asked to be promoted. It would seem that the interviewees from chemistry had had female postdoctoral candidates who had left the research group very quickly. In some cases the professors explained this as being for private reasons, including starting a family as well as other reasons that were not elaborated on. In other cases they did not give any explanation for this.

To conclude: Beyond the supervision of doctoral candidates the interviewees seem to practise a generally very selective and casual promotion of the next generation of academics. This selective, casual promotion consists of publications, participation in conferences and lectures or sometimes also job offers for postdoctoral candidates. From the interviews it is not possible to work out any specific or systematic patterns of promotion for the next generation of academics. The only point that becomes clear from the interviews refers to the material resources of the universities, departments and single chairs. That, for example, active integration of the next generation in academic networks, encouragement or tips for running a scientific career can be, or indeed is, part of a professor's role, was only very seldom and then only mentioned in passing in the interviews.

7 Gender constructions and gender (in)equality in the gatekeepers' views

One part of the interviews attempted to elicit the gatekeepers' views on the reasons why proportionally more women than men leave academia after having finished their doctorates and why there are so few women in top academic positions in Germany. The answers deal with, firstly, family formation and the gendered division of labour in private life, secondly, asymmetric gender relations in private partnerships, thirdly, gendered career planning and necessary investments in academic careers, fourthly, working conditions and the academic work ethic and, last but not least, with psychosocial factors and professional competence (Kahlert 2013a).

The summary of the gatekeepers' explanations for the loss of female academics on the way to top academic positions shows very clearly that most of the answers to the question 'Why so few?' deal with gender differences in the life courses and life plans of the next generation of academics. The gatekeepers' gender concepts are generally orientated to heterosexual partnerships and a family model that consists of a male breadwinner and a female care worker. The issue of children is identified as one of the main problems in women's academic careers after the doctorate and can result in a clash of the different social requirements in the female life course. One might expect that the gatekeepers would mention the problem of reconciling scientific qualifications and family formation or care work. However, worthy of note, but not entirely astonishing, is the fact that this problem is assumed to be mainly a woman's problem.

The gatekeepers do not challenge the fact that women study and may be able to obtain a doctoral degree and that they want or are able to work. However, most of the interviewees see the career possibilities of women with a doctoral degree after having finished the doctorate being immediately influenced by the biological opportunity to become pregnant and by the biological limit of the fertile phase. In the case of experimental chemistry the gatekeepers also mentioned the employment laws that protect pregnant and breastfeeding women by preventing them from working in laboratories.

Some interviewees also mention changes in the familial division of labour between men and women and observed changes on the side of young men and fathers. A female gatekeeper emphasised that by now there are 'modern men, who want to notice a bit more than in former times'. In the light of existing asymmetric gender relations most gatekeepers also foresee the emergence of problems in partnerships if highly qualified women make use of their academic capital in the labour market to run a permanent and ambitious career or even want to start a scientific career and thereby are more successful than their partners.

However, the gatekeepers' explanations of women's career planning are contradictory: In part they mirror the male breadwinner model that makes it possible for women's life planning to give only lower-ranking priority to their professional careers. In contrast, other interviewees stated that women take their professional careers so seriously that becoming and being a professor is not attractive because it goes hand in hand with a high workload, a large amount of insecurity during the qualification process and low income potential. Other gatekeepers stated that women do not get the idea to plan an academic career because they are not supposed to be able to imagine becoming a professor. So, on the one hand, the gatekeepers are able to imagine that women are becoming professors and planning their careers accordingly, while on the other, the gatekeepers deny that women want to pursue such a career plan.

A fourth set of explanations deals with the working conditions and the work ethic in science and academia. These are described in terms of the disadvantages of a professorship and the career path one has to take until one gets a call to become a professor. The gatekeepers regarded a professorship in the German system of science and academia as having many disadvantages: laws for limited employment until one becomes a professor, heavy workloads and expectations to be permanently available. Of course, these disadvantages count for both women and men in academia, but the gatekeepers maintain that these aspects are more problematic for women than for men, because women are also believed to be responsible for care work. At the same time some gatekeepers reflect on different structures of opportunities and chances for women and men in science and academia. According to most of them women are disadvantaged with respect to protection and career advancement because of old boys' networks.

The gatekeepers also outlined different gender concepts relating to psychosocial factors and professional competences. According to these gender concepts, women have high self-reflexivity but also low self-confidence, they lack ambition and the willingness to risk and, in the case of theoretical chemistry, also knowledge. By contrast, men are regarded mirror-inverted. These polar constructed gender concepts make clear that the gatekeepers only partially appreciate gender differences. Gender differences are mainly presented as deficits. Thereby all interviewees explain the gender differences in behaviour and professional competences in terms of primary and secondary socialisation, and not nature.

It is striking that the gatekeepers relate the reasons for gender inequality in science mainly to conditions and influences that lie outside academia. First of all they indicate the gender relations in partnerships and families, as well as socialisation, as reasons why women drop out of the way to top scientific positions. It thereby becomes obvious that the interviewees are often (still?) bound to the modernised male breadwinner model, although they do make it clear that this model is changing and is being replaced by the practice of double careers in partnerships and families. It is also striking that most gatekeepers cannot imagine a (consciously planned) life without children. Accordingly, childlessness is portrayed as the price one has to pay for an academic career and not as the planned result of individual life plans.

Some interviewees presented their own possibilities for producing gender equality in science and academia as limited to the recruitment of personnel for positions to write a dissertation or prepare for postdoctoral lecturing qualifications or for professorships and for the encouragement of the next generation of female academics to have a scientific career. Other gatekeepers do not see themselves as agents of active gender equality. In their view, gender equality depends first of all on changes in societal frameworks, for example the availability and allocation of flexible and high quality childcare facilities, the individual attitudes of men/(potential) partners towards the employment of highly qualified women and the processes of education and qualification through which women have to pass before they enter university. Therefore, both organisational scope and individual possibilities to produce gender equality in science and academia are considered to be limited or unavailable. If science and academia were to contribute to gender equality, then these gatekeepers maintained that this was the responsibility of 'the university' or 'the rectorate' and/or the equal opportunity officer or, more generally, 'politics'.

8 Discussion and conclusions

The analysis of the supervision and promotion of the next generation of academics does not give many hints as to the inequality regime of gender in academic careers. The picture created by the gatekeepers' gender constructions and their ideas on gender equality would suppose that male and female professors unconsciously treat male and female doctoral students and postdoctoral candidates differently, although this cannot be proved by this study for methodological reasons. The concept of gender relations as held by the interviewees still consists of a male breadwinner and a female homemaker and care worker. Although the female homemaker and caregiver may also be (willing to be) employed and willing to make a career for herself, according to the gatekeepers she also partly withdraws her ambivalent career ambitions because of the problems related to reconciling a career with the power asymmetry in the partnership. Some professors explicitly hinted at the fact that women's further academic education is nowadays seen as 'normal' up to the dissertation. Implicitly, this also means that the aspirations of (some) women to take a top position in science and academia and therefore to stay in the university is (still?) not regarded as 'normal'. One can assume that this internalised gender concept also has an impact on the different gender practices involved in supervising and promoting the next generation of male and female academics; however, this maybe unintended because the professors do not seem to be aware of their practices.

Compared to older German studies on the professorial views of female students and professors (Anger 1960), both stability and change are apparent in the gender constructions of the interviewees in this study. Compared with older studies the gatekeepers do not use naturalising arguments to explain why women are not interested in science or why they are not able to work in academia. Instead, the interviewees seem to be well informed about the influence of socialisation on career planning and career courses. Also, as in older studies, the gatekeepers see the main reasons for gender inequality in science and academia first of all in terms of conditions and influences *outside* academia. Accordingly, the gender relations in private partnerships and families and socialisation processes outside science and academia are used to explain women's career practices. Even when the gatekeepers do explain the loss of women in academia by referring to aspects that are internal to science or academic organisations, these apparently are not areas that fall within the interviewees' influence: Employment laws, laws of employment protection and the payment structure in academia are determined by legislation, and the heavy workload in the sciences seems to be caused by global competition in the scientific knowledge market and the scientific dynamics of knowledge production rather than by the professional practices of the gatekeepers.

Thus, individual possibilities to influence the academic career system and the careers of the next generation of academics are introduced as being highly limited. Very few gatekeepers in the study regard it as their job to influence the careers of younger academics in terms of their practices in hiring, supervising and promoting the personnel for postdoctoral positions and professorships and for encouraging female (post)doctoral candidates to start and proceed with an academic career. The other interviewees also do not regard themselves as agents of career promotion and/or gender equality. It seems as if they have not developed a gatekeeper consciousness. Although most of the interviewees seem to be more or less informed about the need and concrete measures to promote gender equality in academia, they introduce themselves as being seldom the ones who could put gender equality into action. If they see possibilities in putting gender equality in science and academia into action, it is in terms of abstract institutions that should take responsibility for this and work on gender change. This attitude could be the result of the underdeveloped gatekeeper consciousness mentioned previously. It could also be caused by the gatekeepers' idea of an academic career as being constructed by the candidates themselves and being influenced by luck and not by career strategies and promotion. However, it could also be an expression of resistance to (more) gender equality in science and academia. As such, it makes clear that the inequality regime of gender is still present in science and academia.

9 Lessons to learn for women in sciences

Last but not least I would like to discuss what women can learn from this research for their career development in the sciences. The results of the interviews with the male and female gatekeepers make clear that four aspects with direct gender relevance come to the fore when considering the 'gender issue'.

The first aspect deals with female scientists as potential mothers who may become pregnant or who are breastfeeding. In chemistry these mothers are not allowed to work in laboratories for some time. Closely linked to this, and with relevance for both chemistry and political science, is the image of female academics as still being responsible for care work at home. So, in the views of professors, women as mothers experience conflict between home and scientific work that hinders them from having a career in science or academia. Even if female academics become pregnant and are able to combine science and family they have to be aware that many of the gatekeepers do not think that both life spheres can be easily reconciled by women and that a woman's place is still at home.

Secondly, the gatekeepers mentioned that women in academia need special treatment and encouragement when furthering their academic qualifications, including the dissertation and postdoctoral lecturing qualifications. However, very few interviewees admitted to encouraging female academics to take up a career in science. This illustrates that women should not wait to be encouraged if they want an academic career but should take their careers into their own hands. As the interviews show, very few professors promote doctoral students and postdoctoral candidates in their academic careers. For women this means that they should look for support from other people and institutions, for example mentoring programmes, professional coaches and professional career counselling. Additionally, they should not wait for job offers or other opportunities, but be active in seeking these out for themselves.

The third aspect deals with the gatekeepers' dominant gender concept. The research makes it clear that most of the professors who were interviewed have a traditional gender concept in their minds. This seems to influence their behaviour and attitudes towards women in academia. Even if there are female professors, and their numbers are growing slowly, gatekeepers do not see female professors as being 'normal' in daily practice in science and academia.

Finally, there are strong hints within the research that gatekeepers suffer from a lack of gatekeeping consciousness. Many male and female professors are not aware that they are indeed gatekeepers and should behave as gatekeepers. This seems to be especially true in issues related to gender equality. In this regard, there are very few differences between male and female professors. This means, for example, that there may be male professors who have a gatekeeping consciousness and are also willing to support female academics and work for gender equality, while there may also be female professors who do not. In other words, the stereotype of the gender-blind male professor who does not support female academics and the gender-reflexive female professor who is always working on behalf of gender equality has not been proved by the data. It is therefore important that women in the sciences should also be aware of their gender concepts.

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The Journey of Female Professors in South Africa

Tendani Mawela[1]

1 Introduction

Gender equality and the career development paths of women in the private, public and non-profit sectors are regularly the focus of academic studies (cf. Ragins/Townsend/Mattis 1998: 28; Sonnert 1999: 34; Mason/Goulden 2002: 21; White 2004: 227; Van den Brink/Brouns/Waslander 2006: 523; April/Dreyer/Blass 2007: 51; Whitmarsh et al. 2007: 225; Sappleton/Takruri-Rizk 2008: 284; Alpay et al. 2010: 135; Dambrin/Lambert 2012: 2).

Globally, the spotlight on gender equality issues continues to shine through various programmes. For instance, various United Nations member countries have, since 2000, pursued eight Millennium Development Goals of which Goal 3 is stated as: 'Promoting gender equality and empowering women' (United Nations 2012). Locally, in South Africa, our unique history highlights gender as one of the recurring themes in the fabric of our society which is included under the general umbrella of diversity management and the promotion of social cohesion. Furthermore, in South Africa gender equality across society is enshrined in the Constitution and is considered sufficiently important to have a government ministry dedicated to women, which is currently in the process of developing a women empowerment and gender equality policy and bill (DWCPD 2012). Thus, the importance of understanding women's evolving status and circumstances in our modern society remains relevant and timely.

Worldwide, studies indicate that female academics are underrepresented at the senior levels of associate and full professor. The Association of American Medical Colleges (AAMC) reports that in the medical field more than half (52%) of the instructors and educators are female, although female associate and full professors represent only 31 and 19% of the total number of professors respectively (AAMC 2011: 6). An Australian study by White (2004: 228-239) found

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that women are over-represented as junior lecturers and particularly under-represented at the professor level (White 2004: 228-239). In the South African context, similar trends are seen regarding the representation of women in senior positions. The literature suggests various reasons for the lack of women in senior academic echelons, including a dearth of mentors and role models, discrimination in the workplace and general work-life balance challenges (Alpay et al. 2010: 135). As Sappleton and Takruri-Rizk (2008: 284) argue, the lack of females in the science, engineering and technology (SET) domain remains a great challenge.

The focus of this article is on the discourse of gender equality in the higher education environment with an emphasis on the SET fields. This article concentrates on the factors surrounding the representation of female academics in the areas of SET and aims to develop an understanding of both the opportunities and obstacles that women encounter in SET, particularly on the journey towards the attainment of the milestone of professorship.

2 Research context

This research finds its roots in the South African higher education context. The South African higher education landscape faces several challenges such as the need to increase access levels, a weak pipeline of entry-level students, transformation of higher education institutions, ageing researchers, funding constraints, and the requirement to increase knowledge capacity and contribute to South Africa's socio-economic imperatives (University of Pretoria 2011: 4).

The Council for Higher Education (CHE) reports that in South Africa there are 23 public higher education institutions which include 11 universities, six comprehensive universities and six universities of technology[2] (CHE 2012a). These public higher education institutions enrolled 892 936 students and awarded 153 741 qualifications in the year 2010. Science and technology-related quali-

2 Traditional universities: 'This refers to institutions that offer a broad range of general formative and professional programmes at both undergraduate and postgraduate levels'.
Universities of Technology: 'This refers to institutions (previously called technikons) that offer a range of programmes that are vocationally and/ or professionally-orientated, primarily at the undergraduate level'.
Comprehensive Universities: 'This refers to institutions that offer the full spectrum of programmes, including vocational, professional and general formative programmes at both undergraduate and postgraduate levels' (CHE 2012b).

fications amounted to just 37 405 in the same period (CHE 2012a). Moreover, only 1 423 doctoral degrees were conferred in the year 2010. These institutions employed 127 969 staff members in 2010 with a 52% representation of women overall and a total of 46 579 instruction and research staff members (CHE 2012b: 37-46).[3] The instruction and research staff comprised 46% females and 54% males. A review of the qualifications of these instruction and research professionals shows that 9 265 had a doctoral qualification (an essential requirement for professorship). Of the 9 265 academics in possession of a doctoral degree, the majority were male (65%) while females represented only 35% (CHE 2012b: 37-46).

Furthermore, the South African branch of the international non-profit organisation Higher Education Resource Services (HERS-SA) laments that:

> *In South Africa, the highest proportion of women are in the lowest academic positions and the lowest occupational levels in support departments, this despite employment equity legislation and the articulated priorities of the Department of Education (HERS-SA 2012).*

This research is situated within this concerning reality and attempts to grapple with the factors driving the lack of female professors within this context.

3 The case for women science, engineering and technology academics

A European Commission study argues that supporting female participation in the labour market is necessary for viable and long-term economic growth (European Commission 2009: 8). Additionally, a study in corporate Australia found that companies with female board members outclassed all male board companies (Corkery/Taylor 2012: 1-12). The Australian study further purports that there is growing proof that gender diversity contributes positively to organisational performance and innovation (Corkery/Taylor 2012: 1-12). Subsequently, the necessity for a parallel argument for the advancement of female SET academics may be questioned. Wallace and Marchant explain that academia in particular faces a diminishing workforce and if we are to advance the developing nations towards becoming knowledge economies it may require a strategic focus on attracting women (Wallace/Marchant 2009: 781). Also, Monyooe and Ledwaba maintain

3 Instruction/research professional: ‘A position in which (a) at least 50% of time is spent on instruction and/or research activities, and (b) the position requires a higher education qualification equivalent to at least 4 years of higher education study’ (ibid.).

that gender equity should not be disregarded since it contributes to economic growth and this is essential for a developing nation such as South Africa (Monyooe/Ledwaba 2004: 3) which is faced with skills shortages. Huyer (2003) argues that 'women's participation in science and technology related professions is critical for a nation's future' since it will increase creativity, technical capability and competitiveness and attract direct foreign investment. A similar view is offered by Goulden, Frasch and Mason, who raise the need for professors who are research focused since they are important contributors to science infrastructure and the development of future scientists (Goulden/Frasch/Mason 2009). It is within this milieu that this study seeks to understand the course of female academics towards professorship.

4 Research method and theoretical foundation

This article leans towards a critical-interpretivist philosophical paradigm. The critical stance was pursued because it is argued that 'social reality is historically constituted and that it is produced and reproduced by people' (Myers 2009: 38-44). Thus, social critique exposes the limiting circumstances of the existing state of affairs (Myers 2009: 38-44). Semi-structured interviews coupled with secondary data were used to illuminate the views of Gauteng-based South African women regarding the trajectory towards achieving success within the academic realm as represented by the attainment of professorship. The study was essentially qualitative in nature. The qualitative paradigm assumes a commitment to perceiving the world from the viewpoint of the research study participants (Brynard/Hanekom 2006), which in this study were female academics. The overarching research question was: *How can South African female academics in the Science, Engineering and Technology fields enhance their own career paths to reach the position of professorship?*

Respondents were identified through purposive and snowball sampling. Twelve female academics were interviewed, half of whom were professors with the balance representing lecturers and senior lecturers with doctoral qualifications. The number of years since respondents had attained professorship ranged from the newly appointed (one month) to those that are well established (17 years). The group had depth of experience in academia (average of 18 years) and within the SET field (an average of 15 years).

Rich data was collected through the interviews. A thematic analysis supported by concepts from a social science theory, namely, the actor network theory (ANT), was adopted to analyse the data gathered. ANT was used as a theoretical lens to illuminate the complexity regarding the trajectories of female academics. ANT, which is also known as ‘the sociology of translation’, concerns itself with the ‘mechanics of power’ in society (Law 1992: 379-380). ANT views society, families, organisations, the economy and other social structures as networks of heterogeneous actors (Law 1992: 379-380). These actors are both human and non-human (such as artefacts, text, machines, ideologies, concepts and animals) (Sarker/Sarker/Sidorova 2006: 51) and contribute to the formation, organisation and durability of the networks. ANT further questions how these networks of actors result in effects such as inequality and power in communities and organisations (Law 1992: 379-381). As McLean and Hassard (2004: 493) explain, neither human actors nor non-human actors are viewed as being more important than the other. The theory highlights the fact that the various actors have an impact on the network and by being within the network are influenced by the network (Teles/Joia 2011: 191). ANT emphasises that social networks are not stable (Latour 2005: 316) and, as Law (1992) purports, ‘social structure is a verb not a noun’ (Law 1992: 385). This article aimed to understand female academics through the idea that ‘people are who they are because they are a patterned network of heterogeneous materials’ (Law 1992: 383), resulting in the manifestation of a social order in academia. This research study focused particularly on the notion that the ‘social order is not final, it is never completed and is contestable’ (Law 1992: 386) to critique and understand the social structure of female academic career journeys in the SET environment.

5 Towards an Academic Network

To understand the journey towards professorship an analysis of the actors that contribute to the development and fostering of the academic network is investigated. The analysis aimed to ‘follow’ the actors since the heterogeneous actors (people and things) in this network result in a social structure (Law 1992: 386) that in this case is the social order which is said to be the ‘academic network of females in SET’. A myriad of actors influence the achievement of professorship and the current status quo with regard to female professor representation in academia. Various actors are captured below.

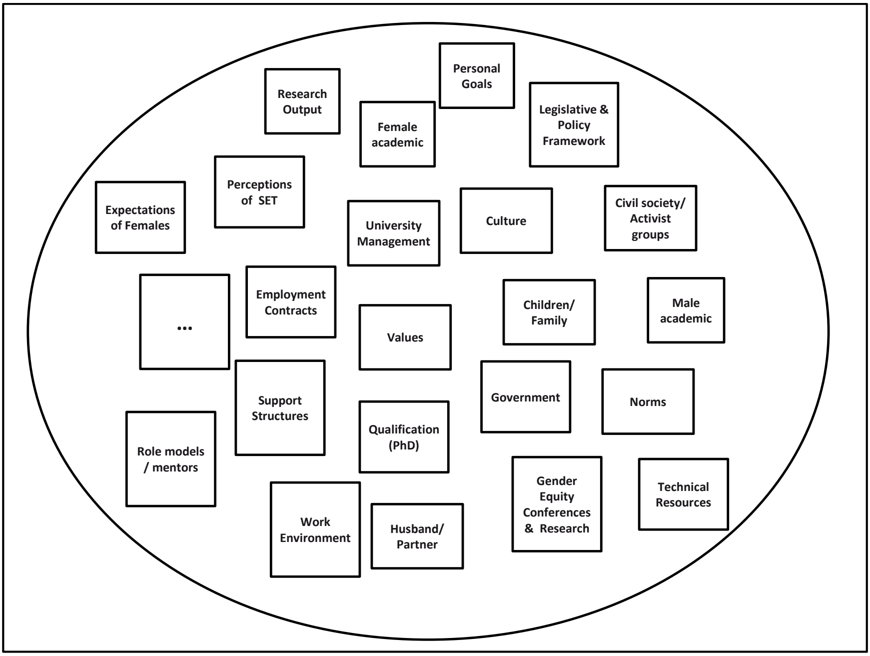

Figure 1: Sample of actors in the complex academic network

It is to be noted that the career paths of females to professorship are as unique as each individual concerned. However, various actors are included, indicating a complex interaction between the human and non-human influencers in the network with the perspective that humans are not 'necessarily special' (Law 1992: 383). The interests and actions of each of the actors vary and, as ANT argues, the interactions of the various actors may result in 'who female academics are'. The actors also influence the 'ordering' and structure of the academic SET network, as well as contributing towards or hindering the representation of women professors in SET. These actors (such as female academics, policies, societal culture, perceptions of women) through their interactions change the social order and are in turn changed by it. The article uses ANT to argue that the social order under investigation is dynamic and thus the current status quo can be challenged and transformed.

6 Exploring academic black boxes

Understanding and challenging the current social order of female SET academics requires an appreciation of the actors and their effects in this social order. The remainder of the article reflects on the data collected and analyses the status quo through the concept of 'black boxes'. According to ANT 'black boxes' represent actor networks (human and non-human) that have stabilised and cemented themselves such that alternatives to the network may not seem feasible (Whittle/Spicer 2008: 611). Resnik (2006: 179) cites the example of scientists as involved in endeavours to endorse their own research outputs and thus create them into 'black boxes', that is, 'into knowledge that is accepted and used on a regular basis as an unquestioned matter of fact' (Resnik 2006: 179). Thus, the article purports that there may be black boxes in the way the career paths of female SET academics are currently perceived. These black boxes are manifested in the representation of female SET academics in the senior positions of associate professor and professor. This article questions the network and its black boxes. As Law elaborates, some network patterns are entrenched and as such the network patterns are extensively reinforced and thus become 'punctualized' (Law 1992: 384-385). Furthermore, this is linked to the concept of 'irreversibility' that Mähring et al. explain as the extent to which the actor network or social order is increasingly difficult to change or even to consider alternatives (Mähring et al. 2004: 210).

The discussion on black boxes centres on three main areas: objectives of the pursuit of gender diversity in academia; the goal of becoming professors; and the perceived barriers and enablers of attaining professorship.

a. The pursuit of diversity in academia

In this section the black box pertaining to the desirability of diversity in academia is explored. Haataja, Leinonen and Tervonen indicate that that the notion of gender equality means that the 'different behaviours, aspirations and needs of women and men are equally valued' (Haataja/Leinonen/Tervonen 2006: 8). As Hoover (2006:154) argues, diversity is a desirable goal and efforts should be made to address inequalities. The respondents reiterated this by stating as follows: *'It's important for South Africa to have more diverse people at professorship level', 'We have a diverse society and everyone needs to have a voice and be heard' and 'It's good to have diversity'*. However, interestingly, some argued against pursuing diversity for the sake of having 50% women professors, which they referred to as 'number crunching'. These respondents believed that there should not be an artificial 50:50 split. Therefore, if the split is 60:40 with more men being represented and they are competent then that is fine; conversely, if the opposite is true and more women are capable and ready then the professorship figures should show more women. The discussion on diversity also turned to the issue of discrimination based on gender. Some of the respondents faced discrimination: *'When I initially applied for professorship I was asked if I would cope with children which I felt was discrimination.'* However the overwhelming majority felt that there was no discrimination *'I have never had problems with gender equality issues or discrimination. I have never found any discrimination because I am a woman' and 'I don't think there's discrimination. I personally haven't experienced it'.* As the literature indicates, diversity remains an issue and some respondents agree *'We aspire to get gender equality but we are not quite there yet. It mirrors our society',* but not all female academics perceive it as such. *'I don't think it's an issue of men versus women. If everyone does their job it will solve the problem.'* Another respondent argued *'I don't want to be a woman in engineering. I am an engineer and as long I do my job and do it well it doesn't matter if I am a woman or man.'* Furthermore, another lamented that *'I think it's easier to work with men' and 'why do we have conferences where we whine about how bad it is'.*It would therefore seem that one cannot use the premise that all women perceive gender diversity and representation positively.

b. The goal of professorship

The question of interest relates to whether female academics desire professorship and how the attainment of such a goal is perceived. There is definitely a need for professors who are research focused, as such professors may enhance science infrastructure and groom future researchers (Goulden/Frasch/Mason 2009). The majority of the respondents believe the goal of professorship is desirable. As they indicated, becoming a professor means that your efforts and contributions to your academic field are recognised. However, becoming a professor is not necessarily the ultimate measure of success since '*you may be a lecturer or senior lecturer and be content and happy with what you are doing*'. Thus, respondents often referred to the personal ambitions of each woman and the fact that these may differ. The discussion also made it clear that '*some women just do not aspire to be professors*' and that '*it is their choice*' and '*it's okay not to be a professor*'.

To further understand what factors may be contributing towards the attainment of professorship, respondents were quizzed on their views of the academic system as a meritocracy. Essentially, the interviews explored the question: Is the awarding of professorship based solely on merit? Respondents agree that appointment to professorship appears to be based on merit. A candidate needs to show a substantive publication record, have supervised master's and doctoral students, and have obtained national and international recognition such as the National Research Fund (NRF) rating. One indicated that '*In academia professorship is based solely on merit and it must be'* and another '*Yes it is merit. I have just been through it. It is very rigorous*'. One respondent did raise the need for the requirements for professorship to be made clearer and objective: '*But how much is enough is not clear. Is it 20 papers? Is it 10 students? A million rand research project? What are the criteria? I know it's something you can push and say "I believe I'm ready" but based on what?*' Those who had attained professorship reflected on the journey as being fulfilling; however, even after achieving the professorship some women felt that they were still constantly trying to '*prove themselves*'.

c. Barriers and enablers for professorship

This discussion seeks to highlight respondents' thoughts on what is actually perceived as barriers and enablers in the achievement of professorship. Women have progressively entered domains that were historically the territory of men (Doucet 2011: 16). However, there are persistent issues such as the leaky pipeline and the scissors that are still faced in the present day (European Commission 2009: 8). The aptly termed 'leaky pipeline' refers to 'the steady attrition of girls and women throughout the formal Science and Technology system, from primary education to Science and Technology decision making' (Huyer/Westholm 2013). It is said that the attrition of females from SET is as a result of a variety of reasons: socio-cultural practices and socialisation of females, access to further education, experiences in employment, and institutional and financial challenges (Huyer 2003). The respondents raised a variety of barriers to becoming a professor, including a lack of a talent pool of young scientists, women focusing excessively on teaching and administration, not obtaining the PhD early on in one's career so as to establish a publication record and general work-life balance matters. Women's varying responsibilities in the home featured strongly along with the lack of time to complete research. A respondent who had chosen not to marry and have children raised a thought on this '*well if they don't marry there are no* *barriers*'. This highlighted the difficult choice that women constantly have to make with regard to choosing between family and their careers. However, despite this real difficulty the academics interviewed seemed to display a resilient spirit: '*Yes it's male dominated but just toughen up! Have staying* power' and '*Just cope!'*.

The perennial question of why women seemingly have less successful science careers may also be explained by the deficit versus difference models offered by Sonnert (1999). This model purports that the reason for the underrepresentation of women in SET may be found in the notion that women are treated differently (deficit model) or that women act differently (difference model) (Sonnert 1999: 34). Thus, either women face structural obstacles to their progress in SET or they have different and deeply entrenched beliefs, outlooks and goals from men which influence their success as academics in SET (Sonnert 1999: 34). This was posed to the respondents and there was no agreement among them regarding which model prevailed. Some believed that there were no structural barriers (deficit model), while other said sometimes examples of the deficit model are observed:

> 'We were reviewing funding applications and somebody said "I wouldn't fund a woman who is in the age 30–35 since she will leave and have a baby". But we don't make babies by ourselves but we seem to be penalised for it as if there is something wrong with having a baby. People look at women having babies as if there is something wrong.'

Regarding the difference model the women would not fully accept that publication and attainment of professorship were solely because they were different from men:

> 'I don't feel comfortable with the difference model. Women are still primary caregivers and thus our attention is split. Physically there will be years where you can't be as productive but when the kids are bigger it will even out.'

They acknowledged that there may be a period in their lives where they do not have as much time as their male counterparts to dedicate to research; however, this is not a reflection of their ambition or ability.

With regard to the enablers, some women felt there were no specific initiatives targeting women and felt that this was satisfactory since they did not want to be treated differently from men:

> 'There are same opportunities for men and women. I don't think there's anything specific being done for women. I was previously tasked with setting up a "support group" for women. Every person I spoke to said no we are strong enough; we don't

> want to be looked down on as if we need extra help. We are just as good as the men.'

Other respondents did, however, identify specific support structures that they had been exposed to in their careers. These ranged from a supportive legislative environment in South Africa, access to bursaries, funding and research sabbaticals, and role models and mentors who can guide young researchers.

7 Conclusion

A multitude of problems face women and contribute to their scarcity, not only in the SET arena overall but also particularly in senior positions within SET academia. The EU argues that the underrepresentation of women in SET cannot be accepted since 'women represent a competitive reservoir of talents', and 'men and women share the same ambition to succeed in their professional and personal life' (European Commission 2009: 5). Wallace and Marchant support this argument, viewing women as a 'rich but untapped source of skills and knowledge' (Wallace/Marchant 2009: 782). An additional argument for the advancement of women in SET focuses on the notion that it will improve the scientific knowledge output since diversity could widen the way in which research problems are approached and multiple perspectives and solutions are offered (Sonnert 1999: 34).

This article focused on female academics in SET fields and investigated the way female academics can enhance their career paths to reach the position of professorship. By considering the main actor involved the complexity of the matter was illuminated. As Fadigan and Hammrich (2004: 835) maintain: 'it is impossible to identify one single cause since all issues affecting women's choices whether to participate in SET careers are complex and interrelated'. However, the study profiled the voice of an integral actor, the female academic, and through the female academics' views further supported the need to reconsider what society has accepted as reality regarding female progression in academia. This questioning of reality must take into account that 'social order is not final, it is never completed and it is contestable' The face of SET professors can change so that comments such as those made by respondents in this study: '*Are you a professor? You don't look like a professor!*' may be very different in the near future.

8 Limitations and opportunities for future research

Research studies face various limitations. This study was qualitative in nature and is thus shaped and influenced by the researcher who is not an objective observer. Also, the use of ANT as a theoretical and analytical lens is challenged because the theory has been accused of not always suited to critical research (Whittle/Spicer 2008: 611). It is also criticised as being excessively goal directed and may ignore the unique factors that influence the formation of an actor network (Andrade/Urquhart 2010: 352). However, the theory has promoted research that follows the actors and interrogates ideas that may often be accepted as 'just the way things are' (black boxes).

Owing to the nature of the study it focused on a small sample of respondents who were interviewed in order to understand the research problem from their personal experiences. This may reduce the generalisability of the findings; however, it is still believed that the respondents' views illuminated the central challenges and opportunities faced by female SET academics. Future research may possibly focus on broadening the study to a wider group and soliciting the views of a greater number of female SET academics through the combination of a survey with questionnaires and focus groups nationally.

9 Lessons to learn for women in science, engineering and technology

The article revolved around the question: 'How can South African female academics in the SET fields enhance their career paths to reach the position of professorship?' The female academics who contributed to this study shared various lessons for young female academics, some of which are reflected below:

- Complete your master's and doctoral qualifications as soon as possible (if this is an option prior to starting a family).
- Once qualified with a doctoral degree establish a publication record. If you are unable to travel to conferences as a result of having a young family, focus on publishing in established journals.
- Actively seek feedback and mentorship. Identify senior colleagues in your department and ask them to help you; collaborate and publish with them.
- Time management – women are hard workers and often take on additional responsibilities in the workplace that their male counterparts do not. Do not fall into this trap; rather learn to say no and prioritise your time for research.

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In Search of the Glass Ceiling: What Mechanisms and Barriers Hinder Qualified Women from Progressing in Academia?

Josefine Lühe[1]

1 Introduction

Despite women's achievements in higher education – more than 50% of university graduates in Germany are female – the proportion of women in top positions in science is still relatively low and 'gets more pronounced on the higher rungs of the academic career ladder' (Gottschall 2010: 256). Although the number of women who are appointed to a professorship has been increasing since 1990, the proportion of female professors was only 19% in 2010 (Statistisches Bundesamt 2012: 26) and the proportion of women in C4/W3 professorships (15%) is still lower (ibid).

Another aspect which should not be overlooked is the differences between the academic disciplines. Whereas languages and cultural studies have a relatively high proportion of female professors (33%), the proportion of female professors in the natural sciences is 13% and in engineering only 9% (ibid: 27). This shows that the science sector is vertically and horizontally segregated: men and women work in different disciplines and in different hierarchical positions (Lind 2004: 9).

Today, the under-representation of women in top positions in the science sector has become a major political issue and there is a large body of research focusing on gendered socialisation processes, the educational system and the problems of reconciling work and family life (for a summary see Lind 2004). However, a sociological perspective should also take into account the science sector itself (Krais/Beaufaÿs 2005: 30f.).

Therefore, this article interrogates those mechanisms and barriers within the organisations of science itself which produce and reproduce gender inequalities.

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First of all, the role of sex as a fundamental code in interactions will be explained. This part includes gender stereotyping, gender status beliefs, the correlation between the image of the ideal scientist and the male gender stereotype as well as statistical discrimination. Secondly, the concept of tokenism by Rosabeth Moss Kanter will be discussed and the under-representation of women in networks of professional contacts will be explained. Finally, the concept of gendered organisations as conceptualised by Joan Acker will be introduced and the increasing importance of international mobility will be discussed as both a means of distinction and an organisational image of success.

2 Sex as a fundamental code in interactions

2.1 Categorisations

When in each other's presence, individuals make characterisations of the other individuals around them. This characterisation is organised around two fundamental forms of identification: (1) the categorical kind, by which the other is placed in one or several social categories and (2) the individual kind whereby the other is assigned a unique identity according to, for example, appearance, voice or name (Goffman 1983: 3). Although there are several social categories such as age, race and class, 'sex is at the base of a fundamental code in accordance with which social interactions and social structures are built up' (Goffman 1977: 301). The aim of this categorisation is to anticipate the behaviour of other individuals.

Even though in the workplace the relevant social categories are already defined (e.g. professor vs junior researcher), sex constitutes a background identity throughout interaction and therefore functions as an invisible hand that stabilises and reproduces inequalities in the workplace (Ridgeway 2001: 251). A prerequisite for the powerful impact of sex categorisation is the existence of 'ideas about how people who have been categorized as male or female, generally act' (ibid: 255). These ideas can be found in gender stereotypes.

2.2 Gender stereotypes and gender status beliefs

By simplifying complex situations and information, stereotypes influence not only our behaviour but also our perception of the world and the individuals around us (Pasero 2003: 112). Gender stereotypes are 'cognitive structures that include the socially shared knowledge about the characteristics of men and women' (Eckes 1997: 17). They include expectations about character and personality traits and patterns of behaviour which are the result of cultural norms and values. The male gender stereotype can be characterised by the following attributes: independent, dominant, rational, ambitious, determined and confident (ibid: 57). The female gender stereotype, on the other hand, can be characterised by attributes such as dependent, gentle, communicative, affectionate, understanding and warm-hearted (ibid).

Gender stereotypes on the one hand arouse specific expectations and therefore influence the way in which men and women are perceived by others. Women, for example, 'tend to be perceived as aggressive whereas men exhibiting the same behavior are seen as decisive' (Foschi 1992: 181). In the science sector, women are continuously confronted with gender stereotypes which ascribe low achievements to them and which devalue their potential (Kahlert 2013: 132). On the other hand, gender stereotypes are also part of the self-perceptions of individuals. As a consequence, they have an influence over their own behaviour, which means that they conform to gender stereotypes (Pasero 2003: 112).

However, gender stereotypes alone do not necessarily result in inequality. The crucial point is, however, that they contain assumptions about a different social status for men and women. Research has shown that 'male' character traits are considered to have a higher status than 'female' character traits. This is what Ridgeway terms *gender status beliefs* (Ridgeway 2001: 255f.). Again, these gender status beliefs influence both the way individuals are perceived by others and their own self-perceptions. Studies show that 'the sex of the performer biases the evaluation of performances in achievement contexts, so that men's contributions to the task solution are judged better than women's' (Foschi 1992: 181f.). Therefore, junior and even senior female scientists often experience that their achievements are devalued by their male colleagues (Beaufaÿs/Krais 2005: 90).

2.3 The correlation between the image of the ideal scientist and the male gender stereotype

Attributes which are considered to be factors of success in science often connote 'male' attributes (cf. Beaufaÿs 2012: 87 and table 1). According to an analysis by Hageman-White, scientists feel that they have to present themselves as dominant, aggressive and rational (Hageman-White 1992: 248).

Table 1: The correlation between the ideal scientist and the male gender stereotype

Male gender stereotype	Ideal scientist	Female gender stereotype
Dominant	Dominant	Subordinated/submissive
Aggressive	Aggressive	Understanding
Rational	Rational	Emotional
Independent	Independent	Dependent
Restrained	Restrained	Warm-hearted

Source: Rosenstiel (1992: 173), modified

According to Leeb (2004), there are two different categories of tasks in academia. On the one hand, there are the teaching and mentoring of students, which are less valued and associated with 'female' character traits. On the other hand, there are prestigious tasks such as publishing and research which are associated with the mind and therefore with 'male' character traits. As a result, women are often overloaded with teaching and mentoring, whereas their male colleagues can engage in academically valued tasks which improve their career prospects such as research and publishing (ibid: 126f.). As a consequence, women often have less publications and research on their curriculum vitae than their male competitors when it comes to evaluating their 'professionality'. However, female researchers who do engage in publishing and research are often considered to be 'aggressive, masculine and difficult' (ibid). This indicates that women in the science sector are not only confronted with role conflicts, but also with a high amount of uncertainty about their career opportunities since the judgement of academic achievements is biased in favour of 'male' attributes. As a consequence of these gender stereotypes and status beliefs, women tend to be more self-conscious and underestimate themselves and their achievements, which, in turn, can have a negative impact on their career advancement.

2.4 Statistical discrimination

Although overt forms of discrimination have lessened in the past decades, subtle forms of discrimination persist (Lind 2004: 100). Gender stereotyping and the activation of gender status beliefs can result in statistical discrimination (Arrow 1973). Statistical discrimination is an economic theory used to explain group inequality: 'the basic insight is that race or gender may be a useful signal of productivity, provided that productivity is imperfectly observable and correlated with group identity' (Norman 2003: 615). Therefore, individuals belonging to different groups may be treated differently, even if they are as equally qualified and competent, since their employers make use of group averages in order to evaluate them.

As a result of the existing gender stereotypes, women are expected to be less productive, less motivated and less interested in the advancement of their career. Moreover, they are perceived as potential mothers who are therefore less resilient and more likely to interrupt (full-time) work. As a consequence, women face disadvantages concerning their career prospects: they are less likely to be offered interesting and prestigious positions and projects as well as further education (Osterloh/Littmann-Wernli 2000: 263; Zimmer/Krimmer/Stallmann 2007: 81). Finally, women realise that they face disadvantages relating to their career prospects and invest more time in other activities.

Eventually, such discrimination can result in a 'vicious circle of statistical discrimination' (Osterloh/Littmann-Wernli 2000: 263) and become a self-fulfilling prophecy.

3 Female scientists as tokens and their under-representation in networks

3.1 Female scientists as a minority group

The theory of tokenism, introduced by Rosabeth Moss Kanter (1977), argues that women's organisational experiences cannot be explained by their personalities and socialisation but rather by their status as a minority group,[2] which leads to three main issues in the workplace.

First of all, their minority status leads to higher visibility – 'they are subject of conversation, questioning, gossip, and careful scrutiny' (ibid: 212) and it is not only their success but also their mistakes and their private lives that are made known to other members of the organisation. It is because of this visibility that women feel that they are forced to give an outstanding performance, since 'the token does not have to work hard to have her presence noticed, but she does have to work hard to have her achievements noticed' (ibid: 216). A study by Zimmer, Krimmer and Stallmann (2007: 166) confirmed that female professors think that they have to work harder than their male colleagues in order to get the same amount of recognition. However, although women often feel that they have to

2 Therefore the theory of tokenism can also be applied to other minority groups.

excel, they also feel that they should not 'make the dominants look bad' (Kanter 1977: 217) and therefore decide to keep their success to themselves.

The second tendency is assimilation. Women who are in the position of a token are not only perceived as individuals but as representatives of their minority group and they are 'more easily stereotyped than people found in greater proportion' (ibid: 211). Therefore, they are often 'measured by two yardsticks' (ibid: 214) – how as a woman they carry out the role of a scientist, and how as a scientist they 'live up to the image of womanhood' (ibid). Since the female gender stereotype and the image of the ideal scientist include opposing attributes (rational vs emotional, aggressive vs understanding), women are likely to fail in one of the categories, but it is easier for tokens to find an identity by conforming to the pre-existing stereotypes.

The third phenomenon is the polarisation and exaggeration of differences. Whereas members of homogenous groups are likely to remain unaware of their common culture, the presence of a minority group increases the self-consciousness of the majority group. Its members become aware of the commonalities they have as well as of their differences from the tokens. In order to underline their affiliation with the dominant group, they tend to emphasise their differences from the minority group by stressing their commonalities and thereby keep the tokens somewhat outside (ibid: 210f.). A way of drawing the distinction between 'male' and 'female' is to organise 'masculine' activities such as watching football together. Although it is not forbidden for female researchers to participate in these activities, they are not very likely to include them either. However, since it is often in these informal contexts that important information is exchanged and scientific ties are deepened, these practices result in a disadvantage for women.

All in all, women who are tokens are 'symbols of how-women-can-do, stand-ins for all women' (ibid: 207) and their situation generates 'a set of attitudes and behaviors that appear sex-linked […] but can be understood better as situational responses, true of any person in a token role. Perhaps what has been called in the popular literature "fear of success in women" […] is really the token woman's fear of visibility' (ibid: 221).

In her autobiographical report, Renate Mayntz, a German sociologist, illustrates her situation as a token by saying 'what bothered me most about my female minority status was that I remained excluded from the camaraderie of my male colleagues; sometimes I even felt like a circus horse whose feats they can be proud of' (Mayntz 1996: 235).

3.2 The under-representation in networks as a result of the token position

Whereas sixty years ago networks were regarded as a substitute for individual achievements, today they are considered to be an important factor for career prospects (Schneidegger/Osterloh 2004: 199). Research on gender and networks has shown the under-representation of women in (informal) networks of professional contacts, even if they occupy the same position as their male counterparts (cf. Zimmer/Krimmer/Stallmann 2007: 166), which has had a negative impact on their career advancement.

This under-representation can be explained by the historical and numerical domination of men in the important and powerful positions in the organisations of science, as well as by the mechanisms through which new members are accepted into networks. An important criterion is stereotypical self-similarity which means that the more similar a person is to another, the more positively he or she will be assessed. Therefore, women are disadvantaged because they are perceived to be ‘different’ (Ohlendieck 2003: 177 f.).

However, networks of professional contacts within the scientific community play a vital role in career advancement; they provide detailed internal information on vacancies in advance (Zimmer/Krimmer/Stallmann 2007: 92) and can assist in finding a mentor. In Germany in particular, the advice and help of a mentor is of great significance in the science sector (Krais/Beaufaÿs 2005: 41). Mentors not only give advice, for example on publication in international journals, but also occupy a privileged position in relation to essential resources such as jobs, research funds and professional contacts within the international scientific community (Zimmer/Krimmer/Stallmann 2007: 121). However, the relationship between mentor and mentee is also often characterised by self-similarity. Since women are under-represented in prestigious positions, it is more difficult for female researchers to find a mentor.

A study conducted by Zimmer/Krimmer/Stallmann (2007) shows that over 65.5% of female professors think that it is the informal networks that provide power, whereas only 39.4% of their male counterparts are of the same opinion (ibid: 164). This can be explained by the fact that the majority of male professors are part of these networks, whereas two out of three female professors think that women are under-represented in these networks – 42% of the interviewed females even believe that women are isolated from them (ibid: 166). As a result of their under-representation in networks, women are less integrated within the scientific community than their male colleagues. Consequently, their research is less visible which means that they have to work harder in order to get the same amount of recognition.

4 Gendered organisations and international mobility as an organisational symbol of excellence

4.1 The production of gendered social structures within organisations

Although hierarchies and the concept of academic positions in scientific organisations such as universities seem to be gender blind (Beaufaÿs 2012: 92) and jobs are often characterized as '"empty positions" waiting to be filled by the best applicants, regardless of gender' (Martin 1992: 208), organisations are not gender neutral (Acker 1977) but mirror society by paralleling the gendering practices of families and other existential groups (Martin 1992: 208). If organisational structures, processes and cultures are gendered, this means that 'advantage and disadvantage, exploitation and control, action and emotion, meaning and identity, are patterned through and in terms of a distinction between male and female' (Acker 1990: 146). According to Acker, gendered social structures within organisations are produced by at least four interacting processes.

The first process consists of the procedures and activities that are necessary in order to organise and structure the organisation, such as creating employment opportunities and conditions, rules about performance evaluation or working hours and time off (Acker 1999: 180). These activities and procedures result in organisational divisions along gender lines. The domination of men in the highest academic ranks such as C4/W3 professorships, as well as the overburdening of women with less valued tasks such as teaching and mentoring, are excellent examples of these gender divisions.

Secondly, gendered structures are produced by the creation of images and symbols that explain, convey and reinforce these gender divisions. (Acker 1999: 182). The images and ideologies of success and excellence, managers and working hours do not only influence the rules for wage setting and hiring, but also the gendered division of labour. Moreover, they are based on the ideal of a 'disembodied worker' who 'exists only for the work' (Acker 1990: 149) and does not have any other obligations, such as childcare or housework, apart from this work. However, studies show that even in academic couples, women carry the main responsibility for the children and the housework (Lind 2012: 286). According to Zimmer (2004), two-thirds of male professors say that their preschool children are looked after by their wives or partners, whereas the same applies to only eight per cent of the female professors (Zimmer 2004: 82). These findings indicate that men can approximate the ideal of the 'disembodied worker', whereas women almost always cannot. As a result of their overload with both their private and professional obligations, they have less time than men to invest in research and further qualifications, the disadvantages of which, over time, accumulate and create another career disadvantage.

Thirdly, it is the interaction between men and women in the workplace which produces gendered social structures. Although there are some interactions in which gender is not present, there is a large body of research describing the ways in which 'gender is produced even in ordinary encounters between equals in the workplace' (Acker 1999: 184) and which shows gender differences in interruptions, turn taking or setting the topic for discussion (Acker 1990: 147).

The fourth process which produces gendered social structures in organisations is the 'internal mental work of individuals as they come to understand the organization's gendered expectations and opportunities, including the appropriate gendered behaviors and attitudes' (Acker 1999: 184). As a result of the other processes, the concepts of job requirements, career prospects and workplace behaviour that men and women have differ from each other and this, in turn, affects their careers.

All in all, the described gendered organisational structures, processes and cultures create a strong barrier for female scientists since they are biased in favour of the male majority group and create an extremely complex interrelation which affects different organisational levels.

4.2 The imperative of international mobility

An example of an organisational image of success that is not gender neutral but produces gendered organisational structures is the imperative of international mobility. In the past few years, international experience and mobility have become extremely important in all disciplines and are perceived as a symbol of rationality, progress and excellence. Therefore, it has become increasingly important for scientists to go abroad at some point in their career (cf. Leemann/Boes 2012: 197 f.). However, this organisational symbol is based on the ideal of the 'disembodied worker' who does not have any other obligations apart from work. Studies show that women are less likely than men to spend some time in an English-speaking country in order to conduct their research (ibid: 198). Among other factors, such as their overload with both private and professional obligations, this lack of international experience is considered to be a result of their lack of mentoring by senior scientists who occupy prestigious positions.

All in all, the lack of international experience is a disadvantage since it results in a lack of international cultural and social capital, the possession of which can be crucial when competing for national and international recognition. Therefore, the increasing importance of international mobility cannot only be interpreted as a demand brought about by globalisation, but also as a search for new differences in times when women are equally as qualified as men (cf. Hofbauer 2004: 56).

5 Conclusion

The under-representation of women in top positions in science cannot only be explained by gendered socialisation processes, the educational system or a lack of childcare facilities, but also by the organisations of science itself. This is where men and women enter employment, where they are involved in interactions and where they start and pursue their careers. Moreover, hierarchies and the concept of academic positions in scientific organisations are not always gender blind and the ideals and images of success and excellence are based on a 'disembodied worker' who exists only for the work. Therefore, the science sector and its organisations play a vital role in the (re-)production of gender inequalities. Their glass walls and ceilings that hinder qualified women from progressing in academia consist of subtle mechanisms which often seem to be invisible to the individuals themselves. In the workplace in particular, people do not necessarily realise that social interactions and social structures are built on the basis of sex or at least influenced by it. That is why the knowledge of these processes and mechanisms is of great importance in identifying starting points for establishing equal opportunities.

6 Lessons to learn for women in science

Whether in science or in finance, no matter what career women pursue they have to recognise that, in the workplace, sex often constitutes a background identity that influences both the way they are perceived by others and their self-perception. With this awareness, it is possible to identify even subtle discrimination and to develop strategies to counter it.

There are a number of strategies that have been identified in the research literature, as well as at the conference on Women in Science – Promoting Excellence and Innovation for Future Development, which might help female scientists.

For students who are pursuing a career in science, it is advisable to apply for a job as a research assistant. By working in the science sector they will not only experience what working in this sector is like but they will also come into contact with senior scientists who might eventually become their mentors and give them advice and support concerning their academic career. Moreover, certain universities offer their female students special mentoring programmes and courses on presentation skills in order to prepare them for a professional career by, for example, teaching them how to counteract the differences in turn taking or interruptions in discussions dominated by men.

For junior researchers it is important to build up a network of professional contacts within the scientific community in order to get internal information on, for instance, vacancies and projects in advance. Moreover, these networks provide the possibility for (international) collaboration and joint publications. Since the amount one publishes is considered to be an indication of success, this form of publishing should be kept in mind. Moreover, the possibility of pursuing a career at a university of applied science should not be overlooked, since the career paths at these institutions are more flexible and differ from those at universities.

Senior researchers could become mentors and share their career experiences and – if experienced – their difficulties in order to serve as role models for younger researchers.

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Women, Research and Universities: Excellence without Gender Bias

Without crisis no change and no change without crisis

Bettina Schmidt[1]

1 Introduction

While all can agree on the wording of the first line of the heading, the subtitle is provocative but intentionally chosen. What will it take to bring about equal opportunities for women and men in science? Will change come about in academia as a result of a general understanding that women and men can and should contribute equally to science and innovation or do we need a crisis for change to happen?

With decades of committed work on equal opportunity and equity in academia, and the limited tangible results and impact achieved, it is worth considering aspects such as specific instruments, interventions and good practice examples which could assist us in bringing about more significant and tangible progress.

In the past years, scientific research and innovation have brought about decisive changes and achievements in all spheres of our lives: in entrepreneurship, in technological advancement, in global mobility, in the financial and construction sectors, and in space – the list is endless.

In contrast, the achievements in creating inclusive academic institutions by achieving equal status for women and men in academia are negligible, not to speak of the inclusion of minorities. Nevertheless, gender institutes and specific gender study programmes exist, and we have a small but growing number of women in professorships and as heads of higher academic institutions. However, the most striking aspect of the last 30 years is the feminisation of the student population.

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On the other hand, this positive trend in the student population has not resulted in a significant increase in the numbers of women climbing the career ladder. In higher education in Europe and in other parts of the world, academia loses a considerable amount of female intellectual capacity. Women drop out at various junctures and for various reasons.

Furthermore, we see great variations in the different degree programmes, with very low numbers of female students in the MINT subjects (Mathematics, Engineering, Natural Sciences and Technology) and SET (Science, Engineering and Technology). The low numbers of female intakes is one of the reasons for the low numbers of women working in these professions and of female professors in these subjects.

The gender pay gap is manifest in academia just as in other labour sectors. Moreover, women receive less funding from research grants. A gender dimension in research is not widespread nor has it been well received. Lists of conference speakers – apart from certain niche subjects – are still male dominated. 'Old boy's networks' are in place and provide men with opportunities to be heard and represented. Examples are personal invitations to fill posts, to publish or to speak at conferences.

Irrespective of all the efforts and debate, the experiences of women in science largely correlate and are a reflection of the situation in other spheres of society, neither better nor worse.

The history of the struggle for gender equity at universities is well documented. During the late 1980s, gender equity became a major issue at universities and a few women came to occupy professorships in science. By then it was assumed that their numbers were low compared to men because fewer women were interested in science. With increasing pressure on universities, starting in the United States (US) and spilling over to Europe and other parts of the world, to open up universities to women, ethnic and other minorities, various investigations were undertaken especially at the prestigious institutes of science.

While mission statements of universities stress that they strive to recruit, retain, promote and support the highest quality faculty members, surveys undertaken have uncovered that in practice subtle biases and examples of discrimination and inequities between men and women prevail. Findings have shown that women, for example, have offices and laboratories that are about half the size of their male colleagues of equal status. This is also the case for researchers from minority groups. As women progress in their academic careers they face biases against their qualifications as excellent researchers. At the individual level these biases are less obvious, but at a group level, such as women in science, the effects of bias and mechanisms of exclusion become more obvious and significant. But what has this to do with the crisis mentioned in the subtitle?

Let's not be too hasty and negative by declaring the present situation we have in academia a crisis. Let us first look at the headlines and slogans we have encountered in recent months. Let us also find out how leading professionals in academia and various academic bodies have responded to this situation. It is worth looking at the whole picture and to be open to the continuum of statements from: 'There is no crisis', 'We have done all we can, but change takes time', 'Well, there are some problems, but ...' to 'We are facing a crisis and therefore we will do 1, 2, ...'

2 Headlines 'made in Germany'

The various issues and challenges addressed here are 'made in Germany' and hence specific to this country. But I would assume that the various issues and challenges addressed here, are also debated in South Africa and therefore applicable to other parts of the world.

- Universities, albeit with a few exceptions, lag behind in fulfilling the legal requirements for equal opportunities and gender equity. They even face problems in reaching their own set targets.
- With the increase in worldwide competition between universities for the best talents in teaching and research, for talented students and for staff in science management, expectations have risen and universities are struggling to retain this talent. Universities have responded to the need and established programmes on 'dual careers', mentoring and the 'family-friendly university' in order to attract and retain staff.
- Demographic change in industrialised countries is as much of a challenge to universities as it is to society in general. The population of countries such as Germany is getting older, decreasing (with an estimated reduced labour force of 7 million by 2025) and becoming more diverse.
- Studies done by the Organisation for Economic Co-operation and Development (OECD) present the paradox higher education faces as a result of the economic crisis. Institutions of higher education are viewed as playing a key role in economic recovery, ecological and sustainable development. Yet many institutions cannot meet the rising demands. They are struggling to

improve their responsiveness as well as to improve access to higher education (OECD 2011: 11).

- Studies provide evidence that access to universities is not solely based on individual talent. Hence, universities need to make sure that students, irrespective of gender, socio-economic status or cultural/ethnic origin, have equal access to universities, a fair chance to complete their degrees and opportunities to advance towards an academic career.
- So far universities in Germany have not provided specific programmes for recruiting students and academic staff of minority groups based on a 'package' of personal accomplishments, including, but not limited to, grades. In contrast to the growing awareness at universities in the US, in Germany people do not realise that if the selection process is limited to, say, grades only, the process is in fact discriminatory. By doing so, institutions favour the dominant culture.
- There is a major shift from secure tenure to contingent academic labour as part-time and full-time non-tenure career tracks. In his study, Kreckel (2011: 9) shows that in 2008/2009, 74% of academic staff in Germany had temporary contracts compared with about 26% in France and about 28% in the United Kingdom (UK). Heads of administration and faculties argue that temporary employment saves universities money and gives them greater flexibility in their efforts to strive for excellence. However, there is the danger that as a result of job insecurity scientists become lost to the profession and that their work is affected by the stress associated with uncertainty about their future. This tendency affects all, men and women, but differently.
- The study on 'Science and parenthood? Childlessness and tenure conditions for academic staff at universities in Germany' by the German Federal Ministry of Education and Research (BMBF), undertaken between 2007 and 2010, revealed that there is a correlation between childlessness among female and male scientists and the insecure tenure positions of mid-level non-tenured staff. The overwhelming majority in this study – about 80% – were temporarily employed, while 45% worked part-time. Of the non-tenured staff, 79% were childless, double the amount of tenured staff. The study also asked men and women how parenthood had affected their academic career. In response, 48% of mothers and 24% of fathers stated that they experienced negative consequences. The people interviewed stated that with increased job security their attitude towards parenthood would be more favourable. Hence, childlessness has to be interpreted as an indicator for the existence of great difficulties at German universities in accommodating a work-life-balance for employees (BMBF 2010: 14-15).

- Reports such as 'Fünf Jahre Offensive für Chancengleichheit von Wissenschaftlerinnen und Wissenschaftler' (Five-year offensive for equal opportunity of women and men in science) in Germany presented by the German Council of Science and Humanities (Wissenschaftsrat) in 2012 revealed that voluntary self-commitment did not provide the targeted results. Apart from a number of successful measures – which I will outline below – the Report made clear that more stringent measures are needed in order to ensure that the representation of women in science reflects the demographics of the population. The Report stresses the need to formulate targets more specifically, to monitor measures taken and possibly create financial incentives in order to make a measurable impact (Wissenschaftsrat 2012: 40-41).
- Children and career? *In dubio contra scientiam – in (case of) doubt against science*: Women with children aiming for an academic career face numerous obstacles and therefore often find the decision to have or forgo children very difficult. The problem arises as a result of the fact that the years during which female scientists undergo crucial steps in their academic career coincide with their child-bearing phase. This phase, also termed the 'rush hour of life' is a challenge not only for female scientists but also for universities in retaining talented staff.
- The quota discussion. The proponents of a quota system argue that the number of women in leading positions in universities is so minute that without stringent laws and legal directives no significant change will take place in the near future. The call for quotas is gaining popularity but so far the arguments of those rejecting a quota for women in leading positions dominate. It can be argued that in executive positions in business, in politics, in the public sector as well as in academia, a male quota exists, reaching almost 100% the higher the position. And why are pro-quota arguments so seldom heard? Men also benefit from women in leadership: women think, communicate and interact differently, which is an asset for all. Moreover, some day when women have equal opportunities, the issue of quotas will no longer be relevant. As the example of the Leibnitz Association in Germany shows, a quota can serve as a suitable short-term intervention and instrument to shake up those who prefer to leave things as they are.

Surely, none of the issues addressed so far in itself causes a crisis, but the accumulation of these issues is of major concern for higher education institutions.
In following the debates and studying publications and websites, policy papers and especially reports on research which has generated statistics and identified the causes and effects of gender inequality, one can find evidence of a crisis. Furthermore, the various strategies and interventions that have been put in place

reveal that the leadership in academia is prepared to face the challenges. But what works best?

Before addressing the various activities and interventions, facts and figures will be presented in order to show where we stand at present on the issue of gender inequality and discrimination against women in academia and what needs to be done in order to ensure equal opportunities for men and women. The focus is on facts and figures, as well as the strategies and interventions in place in Germany and the European Union (EU).

3 Facts and figures

The good news first! Most studies emphasise that gender differences in scientific careers are decreasing. This, nevertheless, does not mean that women have equal opportunities to attain equal academic status with their male colleagues.

Literature points to two basic explanations for why men outperform women and women remain a minority in science. One is the presence of role conflict, while the other is subtle discrimination. Needless to say, it suits academic institutions to deny the existence of any kind of gender discrimination and to explain women's under-representation in senior scientific positions in terms of unequal performance or lack of ambition – women are less productive than men because of greater family commitments. However, empirical evidence confirms the existence of discriminatory practices and reveals a far more complex picture in which subtle forms of discrimination are closely connected to time and mobility constraints.

Various studies reveal how structural barriers and subtle discrimination disadvantage women and influence them in the choices they make. Since various conference presentations focus on research and work in this area, my article does not address the causes of the exclusion of or discrimination against women in science.

More good news is that we have figures which help us to communicate the importance of the subject and also the urgency of our concern. During 2013, a report on the new 'She Figures' became available and provided us with facts and figures on the status quo of women in academia in all EU member states.

In Germany, the 'CEWS Ranking on Gender Equality in Higher Education' and the 'Research-Oriented Standards on Gender Equality' of the German Research Foundation (DFG) are two effective instruments that are crucial in challenging the status quo and bringing about change.

3.1 Facts and figures: 'made in the European Union'

Following the United Nations Beijing Conference on Women in 1995, the importance of mainstreaming or integrating gender equality has been highlighted in the EU.

This also led to a discussion on ways in which a gender mainstreaming policy could be implemented in science. Subsequently, the General Directorate of Research commissioned a report on gender factors in research policy in the EU. The report was prepared by the European Technology Assessment Network (ETAN) which is comprised of senior scientists from different disciplines in Member States, from universities, research institutions, business and politics.

The ETAN Report (2000) is regarded as the seminal document on women and science at the European level. It was the first publication to demonstrate that the under-representation of women in science is common across all the EU countries. The ETAN Report reviewed the position of women in science and technology by addressing four major concerns:

- Equity: gender discrimination is a violation of human rights.
- Excellence: the under-representation of women threatens excellence.
- Efficacy: the ageing population makes it essential to target both genders in the shrinking pool of young scientists.
- Efficiency: it is wasteful to educate and train young women scientists but then not to use their skills in employment (ETAN 2000: 2).

The Report presents facts, outlines in detail causes and effects, and concludes that the under-representation of women threatens the goals of science in achieving excellence, as well as being wasteful and unjust. It makes recommendations to a wide range of bodies, including the European Commission, the European Parliament, the Member States and organisations that educate, fund and employ scientists.

Since this first report a lot has happened and figures on women in science show improvements, but as the following facts and figures show, at a very slow pace.

The ETAN Report, which contains figures and facts on women in science in Europe, is worth mentioning since it serves as a baseline when answering the question of how fast or slowly progress has taken place and the impact that interventions have had so far. This is crucial since the European Commission and EU Member States are preparing the launch of HORIZON 2020. Running from 2014 to 2020 and with an 80 billion euro budget, this is the EU's new programme for research and innovation. Accordingly, the question we need to answer here is in what way does Horizon 2020 contribute to overcoming gender inequality in science (Helsinki Group 2013). Before answering this question, we need to get a clearer picture about the status quo of women in science in Germany and in Europe.

3.1.1 She Figures 2003–2009

Since 2003 data on women in European science has been gathered and published every three years under the name 'She Figures' by the Scientific Culture and Gender Issues Unit of the Directorate-General for Research of the European Commission in cooperation with the group of Statistical Correspondents of the Helsinki Group. The She Figures are the widest collection of European indicators on women and science. They have become an important tool for assessing progress and are essential to fully comprehend the situation of women in academia. She Figures provide answers to the following questions:

- What is the proportion of female and male researchers in Europe?
- How is this balance evolving over time?
- Are there scientific fields in which women are better represented?
- Do the career paths of female and male researchers follow similar patterns?
- Are men and women equally represented in science across Europe?
- Are women less represented in knowledge-intensive activities?
- How many women hold senior positions in scientific research in Europe? (EU 2012: 1)

The She Figures, published in 2009, (presenting data of the year 2006) showed that despite progress, gender inequalities in science persist. For example, while 55% of EU graduate students in 2006 were female, only 18% of EU professors were women. In 2006, on average throughout the EU-27, only 13% of institutions in the higher education sector were headed by women and only 9% of universities had a female head of staff (EU 2009: 9).

3.1.2 She Figures 2012

The She Figures 2012 reveal a number of positive trends:

- A 5.4% increase on average per year in the share of women among scientists and engineers between 2002 and 2010, compared to an increase of 3.1% for men.
- In 2010, tertiary-educated women employed as professionals or technicians outnumbered their male counterparts by 3 percentage points.
- In the EU the share of women graduating at PhD level stood at 45% and in 12 EU Member States the percentage stood at 50% or above.
- Although women could catch up with men at PhD level, they remain a minority in scientific research, accounting for only 33% of researchers in the EU in 2009. In 2006 they accounted for 30%. In all EU countries 'there is a clear pattern of female underrepresentation everywhere' (EU 2012a: 5-6).

For Germany the figures available show:

- 44% of PhD graduates were women, just 1 percentage point under the EU average (EU 2012a: 51).
- Female researchers account for 21% of all researchers, which is far below the EU average of 33% (EU 2012a: 122).
- Compared to 2002, the number of female professors (C3 and W4 salaries) has almost doubled.
- The number of female heads leading academic institutions (the highest possible position) is under10% (EU 2012: 115-116). Hence, Germany is among those countries with the lowest proportion of women heading universities (Keil 2012: 4-5).

The under-representation of women at the head of higher education institutions 'reflects their difficulty to influence the design and implementation of the research agenda. The gender gap in leadership has been identified as one of the causes of the perpetuated gender imbalance in sciences' (EU 2012: 1).

3.1.3 League of European Research Universities

Founded in 2002, the League of European Research Universities (LERU) is an association of 21 leading research-intensive universities sharing the values of high-quality teaching within an environment of internationally competitive research. One of the issues LERU deals with is overcoming gender bias in research.

In 2012, LERU published an advisory paper entitled ‘Women, research and universities: excellence without gender bias’ together with recommendations for recruiting, supporting and advancing women to senior levels. The paper presents causes and effects of gender bias in the EU. These include issues such as the following:

1. The ‘leaky pipeline’: from PhD onwards women drop out at various junctures and for various reasons.
2. The bias against women which exists at many levels of their academic careers.
3. The pay-gap: most research funding goes to men.
4. The need for a gender dimension in research (LERU 2012: 5-8).

LERU has become a valued interlocutor for the European Commission on various research topics and acts as the voice of European universities on a wide range of topics related to EU research policy including the proposed programme Horizon 2020.

3.1.4 Horizon 2020

At present the European Commission is promoting its new research and innovation funding, Horizon 2020 to be launched in 2014. One of the objectives of Horizon 2020 is to break down barriers and create a genuine single market for knowledge, research and innovation. On the websites the programme is viewed as Europe’s

> *… flagship initiative aimed at securing Europe’s global competitiveness. Running from 2014 to 2020 with an €80 billion budget, the EU’s new programme for research and innovation is part of the drive to create new growth and jobs in Europe. Horizon 2020 provides major simplification through a single set of rules. It will combine all research and innovation funding currently provided through the Framework Programmes for Research and Technical Development, the innovation related activities of the Competitiveness and Innovation Framework Programme (CIP) and the European Institute of Innovation and Technology (EIT). Horizon 2020 will make it*

easier for applicants to seek funding and is designed to help bring more good ideas to market. Horizon 2020 will run from 2014 to 2020 (EU 2013).

Besides this proclamation, neither the Green Paper nor the White Paper stipulates clearly how it intends to overcome the gender bias in research. Also, the correlation between research excellence and innovation and a system based on gender equality was not explored.

3.1.5 Two responses by women networks in Europe

The publication of the Green and White Paper on Horizon 2020 resulted in numerous responses by gender specialists, scientists and policy makers concerning the issue of gender equality. The question raised was: 'What actions should be taken at EU level to further strengthen the role of women in science and innovation?' There was great concern that twenty-five years of research demonstrating how gender impacts the quality of research and innovation was not adequately taken into account.

One response came from the Helsinki Group on Women in Science; the other came from a group of concerned scientists and researchers who initiated the 'Manifesto for Integrated Action on the Gender Dimension in Research and Innovation' during the Second European Gender Summit in November 2012. Both documents address in detail how Europe can benefit from a more effective mainstreaming of the gender dimension in research and in the scientific system.

In their declaration on Horizon 2020, the Helsinki Group on Women and Science suggests that

- gender balance should become a rule for all committees and decision-making bodies established under Horizon 2020; and
- in order to satisfy the ambitions of increasing the proportion of female scientists, the Commission must develop instruments that correlate with this aim.

The Gender Summit is a platform supporting and advancing excellence and effectiveness in research and innovation through the inclusion of the gender dimension in research and science knowledge making (Gender Summit 2012). With the 'Manifesto for Integrated Action on the Gender Dimension in Research and Innovation' the authors and signatories voiced their concern that 'past EU Framework Programmes have failed to engage, benefit, and promote women to the same extent as men (still less than 20% of senior Grade A posts are awarded to women)' and that they feared that the documents on Horizon 2020 did not put structures and measures in place that would support change.

Therefore the Manifesto outlines what is needed in order for Horizon 2020 to become instrumental in supporting gender equality. Horizon 2020 needs to:

- **Recognise** that past EU Framework Programmes have failed to engage, benefit, and promote women to the same extent as men (still less than 20% of senior Grade A posts are awarded to women).
- **Ensure** that explicit requirements addressing gender issues are included in research calls; budgets should incorporate gender dimensions.
- **Move** towards more gender-balanced systems: welcome diverse leadership styles, fair assessment criteria, researcher team (gender) diversity and gender balance in teams.
- **Consider** accommodating gender in research. Science is not gender neutral. Researchers need to ensure that products and services benefit both women and men.
- **Assess** the merits of women and men fairly: cultural influences and gender stereotypes can influence hiring and promotion decisions.
- **Ensure** that the evidence of how gender shapes and is shaped by science is embedded in science curricula; and negative gender stereotypes are addressed.
- **Create** research cultures that provide flexible working environments equally supporting the careers of women and men: managing gender and diversity in universities and research organisations.
- **Ensure** that plans to modernise European universities include opportunities to enhance the recruitment of women researchers, including women research leaders.
- **Promote** collaborations between schools and universities to support efforts to recruit more women to research: create positive images of women scientists and address Europe's diverse populations (Manifesto 2012).

What instruments are in place in Germany for addressing gender equality and promoting equal opportunities in academia?

3.2 Facts and figures: 'made in Germany'

According to German law, universities have to engage in equal treatment activities. The legal requirements are stipulated in the 'Landeshochschulgesetz (LHG)'

(Law on universities in the Laender/Provinces), which states that, in terms of the German Equal Treatment Act (Allgemeines Gleichbehandlungsgesetz, AGG), each university has to adopt a policy on the equal treatment of women and men (Richtlinien zur Gleichstellung von Frauen und Männern), as well as persons with handicaps.

The major push-factor for all activities and interventions on gender equality in the German research system is the great loss of women. This is seen as highly problematic because investment in human capital is wasted when women drop out at the higher academic levels. This discussion is related to the question of a general 'loss of talents' and the challenges for a knowledge-based economy. Investing in research and development is seen as key factor for the German economy and society at large.

In Germany, two instruments have been implemented successfully in order to assess the performance of universities on gender equality. These are the

- 'CEWS Ranking on Gender Equality' of the Center of Excellence Women and Science, and
- 'Research-Oriented Standards on Gender Equality' of the German Research Foundation DFG.

Both organisations collect data and publish the results regularly. The objective is to create transparency with regard to the engagement and commitment of universities in reaching their set targets for improving gender equality.

3.2.1 The CEWS Ranking on Gender Equality in Higher Education

The Center of Excellence Women and Science (CEWS) was founded in 2000 and was funded for the initial five years by the BMBF, Germany's Federal Ministry of Education and Research. As an external agency it is the national hub for promoting equal opportunities for both women and men in science and research in Germany. CEWS serves as a think tank and is mandated to provide knowledge transfer and extensive information about all topics related to gender equality and women in science and research.

In 2011, for the fifth time since 2003, CEWS published its nationwide university ranking on the basis of gender equality indicators. The objective of the ranking is to allow universities to continuously compare their achievements on equal opportunities for men and women. Universities are benchmarked on the basis of quantitative indicators such as PhDs, habilitations, employed academic staff, professors and students. For example, in the CEWS Ranking 2011, out of

66 universities the Free University Berlin (FU Berlin) was ranked as the best performing German university (CEWS 2011: 27).

CEWS views ranking as an instrument for universities to measure their performance and to position a university in comparison to others. It is used together with others tools such as Gender Controlling, quality standards as defined by DFG for research, evaluations or audits and certificates such as the Total E-Quality Certificate (www.total-e-quality.de) or the 'audit family-friendly university' (www.berufundfamilie.de). All have in common the intention to make sure the universities speed up their efforts on gender equality.

➔ **Intervention** – 'audit family-friendly university' (audit familiengerechte hochschule)

The 'beruf und familie audit' (work and family audit) is a management tool to optimise family-friendly corporate policies in order to balance corporate interests and employees' concerns by developing and implementing family-friendly support measures.

For example, according to their website, www.fu-berlin.de, FU Berlin is not only ranked best performing German university on gender equality, but also received the Total E-Quality Science Award for the fourth time in a row for its exemplary higher education and personnel policies, which embrace the principles of equal opportunity. In 2007 and 2011, the FU Berlin also underwent audits for certification and recertification as a family-friendly university.

The family-friendly university certificate states that the institution has initiated various programmes to enable a family-friendly work and study environment. The certificate is awarded for the successful completion of a 'work and family audit' process. The work and family audit addresses issues of work-life balance and was developed by the Hertie Stiftung (Hertie Foundation) to acknowledge innovative and promising approaches to family-related issues within the work and study context. The specific aim of the audit is to establish a sustainable policy to ensure a balance between the corporate interests of a university and the family duties of its employees and students. Such a policy should be embedded in the long-term functioning of the university. Following the audit process conducted by certified external auditors, the family-friendly university certificate is awarded by berufundfamilie gGmbH (work & family gGmbH). The auditing process takes three to six months and follows a standardised procedure (see Figure 1):

Figure 1: Family-friendly university: auditing process (Source: www.beruf-und-familie.de)

The audit focuses on eight areas of activity. These are:

1. Study/working time
2. Study/work organisation
3. Study/workplace
4. Information and communication
5. Leadership
6. Human resource development
7. Remuneration
8. Service for families (child and elder care)

The topic of family-friendliness is not just a ‘soft’ factor and nice to have. Accordingly, most universities have established a Family Service Centre which offers various programmes that support staff and students in balancing work and study obligations with family matters. Universities do this in order to improve staff and student satisfaction and increase the attractiveness of the university as an employer. With regard to national and international competition for the best talents in science and research it is clearly an asset and secures a competitive advantage.

The activities undertaken under the umbrella of work-life-balance are not limited to supporting women alone. They also address the need to create a work and study environment in which a wide variety of opinions, working styles and diverse views are valued and respected. That means that besides supporting women in their (academic) career paths, structural changes are addressed in order to create an environment where men and women can fully develop their talents and potentials.

➔ **Intervention** – Mentoring programmes

Mentoring programmes are today a generally accepted instrument for supporting female students. Offering cross-cultural or intercultural mentoring for international students is relatively new and at present well established at, for example, Stuttgart University (www.ia.uni-stuttgart.de/mentoring). They are run by the University's International Office.

➔ **Intervention** – Implementing anti-discrimination legislation

Universities have to comply with regulations for employers outlined in the Allgemeine Gleichbehandlungsgesetz, AGG (legislation on anti-discrimination). For example, universities as employers have to undertake measures to protect persons from being disadvantaged (Schutz vor Benachteiligungen) and inform their employees about their rights and responsibilities. They have to establish a grievance procedure (Beschwerdestelle) and can take positive action (positive discrimination) in support for disadvantaged groups such as women or the disabled.

An important study was commissioned by the Federal Anti-Discrimination Agency (ADS) in Berlin, Germany, in 2012. The study was the outcome of workshops that were held at various German universities in which all steps in the staff and student cycle, from application and access to departure, were scanned and studied. By doing so, discriminating structures and mechanisms were identified with the aim of developing indicators and interventions to achieve a non-discriminatory university. The results were published in the final report 'Diskriminierungsfreie Hochschule – Mit Vielfalt Wissen schaffen' (ADS 2012). The study revealed that the issues of discrimination, be it on the basis of gender, sexual orientation, handicap, age, religion or cultural/ethnic origin, are seldom reflected on campus. The study served as an eye-opener to those involved in leaving the comfort zone of denial. On the basis of this study a practical guide-line was published to assist staff in dealing constructively with discrimination (ADS 2013).

One example of good practice: Under the heading ‘Bringing Together and Transparency’, the University of Aachen established an Equal Treatment and Antidiscrimination Round Table (University Aachen 2012). The members of the Round Table meet twice per semester. They campaign for a culture of respect, fairness and equal treatment on campus by creating awareness, providing counselling services and initiating preventative measures.

➔ **Intervention** – Diversity audit ‘Vielfalt gestalten/managing diversity’

Whereas the ‘audit family-friendly university’ focuses solely on the aspect of gender and work-life balance, the Diversity Audit developed in 2012 by the Stifterverbands für die deutsche Wissenschaft, together with the Centre for Development in Higher Education (CHE), covers seven clusters for action. These are 1) strategy and structure; 2) human resource management; 3) service and counselling; 4) internal communication/participation; 5) external communication; 6) information technology and infrastructure; and 7) studying and teaching. The auditing process is designed as a change process and takes two years, consisting of two elements, the internal auditing process and the participation in a diversity forum (De Ridder/Jorzik 2012).

➔ **Intervention** – establishing gender and diversity boards

The University of Munich, for example, has established a body to consult with the University’s leadership on strategic issues relating to diversity and talent management as well as mainstreaming gender and diversity on campus in all sections and at all levels of the hierarchy.

The University of Duisburg-Essen is the first German university with a vice-rector for diversity management (University Duisburg-Essen 2013). The main objective of this body is to mainstream diversity management in all aspects of the University’s transformation and development efforts.

➔ **Intervention** – quality criteria and standards on equal opportunity in selection and recruitment practices

Gender has an impact on who gets offered a post, who can take up fellowships and who gets promoted (LNHF 2011). Research shows that the lower the percentage of women on selection committees and the less transparent the criteria for selection, the less likely women are to be appointed (LERU 2012: 6). In such circumstances, the definition of ‘capable’ seems to favour men over women. Hence, various measures have been undertaken to establish and implement quality criteria and standards for positions of leadership in academia in Germany. These include, for example,

- reconsidering the existing methods of assessing merit, quality and productivity
- uncovering stereotypical images of scientists, of women and men
- addressing the issue of the old boys’ network and patronage in the allocation of jobs
- installing positive action measures to address disadvantage, such as mentoring, networks and women-only opportunities
- formulating family-friendly policies.

As the benchmarking study of the universities in Lower-Saxony (Niedersachsen) reveals, quality criteria and standards regarding equal opportunity in selection and recruitment practices is one way of having more women take on professorships (LNHF 2011).

3.2.2 DFG’s ‘Research-Oriented Standards on Gender Equality’

In Germany, the subject of equal opportunities for women and men in science has become a main focus of policies and actions of all major science organisations. In 2006, the German Rectors’ Conference stated:

> *Insufficient participation by women compromises efficiency and excellence in academia. The innovative potential of science and research can be fully leveraged only if outstanding talents, regardless of gender, work in large numbers in science and academia and do not drift off into other occupational areas even as they approach their peak performance. Men and women must be given equal opportunity to participate in all levels of scientific inquiry (Recommendation by the German Rectors’ Conference on Promoting Women, 14 Nov 2006, quoted in DFG 2008: 1).*

In 2008 the German Research Foundation (DFG), one of the most important research funding agencies in Germany, agreed to develop structural and personal standards on gender equality. Since 2009, the DFG member institutions have voluntarily committed themselves to implementing research-oriented standards on gender equality. Adherence to the ‘Research-Oriented Standards on Gender Equality’ is also one of the key criteria for the approval of research applications. As part of its equal opportunity monitoring the DFG publishes figures on the representation of women in DFG structures and as recipients of funding (DFG 2012). In the preamble to its ‘Research-Oriented Standards on Gender Equality’ the DFG deliberately links gender equality in research with the diversity of perspectives that can evolve when women are integrated into research activities.

> *A successful strategy for gender equality delivers significant added value. Gender equality enhances research quality because it enlarges the talent pool, promotes a diversity of research perspectives, and eliminates blind spots regarding the significance of gender and diversity aspects in research and methods. Thus the inclusion of relevant gender and diversity aspects is a key ingredient of high-quality research (DFG 2008: 1).*

The responsibility to concretise and implement these ‘Research-Oriented Standards on Gender Equality’ lies with each individual institution. According to the Report in 2010 and the interim report in 2011, the universities were classified from 1 to 4 and the results were published on the DFG website. Additionally, universities received individual reports about their classification. The ‘Research-Oriented Standards on Gender Equality’ and the publication of the classification of individual universities on work in progress not only support universities in making gender equality a quality criterion but also influence universities to step up their programme of action.

➔ **Intervention** – Service Gender Consulting

Various universities, including Stuttgart University, have established a ‘Service Gender Consulting’. In order to meet the requirements for high-quality research, scientists receive assistance in their efforts to integrate gender aspects in research grant applications. University executives in particular are supported in their efforts to integrate the principles of equal treatment in the portfolio of their management philosophy. Furthermore, this service unit contributes to enhancing the gender competence of academic staff.

➔ **Intervention** – Quota

The Leibniz Association (Leibniz-Gemeinschaft) is a union of German non-university research institutes from various disciplines and the first scientific institution to implement a quota.

The aim of the Leibniz Association’s gender equality activities is to guarantee men and women equal opportunities in realising their individual career ambitions on the basis of their qualifications. This applies to all levels of the organisation.

At 41.1%, women already account for a comparatively high proportion of scientific staff in the Leibniz Association. Among doctoral students (49.2%) and postdocs (41.9%) in particular there has been a remarkable increase in the proportion of women. However, at the higher levels of qualification and salary up to and including leadership positions, the percentage drops noticeably to 10.8%. In 2005, just 6% of the institutes were headed by women (Leibniz Gemeinschaft 2012).

The Leibniz Association has set itself the goal of raising the number of women in leadership positions quickly and continuously. In the context of the Joint Initiative for Research and Innovation it has committed itself to increasing the share of women in leadership positions to 20% by 2017. The Leibnitz Association is one of the first academic institutions in Germany to implement a quota system. According to their so-called 'Kaskadenmodell' (cascade model), all levels of the organisation will increase the proportion of women in the workforce and, by 2017, one-fifth of all institutes will be headed by women (Leibniz-Gemeinschaft 2012).

4 Summary

All the above mentioned activities have in common that they aim at overcoming gender bias and ensuring gender equality in science. One can observe a trend away from single interventions, well-meant but with minor impact, to a more systematic approach whereby published figures on how institutions perform become an important push factor.

Figures show that there is evidence of bias and discrimination against women (and minorities) in the academic workplace. Alone this fact constitutes a crisis. However, this crisis not only has an ethical and political dimension, it also has far-reaching economic consequences, such as a loss of talent and potential which no society can afford. The existing talent crisis in, for example, science and engineering in Germany and in other parts of the world constrains economic productivity, sustainable development and quality of life.

Many academic institutions are trapped in a dilemma whereby the people, i.e leadership, who are in charge of the present system and state of affairs, are struggling to find a balance between defending the status quo and its achievements and addressing the need for change due to the existing crisis which results from inequality and exclusion.

The slow progress shows that proclaiming the principle of equal treatment is not sufficient. Recognising the need for a greater diversity in academia is a prerequisite for overcoming the gender bias in science and research, in other words, encouraging, recruiting, hiring and supporting women and minorities. This applies not only to Germany and the EU Member States but also applies to South Africa.

5 Lessons to learn for women in science

➔ Waiting for equality will not work.

As outlined in the ETAN-Report on Women in Science, a lack of women in science poses a threat to equity, excellence, efficacy and efficiency.

What can academic institutions or funding agencies do to bring about change? There are three broad approaches to promoting gender equality:

- equal treatment so that men and women are treated the same
- positive (special) actions to redress disadvantages and
- mainstreaming gender and diversity by integrating gender equality and diversity into systems, structures, programmes, policies and practices.

Concrete: Mainstream gender equality and diversity into EU and Member State programmes that fund science and technology, such as Horizon 2020, formulate compulsory requirements for research funding such as the German Research Foundation (DFG) and create positive action, such as specific programmes promoting women in science.

More stringent measures should not be viewed as a threat to men. Good male scientists have nothing to fear from transparent, fair and effective recruitment and promotion practices. Positive action projects and programmes are essential to overcome the gender bias in science and especially in research.

➔ We need facts and figures.

We need systematic and reliable data on women in science, education and technology to show the reality of gender inequality and to monitor progress. We need in-depth studies on processes that cause gender imbalances and more research to understand the leaky pipeline, that is, why women leave universities.

➔ **We need to uncover discriminatory practices.**

We need to recognise that discriminatory practices exist. A very common example is the image of the 'ideal scientist' which prevails in academia based on the expectation that the scientist will have an unlimited commitment to science throughout the working life. Women are less likely to fulfil such an expectation. By paying special attention to the interrelationship between personal and professional events at each stage of the life course, the cumulative effect of positive and negative influences that shape the scientific careers of men and women and the existence of professional trajectories that do not follow the normative scientific career can be overcome.

➔ **We need to check good practice interventions and implement them.**

Rankings on gender equality as well as research-oriented standards on gender equality have proven successful in Germany and could be implemented elsewhere. More resources are needed for mentoring programmes for women and other minority groups.

➔ **We need structural change.**

All universities today have projects and policies on gender equality in place and most countries have legislation on equal opportunity. What we need is structural change. So far in academia, programmes for women instead of change in organisational culture and structures prevail. Structural change refers to moving beyond promoting gender-aware 'people strategies' (human resource management) in universities and research institutions and transforming the monocultural organisation of universities.

➔ **Not 'one size fits all'.**

Universities need to be able to decide which mix of policy decisions, structures, measures and processes best suites their needs in view of the institutions' overall strategies, and their national gender and diversity agendas.

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Women in Male-Dominated Technology Study Programmes – Findings of a Survey Conducted at the Kiel University of Applied Sciences

Britta Thege[1]

1 Introduction

Despite all the efforts of policy makers, educators and researchers to go against gender stereotyped study choices and to overcome structural barriers, especially in the STEM (science, technology, engineering and mathematics) subjects/SET (science, engineering and technology) field over the last 25 years, study choices in German universities remain fairly gender specific. Although the top leading study, business management, is the number one choice of both genders, the following subject choices in the ranking are prominent: The five dominating subjects chosen by women are German philology, medicine, law, pedagogy and English language and literature studies; by men, mechanical engineering, computer sciences, electrical engineering, law and business information systems. The difference in higher education results, further on, in occupational segregation, horizontal as well as vertical.

At the Kiel University of Applied Sciences conspicuous gendered study choices are noticeable in three of the six faculties: At 75%, female students are clearly overrepresented in the Faculty of Social Work and Health and, with 10%, clearly underrepresented in the Faculty of Computer Science and Electrical Engineering, as well as in the Faculty of Mechanical Engineering with 12%. The current gender composition of the social and engineering study programmes is highly imbalanced; men are persistently in the minority in the study of Social Work and women in the study field of Engineering.

In contrast to so-called hard-core engineering course programmes, three cross-disciplinary programmes at the Kiel University of Applied Sciences, which combine business and engineering know-how, seem to attract more women,

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namely, Business Information Systems (BIS), Technology Management/ Marketing (TMM), and International Sales and Purchase Engineering (ISE). While the proportion of women in the hard-core engineering fields lies between 5 and 10%, the proportion in BIS, TMM and ISE is almost 20%. In total, 787 students were registered at the Kiel University of Applied Sciences in the winter semester of 2011/2012 in these subjects; 143 (18.2%) women and 644 (81.8%) men. Job opportunities for graduates are perceived as being very good in these fields:

- The consecutive study programme Business Information Systems (BIS) (Bachelor/Masters) offered by the Faculty of Business Management qualifies students for management positions in information and communication systems in the economy and in public administration.
- The interdisciplinary study programme, Technology Management/Marketing (TMM), is the result of cooperation between the Faculty of Computer Science and Electrical Engineering and the Faculty of Business Management, qualifying students for posts in management and marketing interfaces mainly in the power technology business and the field of information and communication technology.
- The study programme, International Sales and Purchase Engineering (ISE), offered by the Faculty of Mechanical Engineering, combines basic education in engineering with business management know-how and foreign language competence in order to qualify students for posts in sales management, purchasing and the conception of high-quality technical products as well as services and system solutions.

However, not all students complete their studies successfully. The discontinuation rate in BIS (B) was 15% (SS 2009) in TMM, 6% and in ISE 3% (WS 09/10). In this context, the Institute of Interdisciplinary Gender Research and Diversity at the Kiel University of Applied Sciences, in cooperation with the Faculty of Business Management, was interested in exploring the study satisfaction of students as well as the stress factors that could possibly interfere with study success or even lead to students dropping out of the three highlighted study programmes.[2] The major interest of the survey, however, was to investigate gen-

2 This article is based on a research project undertaken by the Institute for Interdisciplinary Gender Research and Diversity (IGD) in cooperation with the Faculty of Business Management. I would like to thank Prof. Dr. Roswitha Pioch, Prof. Dr. Doris Weßels and Annelie

der differences. The risk of termination of studies is influenced by a multitude of individual and external factors. In our context we were particularly interested in external factors, such as satisfaction with study conditions and study successes, because besides wrong notions of one's own capabilities and wanting study success, institutional shortcomings have a major impact on increasing the risk of termination of studies (cf. Heublein/Spangenberg/Sommer 2003: 59). Our research question was whether women in three cross-disciplinary course programmes combining engineering and business management were less satisfied with their studies, exposed to greater study problems and more likely to drop out of studies compared to their male counterparts.

2 Data collection and sample description

The research was conducted in December 2011 through a quantitative survey using a questionnaire that contained closed questions as well as some open-ended questions. With the consent of the lecturer, questionnaires were distributed to students and collected by staff of the Institute of Interdisciplinary Gender Research and Diversity prior to their courses. Completed questionnaires were coded and analysed by means of the statistics software SPSS Version 20.0 for Windows.

In total, 270 students participated in the survey, 54 women and 212 men (4 missing values), which corresponded to 34% of all registered students in Business Information Systems (BIS, Bachelor/Masters), Technology Management/Marketing (TMM), and International Sales and Purchase Engineering (ISE). The sample was fairly representative of the basic population registered in the three course programmes under investigation; both in terms of students' proportions in the subjects and the proportions of the two genders in the subjects (cf. Table 1 and Table 2):

Tallig for their indispensable contributions to the project and Sabrina Flindt in particular for the data processing.

Table 1: Students' proportions in the course programmes and in the sample, WS 2011/12

Course	Basic population %	Sample %
BIS (B)	22.6	15.6
BIS (M)	5.7	5.1
TMM	27.3	28.9
ISE	44.4	50.4
Total	100.0	100.0

Table 2: Female and male proportions in the course programmes and in the sample, WS 2011/12

Course	Women registered KUoAS		Men registered KUoAS		Total reg. students	Women in sample		Men in sample		Total sample*
BIS (B)	14	8%	164	92%	178	4	9%	39	91%	43
BIS (M)	9	20%	36	80%	45	3	23%	10	77%	13
TMM	46	21%	169	79%	215	19	25%	57	75%	76
ISE	74	21%	275	79%	349	28	21%	106	79%	134
Total	143	18%	644	82%	787	54	20%	212	80%	266

* Four missing values.

3 Findings

3.1 School education and vocational education background

School and vocational qualifications have a significant impact on study choices and there is evidence given for a correlation between advanced-level courses at school and study choices (cf. BMBF 2008: 3-4). Research shows that, firstly, students of universities of applied sciences who specialised in the natural sciences segment at school are likely to take up a study in engineering, although far fewer girls than boys choose mathematics, physics or chemistry as a special course (except biology). Secondly, significantly more students registered at universities of applied sciences have considerably more vocational experience or were professionals before the beginning of their studies than university students (ibid).

Our interest in the respondents' educational background was therefore based on the assumption that subject choices at school, as well as professional experiences gained prior to study admission, influence study choices and that women and men studying BIS, TMM or ISE have dissimilar educational backgrounds; consequently, women lack technical qualifications compared to their male counterparts and, thus, are put at disadvantage at the beginning of their studies. As a result, their 'subject-specific interest' as a motive for their study choice may be much weaker compared to the interest of their male fellow students.

About 31.5% of the female and just over 46% of the male students had taken a technical or computer-related special course during their school education. However, the greater proportion of trained male students is noticeable. Women chose physics as a special course significantly less often and biology significantly more frequently, which fully corresponds with other study findings (BMBF 2008). They also possessed fewer experiences in repairing and handcrafting. The greatest confidence with regard to being successful in their studies in future is drawn by both genders from the conviction that they are capable of understanding facts easily and that they have always succeeded in doing things up to now.

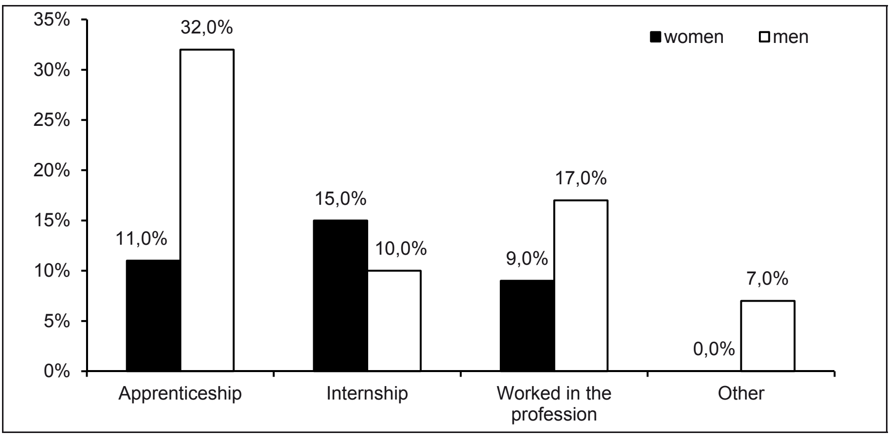

Figure 1: Vocational education background according to gender

Moreover, men had significantly more confidence in completing their studies based on their practical technical competences, while women based this on their mathematical competences.

Of the total sample, two-thirds (67%) of the male students had completed a vocational training before taking up their studies, and just more than half of the female students (52%). Almost 40% of all respondents had a specifically technical or computer-related qualification – with a significant gender difference: in contrast to 43% of male students, only 28% of female students had a technical or computer-related background. As figure 1 illustrates, the proportion of male students with a completed vocational training is, at 32% almost three times as high as for females. With 17%, almost twice as many men as women had already worked in a job. Finally, in contrast, 15% of women, 5% more than men, had completed a study-related internship. In conclusion, male respondents had far more practical, job-related experience than women from which they might benefit during their studies and which women still had – if at all – to acquire.

3.2 Reasons for study choices

Study motives can be distinguished into extrinsically and intrinsically motivated choices. While extrinsic motivation arises from outside the individual, intrinsic motivation arises from within. From a variety of motives in this survey, more than half of the respondents gave extrinsic motives for their subject choice, namely, good career and good income prospects as well as many job opportunities; intrinsic motives were primarily related to interest in the subject, the hope of obtaining a managerial position and personal affinity/talent. However, subject choice at school, as indicated above, was of minor significance (see Table 3).

Several studies provide evidence for a dominance of intrinsic motives with regard to study choices (cf. Willich et al. 2011; Brahm/Gebhardt 2011). Yet, it is said that in universities of applied sciences material motives (such as a good salary) occur more frequently than in universities; hence, our results corresponded with this finding.

Table 3: Motives for subject choices, agreement

Motive for subject choice/all	Agreement %	Motive
Good career prospects	78.9	extrinsic
Good income prospects	54.9	extrinsic
Many job opportunities	54.5	extrinsic
Subject-specific interest	45.5	intrinsic
Obtaining a managerial position	36.8	intrinsic
Affinity/talent	27.8	Intrinsic
Relative/acquaintance has a similar occupation and has inspired me	17.3	extrinsic
Personal development	16.5	intrinsic
Particular career aspirations	13.9	intrinsic
Testing one's own abilities/skills	12.4	intrinsic
First study choice could not be realised	9.0	extrinsic
Subject choice at school	9.0	intrinsic
Good work-life balance	3.4	extrinsic
Other	2.6	

According to Lojewski (2011), there are gender-specific differences in terms of the importance of extrinsic and intrinsic motives; for women it is supposed that intrinsic motives are more important than for men. Hence, our interest in students' reasons for subject choices was based on the assumption that the women in the sample tended to have intrinsic and men tended to have extrinsic motives for their individual choices. However, Fisher's exact test with Bonferroni correction showed no significant differences between the two genders with one exception: among the intrinsic items 'subject-specific interest' stood out. This item was affirmed by only 22% of the female but by 51% of the male students. Here, the Fisher test was significant through the Bonferroni correction minimised alpha level ($p < .0001$) and indicated a significant gender-specific difference between male and female students.

3.3 Satisfaction with studies

Our interest in study satisfaction was based on the question as to whether female and male students differ in their study satisfaction and, if so, in terms of which aspects, namely, study conditions, course programme organisation, course programme quality, social aspects and university services. We assumed that female students would show in particular greater dissatisfaction with social aspects because of the male-dominated environment. Furthermore, we were also attentive to faculty-related differences. The survey measured satisfaction by 20 items (some general items, specific course programme-related items, as well as some personality-oriented items) on the Likert scale in forced-choice format with four levels, that is, 'satisfied', 'rather satisfied', 'rather dissatisfied' and 'dissatisfied'. From a maximum of a total score of 60, a score of 18 to 58 was reached. The average in the sample was 40.04, which means that across all items respondents were 'rather satisfied' with studies and the overall assessment of the study conditions, course programme organisation, course programme quality, social aspects and university services was very positive. The highest scores received, which for us was a bit unexpected, were the items 'lecturers' acceptance of women' and 'fellow students' acceptance of women', both affirmed by more than 94% of respondents. These positive scores gave proof of the fact that despite the male-dominated environment in BIS, TMM and ISE, female students did not feel discriminated against. The highest shares of dissatisfaction were for the items 'contact with students in other study courses' (59%) and 'overall faculty communication and cooperation' (55%), both attributable to aspects of study organisation and not social disharmony. In terms of gender differences, the assumption that female students' satisfaction differs from that of their male fellow students was tested with the Mann–Whitney U test and came out as not significant ($p > .2$) for all items.

3.4 Sense of achievements in studies

Study success is perceived as one of the most powerful conflict factors in terms of termination of studies. Aspects of achievements considered in the survey concerned the period of study, grades and certain individual experiences in terms of achievements (self-assessment). The latter was captured with the items 'can cope with assignments', 'regular success in exams', 'received praise', 'can present well', 'study is congruent with personal abilities', 'well connected with male fellow students' and 'well connected with female fellow students'. First-year students were deliberately omitted from answering this question because they lacked experience.

All respondents were studying during the prescribed period of study. The mean value of respondents' grades was 2.5 with a wide range from 1.2 to 4.5.

We assumed that study success factors such as successful exams and assignments or positive feedback from lecturers lessen intentions to drop out of studies and that the sense of achievement of female and male students differs in such a way that women underestimate their performance.

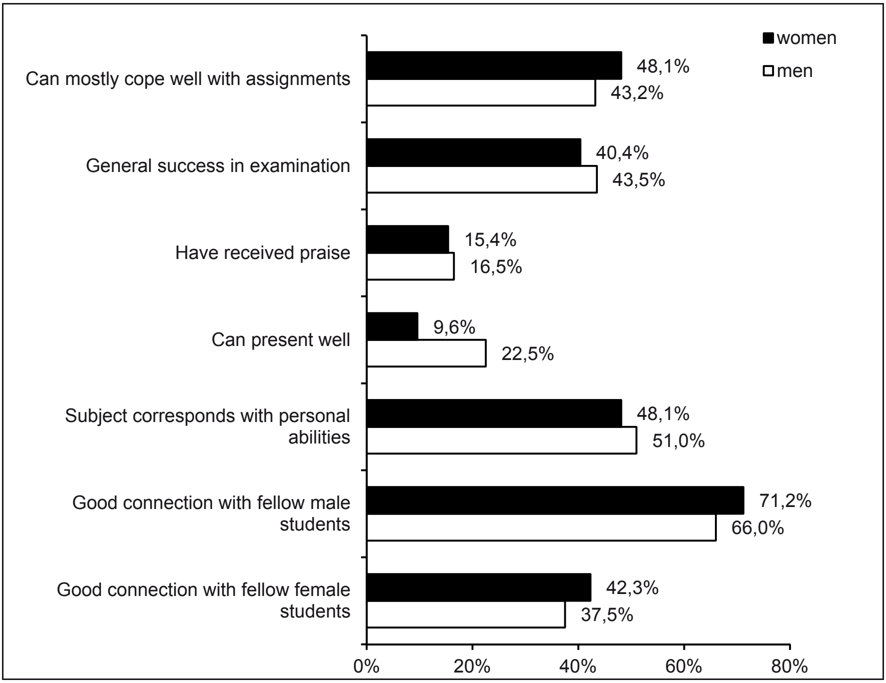

Figure 2: Sense of achievement in studies according to gender

Except for the item concerning presentation skills, all other items were more or less equally distributed. Women seem to be a bit better networked (social integration is a supporting factor to remain in study) and can cope better with assignments. Men do a bit better in exams and for more than half of male respondents the subject corresponds with their personal abilities, while this was true for just 48% of the female respondents. Across all study programmes most students did not assess their presentation skills as good. However, with only 9.6%, significantly fewer women than men, with 22.5%, assessed their presentation skills as good. Measured with Fisher's exact test this was the only significant gender difference regarding sense of achievement in studies ($p = .005$).

3.5 Study problems and demands

Working against study success is the question of study problems and demands. Generally, study problems refer to preparing for exams and study planning (cf. BMBF 2008: 23-24). A research study on causes for termination of studies (Heublein/Spangenberg/Sommer 2003) found differences in the problems experienced by university students and students of universities of applied sciences. In universities of applied sciences two problems stood out, namely, financial problems[3] and job-related reorientation which is linked to the strong practical orientation of this group of students (ibid: 111). Our interest in study difficulties and demands was based on the assumption that study-related stress or personal problems can burden students and result in their dropping out and that male students feel less burdened than their female counterparts. We investigated the question of to what extent performance standards, orientation within the subject, contacts among each other or interaction with lecturers or finances created problems for the students and whether gender differences were detectable.

The most pronounced problems in our survey concerned study-relevant factors, namely, workload, preparing for exams, finances and, in this context, the reconciliation of study and gainful employment.[4] Clearly more men felt stress and experienced problems in particular with performance requirements, workload, finding structure in their studies, regimentation, timely submissions, and lack of working groups. More women were aware of the burden of trying to reconcile their studies with their family life.

3 Students of universities of applied sciences often have a less affluent family background compared to university students and depend on gainful employment alongside their studies, which in turn conflicts with study demands.

4 It is supposed that gainful employment of more than eight hours per week can impact on the study process and possibly delay it (BMBF 2008: 22). Fifty-two per cent of the students in this sample (140 out of 270) stated that they were working in gainful employment along with their studies. Of these the majority worked more than eight hours per week: 37% up to ten and 47% up to 19 hours per week. However, 15% worked even more than this: 11% between 20 and 25 hours and 4% more than 25 hours per week.

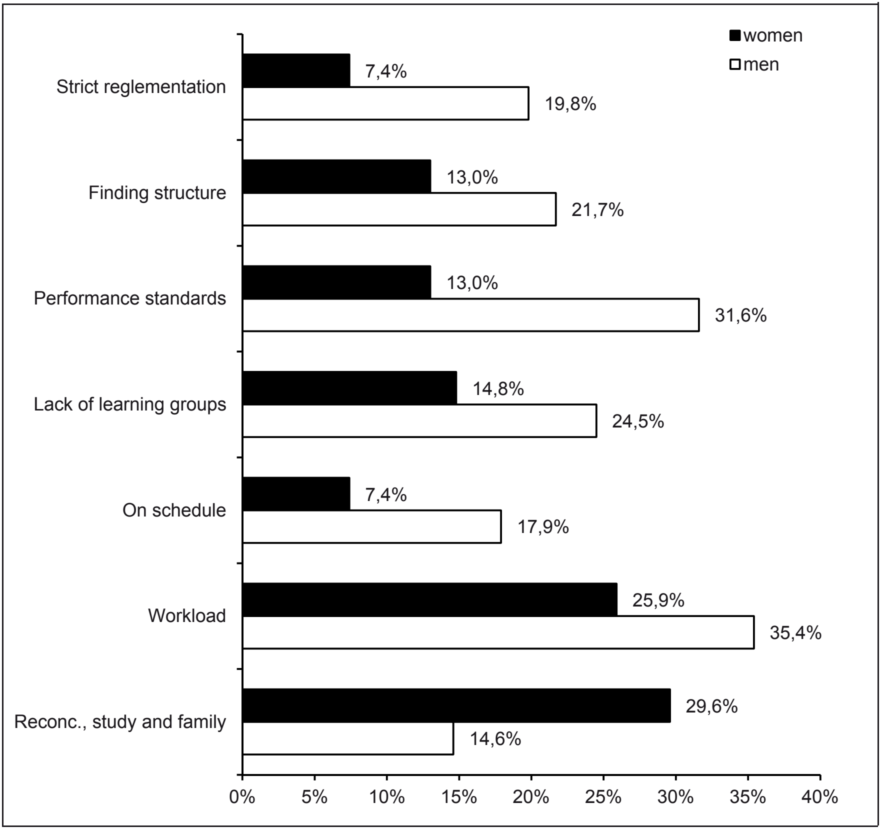

Figure 3: Problems and demands experienced in studies according to gender

3.6 Thoughts about change of subject/change of university/ interruption of studies or termination of studies

In the context of problems and demands during studies, as well as in terms of study choice decisions, thoughts about change of subject, change of university, interruption of studies, or termination of studies are serious matters. In the whole of Germany, 8% of university students and 6% of university of applied sciences students had seriously considered terminating their studies, while another 14% considered it from time to time. Since this was primarily as a result of individual rather than institutional causes (cf. BMBF 2008: 25), it was recommended that termination of studies should not be taken as an indicator for the ‘study quality’ of a study programme (ibid). A study conducted at the Hamburg University of Applied Sciences found that there is no outstanding single cause for termination of studies but many overlapping causes (Richter 2006). Although there no gender differences were revealed with regard to causes for the termination of studies, the priorities of causes differed. While the lack of subject-related and personal integration into the faculty was pivotal for women to terminate studies, it was the pressure of gainful employment alongside with studies for men.

By means of a three-level scale (‘frequently’, ‘rarely’, ‘never’), students in BIS, TMM and ISE were asked in our study if they had ever thought of changing the university or the subject, or of interrupting or terminating their studies. In cases where students answered ‘frequently’, they were asked to state reasons.

Only small percentages of respondents stated having thought ‘frequently’ about changing the university or subject or about interrupting or dropping out of their studies:

- Change of university: 4.4%
- Change of subject: 8.8%
- Interruption of study: 4.1%
- Termination of study: 6.3%

In addition to personal reasons (e.g. illness), reasons for a possible university or subject change, an interruption or even termination of studies were linked to dissatisfaction with the quality of studies and/or lecturers. Thoughts of termination of studies were not explicable in terms of students’ possible deficient study requirements (for both genders). There was also no correlation between thoughts of termination of studies and length of working hours outside university ($r = -.019$ ($p > .41$)), although students had mentioned in the context of another question that the reconciliation of studies and gainful employment is a constraint. Finally, there were no conspicuous differences in any of the items with regard to gender distribution.

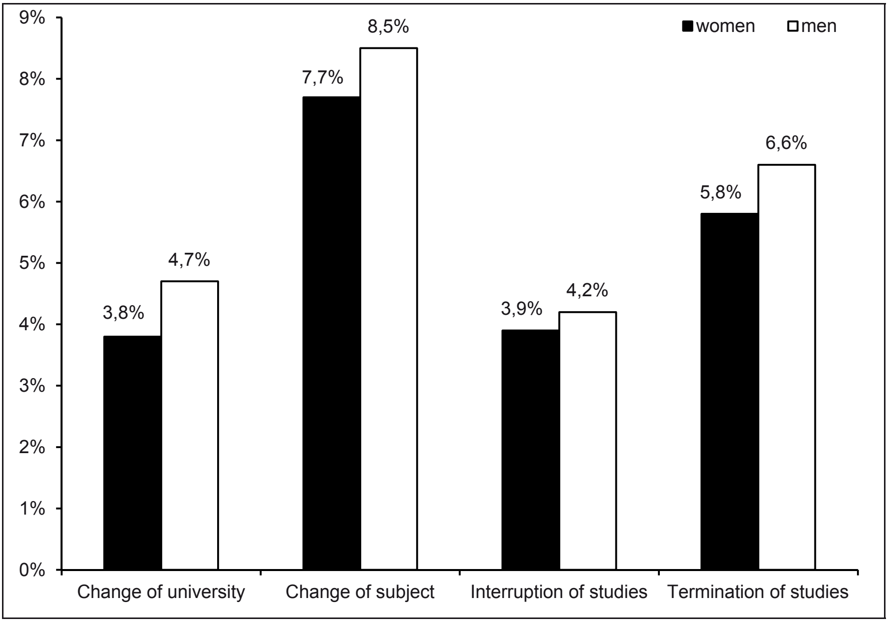

Figure 4: Thoughts of subject and/or university change, interruption or termination of studies according to gender

4 Conclusion

Three cross-disciplinary programmes offered at the Kiel University of Applied Sciences combining business management and engineering attract more female students than pure engineering subjects. In the winter semester of 2011/2012 about 18% women were enrolled in Business Information Systems (BIS, Bachelor/Masters), Technology Management Marketing (TMM), and International Sales and Purchase Engineering (ISE). Thirty-four per cent (N = 270) of all 787 registered students in these three cross-disciplinary study programmes took part in the research, which investigated possible gender differences in relation to study satisfaction, study success, study problems and dropping out of studies.

The small research study sought to explore correlations between study motives and educational choices or job experiences prior to the study, on the one hand, and study success or, in contrast, study problems, on the other. Three extrinsic motives led in the ranking list of the most pronounced reasons for study choice; firstly, good career prospects, secondly, good income prospects, and thirdly, having many job opportunities. With one exception no gender differences occurred and women studying BIS, TMM or ISE did not show greater intrinsic motivation than men. In contrast, the intrinsic motive 'subject-specific interest' was affirmed by only one-fifth of the female but half of the male students, denoting one significant gender difference in study choice motives. The study confirms that women's 'subject-specific interest' as a motive for their study choice was much weaker compared to the interest of their male fellow students.

Another significant gender difference occurred in terms of a technical or computer-related qualification. A far greater proportion of male students had either a technical or computer-related school or vocational education background and job-related experience before studying than their female counterparts. Yet, in relation to their (self-assessed) study successes women's less pronounced qualifications prior to their studies did not impact negatively on their performance.

Apart from the item concerning presentation skills all other items for study success were relatively equally distributed and not significant. Although the majority of students across all study programmes assessed their presentation skills as weak, significantly fewer women than men assessed their presentation skills as good. Measured with Fisher's exact test this was the only significant gender difference regarding sense of achievement in studies. Pronounced study difficulties and demands, on the other hand, were tested as significant: more men than women felt stress and problems, in particular with performance requirements, workload, finding structure in their studies, regimentation, timely submissions, and lack of working groups, while more women felt the burden of balancing their studies with their family life.

In conclusion, women studying BIS, TMM and ISE felt remarkably less burdened by study requirements compared to men. In accordance with the overall positive assessment of their studies only a few students stated having thought 'frequently' of either changing university or subject or to interrupt or drop out from their studies. Reasons for this were personal or related to dissatisfaction with the quality of studies and/or lecturers. No conspicuous gender differences in any of the items became evident.

In sum, the quantitative survey could not provide evidence for discriminatory practices against, or indications of disintegration and exclusion of, female students in the three cross-disciplinary course programmes. Hence, subsequent to this study a qualitative research study would be beneficial in order to provide deeper insights into the dynamic processes of the teaching and learning cultures in the three course programmes. Particular attention should be paid to investigating in more detail and depth the finding of this survey; that is, the rejection of any discrimination against female students.

5 Lessons to learn for women in science

Technical or computer-related education prior to the study of Business Information Systems, Technology Management/Marketing, or International Sales and Purchase Engineering is certainly desirable and helpful especially at the beginning of the study. Yet, it is not a determining factor for study success. If women pursue a career in these sectors, they still have a good chance of succeeding in their studies without preparatory training. Likewise, weaker intrinsic motives do not impact negatively on study success. Social acceptance of women by male fellow students and lecturers in a rather male-dominated study environment, and good social integration, seem to be crucial support factors for women's study success, as well as general satisfaction with study conditions and the quality of study. Comprehensive courses combining engineering and management are attractive to both genders since they offer good job and career opportunities. By attracting far more women than pure engineering study courses they have the potential to support change to a less traditional culture in the faculty.

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Pair Programming, Confidence and Gender Considerations at a South African University

Michael Mitchley, Yasmine Dominguez-Whitehead, and Sabrina Liccardo[1]

1 Introduction

As in most Science, Engineering and Technology (SET) fields, women in computer science continue to be underrepresented (Cohoon/Aspray 2006; Ilias/Kordaki 2006). This shortage of women raises critical concerns surrounding women's rights and their participation in education and science. In South Africa, this shortage is also relevant to the country's socio-democratic transformation efforts and critical skills shortages. Given that women are under-represented in computer science and that this has social and economic consequences, it becomes increasingly pertinent to conduct an examination that addresses discrepancies between women and men studying computer science at the university level. It is also relevant to examine pair programming as a teaching-learning strategy that may help students (particularly women) succeed.

Additionally, the concerning attrition rates of women studying computer science at university provide an impetus to investigate discrepancies between the two genders (Cohoon 2002). It has been noted that attrition for women is twice that of men (Cohoon 2002). This figure, coupled with South Africa's alarmingly high university dropout rate, which is estimated at approximately 50% (Beckmann 2008; Jama/Mapesela/Beylefeld 2008), suggests that university students and women in particular confront difficulties in completing their degrees. We are thus compelled to investigate discrepancies between the two genders in computational science courses and to investigate pair programming as a teaching-learning

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strategy that may help women succeed. Accordingly, the article presents research conducted on university students in a programming-intensive course at a major university in South Africa and focuses on gender discrepancies and pair programming. The data presented is derived from a questionnaire that elicited quantitative and qualitative information from students in a first-year computational mathematics course. The following overarching research questions were pursued: Do men and women report differences in programming experience and confidence? Is pair programming a helpful teaching-learning strategy for women?

2 Selected literature

The literature reviewed below provides a cursory overview of pair programming and its use as a teaching-learning strategy, as well as an overview of women in programming, including some of the barriers to participation and success that have been widely documented.

2.1 Pair programming: selected literature

Different styles of learning and their relevance for teaching and learning in computer science have recently received attention. More specifically, there are indications that gender differences relating to performance in computer science may be attributed to styles of learning and the ways in which learning takes place (Ames 2003). It has been argued that 'learning style-based pedagogical practices [in computer science] need to move from a gender neutral to gender sensitive approach' (Lau/Yuen 2010: 1090). In other words, environments that are women friendly and that encourage the participation of women should be promoted. In particular, it has been suggested that women in computer science courses have opportunities available for them to work with others (Ross/Schulz 1999).

Pair programming, a style of programming that can be used as a teaching-learning strategy, requires programmers to work together. It requires two individuals to sit next to each other at one computer to continuously collaborate on a design, algorithm, code or test (Williams et al. 2002). In some instances, the roles of the collaborators may be prescribed, with one acting as the 'driver' (the person responsible for typing) and the other acting as the 'navigator' (the person responsible for observing the work of the driver and looking for errors in the work) (Williams et al. 2002: 198). However, even when roles are prescribed, either of the partners can brainstorm spontaneously, and the prescribed roles can be exchanged periodically. Some of the benefits of pair programming include producing higher quality work within a shorter amount of time (Williams/Kessler 2001). Additionally, it has been found that, in using pair programming, students perform better on projects, are more likely to pass the class, and are more self-sufficient (Williams et al. 2002). Given that professional software developers spend about 50% of their time working with one other person and 20% of their time working with two or more individuals (DeMarco/Lister 1987), it would be good practice for students to become accustomed to working closely with others in their programming training. Moreover, this teaching-learning strategy may be well suited for students enrolled in introductory courses, since it creates a space for them to discuss problems and apprehensions that they may have as novice programmers with a peer. It is nonetheless a possibility that conflicts may emerge between partner students. It is worth noting, however, that even such conflicts provide opportunities for students to learn to work with others and to resolve problems that arise as a result of this collaboration.

2.2 Women in programming: selected literature

In South Africa, approximately 31% of degrees in computer science and information technology are awarded to women (Shapiro/Jacobs 1999). However, this figure alone does not provide an accurate account of the extent to which women are under-represented in computer science. We must take into consideration that women are less concentrated in computer science and more concentrated in information technology (Randall/Price/Reichgelt 2003). Thus, the women who enrol in computer science majors or courses at the university level are a minority who have undoubtedly challenged stereotypes about who can and should pursue computer science studies (Singh et al. 2007). It thus becomes that much more critical for the gender minority to receive the necessary support and access to helpful teaching-learning strategies in order to succeed.

It has been overwhelmingly documented across countries (South Africa included) and across institutions that women report having lower confidence (or self-efficacy) in their computer programming abilities compared to men; however, discrepancies between the abilities of men and women have generally not been found (see, for example, Beyer/Rynes/Haller 2004; Beyer et al. 2003; Galpin et al. 2003; Scragg/Smith 1998; Shashaani/Khalili 2001; Varma 2002).

In taking this into consideration, it has been suggested that women as a group need to develop an 'identity of competence'; that is, they need to be confident in working with computers in a male-dominated environment (Irani 2004: 195). This is not altogether an easy endeavour. While it is acknowledged that women have agency and can develop attributes that may help them succeed and in the long run encourage more women to enroll in computer science courses, the onus to change their situation should not rest on their shoulders alone. Educators should also proactively create environments that are women friendly and that introduce teaching-learning strategies that may be more helpful and amenable to women. Hence, our research is concerned with assessing the extent to which pair programming is a helpful teaching-learning strategy for women and with examining reported differences between men and women as they relate to experience and confidence in computer programming.

3 Methodology

Students in a first-year computational mathematics course were given six weeks of assessed programming work, with the option to complete each task in pairs. An optional online multiple-choice questionnaire was made available to the students, and the results of the questionnaire were paired with their marks. Sixty-six students responded to the questionnaire out of a class of approximately 240 students. Eighteen of the respondents were women and 48 were men, which was representative of the gender breakdown of the class (fig. 1). Ethics approval for this project was obtained from the Ethics Committee of the university in which this research was conducted.

Figure 1: Gender breakdown of the sample group, in total numbers

Separate counts of the frequency of each response were taken for the men and women in the sample group, which were then compared to the total count of each response. Owing to the sample size and lack of prior distribution, statistical measures were not considered appropriate.

4 Results

The students were asked what effect their gender had on their programming experience (fig. 2). No women reported a positive effect, and only one man reported a negative effect. Twelve of the 18 women (67%), and 35 of the 48 men (73%) reported no effect of gender on their programming experience.

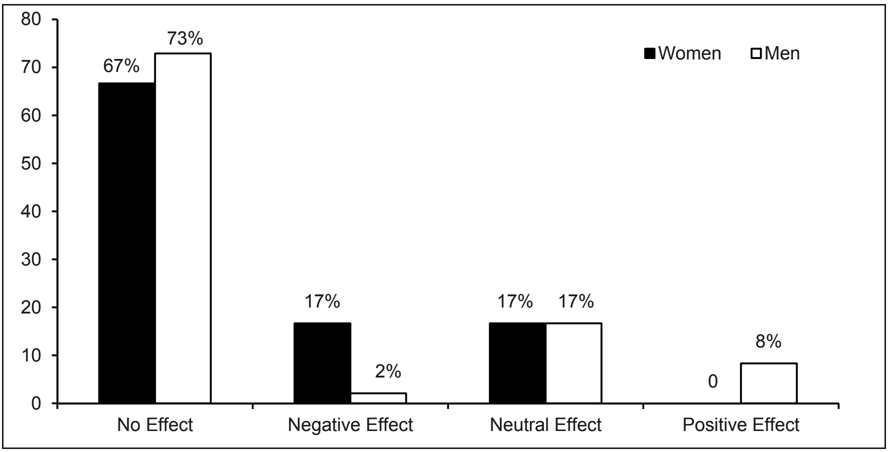

Figure 2: Self-reported effect of gender on programming performance, in %[2]

The students were asked what effect their gender had on their confidence as programmers (fig. 3). Most students (73%) reported no impact (61% of the women and 77% of the men), and 24% of all respondents reported either a slightly negative or slightly positive impact (33% of the women, 21% of the men).

2 The numbers in the figures have been rounded off to the nearest percentage.

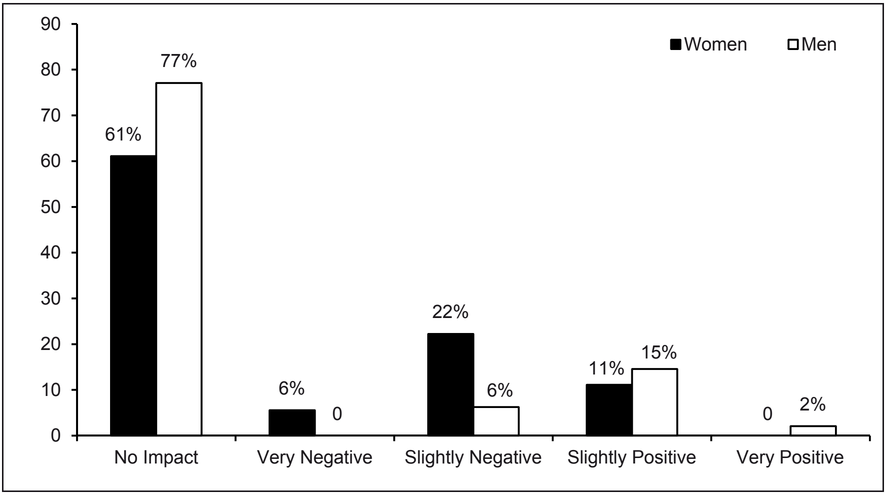

Figure 3: Self-reported effect of gender on programming confidence, in %

The students were asked to rate the programming abilities of those of the same gender, and those of the opposite gender. Numerical values were assigned to the perceived abilities of women and the perceived abilities of men (1 being very low, 5 being very high). The difference between the values assigned to the abilities of women and men was computed, giving a score from -4 (heavily biased towards the abilities of men) to 4 (heavily biased towards the abilities of women), where 0 is a neutral point at which both genders were perceived to have the same ability (fig. 4). No students reported a heavy bias towards the abilities of women. Men were more likely to report a neutral or slightly biased position while women were more likely to report a heavy bias towards the abilities of men. The average score for women was -1,33, while the average score for men was -0.52. The average total score was -0.75.

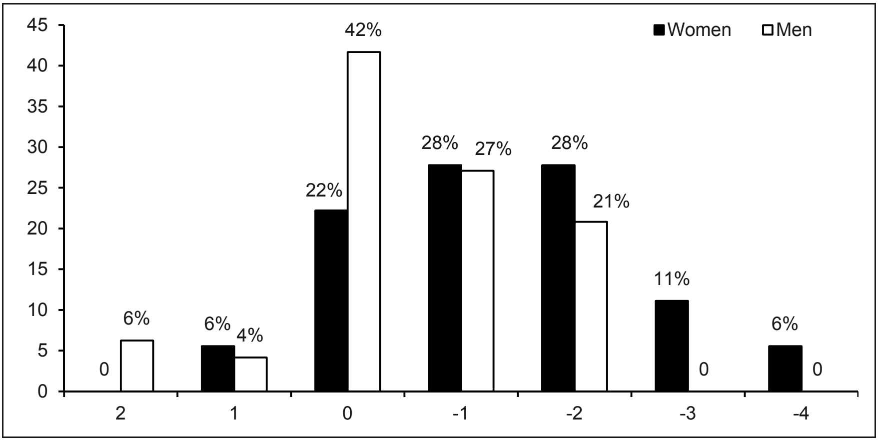

Figure 4: Bias present in views of the programming abilities of each gender, in %. A negative number indicates a bias in favour of men.

Students were asked to identify barriers or difficulties encountered in programming from a predetermined list of possible barriers. Students could select multiple options for this question. A count of each response is shown in figure 5. Interestingly, no students selected gender bias as a barrier or difficulty. Lack of prior experience was, by far, the most commonly reported difficulty, and was reported by 15 out of 18 women (83%) and 32 out of 48 men (67%).

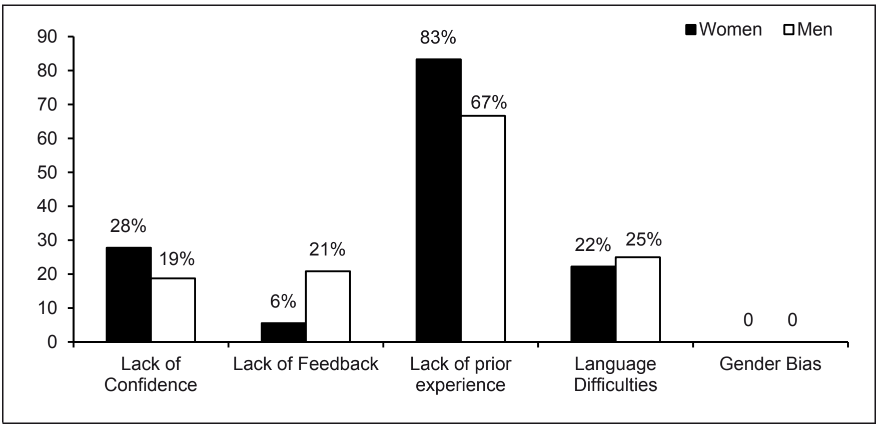

Figure 5: Reported barriers or difficulties encountered in programming, in %, multiple answers

The students were asked whether pair programming was helpful to them, with the option to report having worked alone rather than participating in pair programming. Accordingly, 87% of the students who participated in it found pair programming helpful (fig. 6). More women (89%) than men (75%) found pair programming either entirely, very or slightly helpful. No women and two men reported working alone.

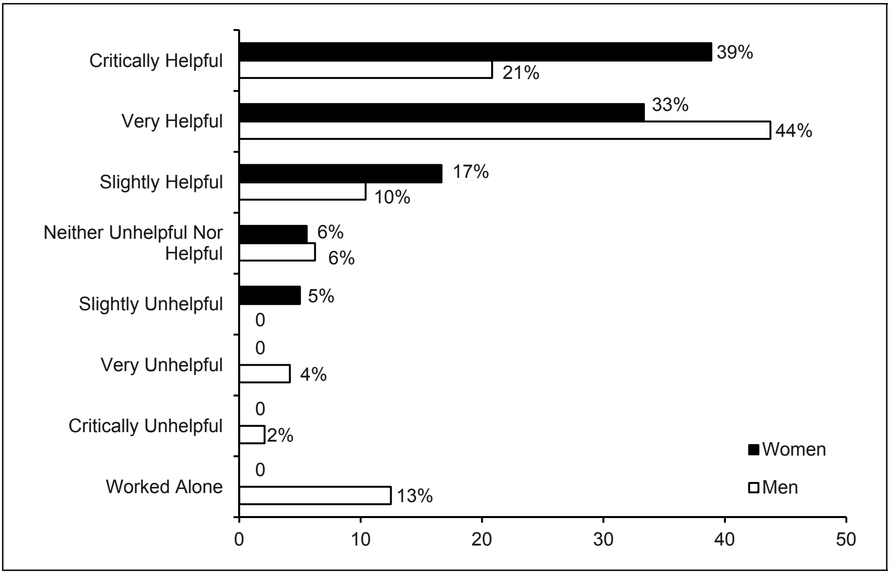

Figure 6: Reported helpfulness of pair programming, in %

Students were asked how the workload was shared between them and their partner if they participated in pair programming (fig. 7). Women exclusively reported either sharing the workload evenly (72%), or their partners doing most of the work (28%). Only one man reported his partner did all the work.

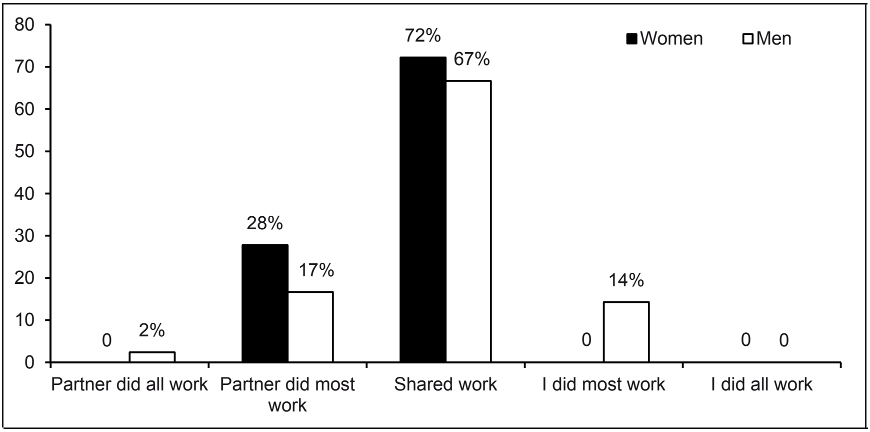

Figure 7: Reported sharing of workload, in %

The marks of the students from a previous programming examination conducted in a previous course were compared to those obtained during the pair programming assessment tasks. To control for different markers, the deviation from the average mark of the class was measured (fig. 8). In the previous course (wherein the students had to programme alone), the women in the sample group scored slightly lower than men and were slightly below the average mark of the class. In the course where pair programming was used, the averages of the men and women in the sample group were the same to two decimal places, with both groups scoring higher than the class average. Women exhibited a 12% increase in marks between the two courses.

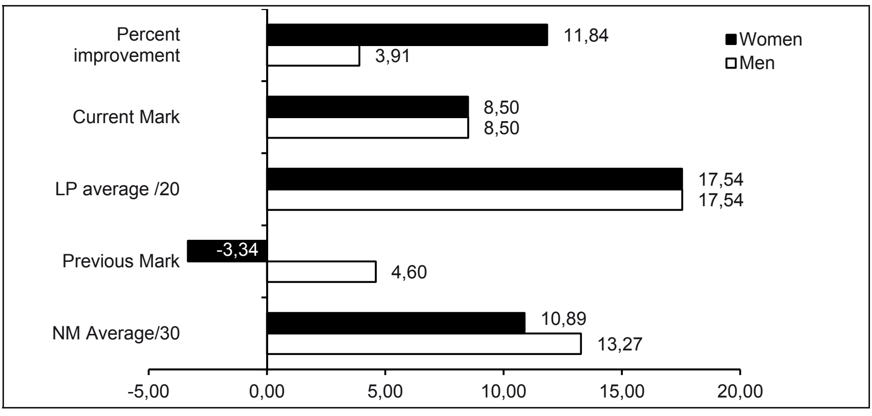

Figure 8: Mark comparison before and after pair programming

In the next section, we examine the discrepancies between the two genders in a first-year computational mathematics course and investigate whether pair programming as a teaching-learning strategy was helpful for women.

5 Discussion

Firstly, the sample, 27% women and 73% men, is representative of the gender ratio of the course. This is consistent with the low participation of women in computing which is an area of concern in South Africa, as only 31.1% of women obtained degrees in computer science and information technology over the period 1991 to 1998 (Shapiro/Jacobs 1999).

We now turn to addressing whether men and women report differences in programming experience and confidence. Although students self-reported that gender had 'no effect or impact on their programming experience or confidence as a programmer' (fig. 2, 3 and 5), upon closer examination of the gender-specific ratings of perceived programming ability, women appear to be less confident in the ability of their fellow women peers. As illustrated in figure 4, women reported more confidence in the perceived programming ability of men (than they did of other women), whereas men reported more confidence in the perceived ability of other men (than they did of women). This indicates that while women generally reported that gender had no impact on their personal confidence as programmers, they nonetheless view women in general as having lower abilities, and men as having higher abilities.

These findings are consistent with the literature on women having low confidence in their computer programming abilities. Despite obtaining equal or higher academic scores than their male counterparts, women consistently report lower confidence than men and underestimate their abilities in computing (see, for example, Zappert/Stansbury 1985; Clarke/Chambers 1989; Sanders/Galpin 1994; Scagg/Smith 1998; Henwood 2000; Shashaani/Khalili 2001; Varma 2002; Beyer et al. 2003; Irani 2004). For instance, research conducted at the same university as this study found that first-year male students in computer science had higher self-efficacy than their female counterparts with respect to their perceived aptitude for computing and academic achievement, although there was no difference in their marks (Sanders/Galpin 1994: 2). In another study that required students to rate their confidence in solving problems with computers, Irani (2004: 196) found that

> women rated themselves an average of a half point less confident than their peers in [a first-year course in computer science] while men rated themselves as an average of six tenths of a point *more* confident than their peers in the course (emphasis in original).

These findings raise critical concerns about women's attrition in computing. The negative affirmation of their capabilities has implications for their participation and persistence in developing a career in computer science and information technology. There are a number of factors that could account for why men and women express more confidence in the perceived programming ability of men (than they do of women). For instance, stereotypes that are associated with 'feminine' and 'masculine' careers (see, for example, Clegg/Trayhurn 2000; Fisher/Margolis/Miller 1997; Wilson 2003) tend to influence people's attitudes toward women in computing and the internalisation of these gender stereotypes by women could lower their self-efficacy and career aspirations.

Similarly, women may find that they are in a minority in a male-dominated culture in which 'gendered self-presentation and communication, rather than objective measures of ability, plays a large role in developing confidence [and perseverance]' (Irani 2004: 195). Bjorkman et al.'s (1998, cited in Singh et al. 2007: 516) theorisation of gender stereotypes as socially situated could account for why women rate the abilities of their fellow women as being lower than those of their male counterparts. Singh et al. (2007: 516) explicate that according to this theory of gender stereotypes, 'typical "feminine" behaviour is incongruent with academic success in computer majors, where implicit social rules work to maintain traditional success in computer majors [and] traditional male-dominated power hierarchies, and where myths of academic success are inconsistent with some female roles'.

As illustrated in figure 5, 83% of women indicated that lack of prior experience of programming was their greatest barrier; this may have had a negative impact on their confidence levels. These findings are consistent with those of Galpin et al. (2003: 17), who reported that university students without prior experience of programming had lower self-efficacy beliefs. This warrants further research, as many under-resourced and rural schools in South Africa have limited computers.

We now examine whether pair programming as a teaching-learning strategy helped students (particularly women) succeed. The majority of students reported that pair programming (or working in pairs in the labs for graded submissions) was helpful for them (fig. 6). It was particularly valuable for women, as 72% of them reported that pair programming was very or critically helpful, and none of the women reported working alone. The ways in which pair programming was beneficial for these students could be interpreted in a number of ways. For instance, pair programming may have created a cooperative and collaborative learning environment. In fact, the majority of the students in this research (especially women) indicated that they had shared the workload evenly with their partners (fig. 7). This environment is conducive to problem-solving activities in which students collaboratively construct scientific knowledge through discussions about their postulations and interpretations of results (Roth 1993; Abboud 1994; Priebe 1997). In this research, the majority of students found pair programming to be helpful.

Werner, Hanks and McDowell (2004: 4) discovered that 88.1% of paired women (compared to 79.5% of women who worked independently) passed an introductory programming course; thus they argue that pair programming increases the likelihood of academic achievement. Similarly, in this research, when we compared participants' marks in a previous course (in which students had to programme alone) with the course under study (wherein pair programming was implemented), we found that women as a group experienced a 12% increase in their marks (fig. 8). Although we cannot claim that pair programming directly caused an increase in their marks, the findings suggest that pair programming may have initiated other contributory factors (e.g. a collaborative learning environment, opportunities to discuss problems with others and a supportive environment) that increased the likelihood of academic achievement.

6 Conclusion

Given that women are under-represented in computer science and that this has social, economic and ethical consequences, this article addressed discrepancies between women and men studying computer science at the university level. Furthermore, we examined whether pair programming as a teaching-learning strategy can help students (particularly women) to succeed. Although students self-reported that gender had no effect or impact on their programming experience or confidence as a programmer, on closer examination of the gender-specific ratings of perceived programming ability, we found that gender does have an impact on how the abilities of women and men are rated. Women reported more confidence in the perceived programming ability of men (than they did of other women), whereas men reported more confidence in the perceived ability of other men (than they did of women). Put differently, despite obtaining equal or higher academic scores than their male counterparts, women rate the abilities of their fellow women as being lower than those of their male counterparts.

7 Lessons to learn for women in science

The female student population in computing and information technology across public higher education around the world is consistently lower than that of male students (Cohoon/Aspray 2006; Gadalla 2001). In South Africa, the widening gender gap in computer science raises critical concerns surrounding the country's socio-democratic transformation efforts and the advancement of science and technology. Several studies report that women's attrition in computing may be attributed to a classroom or workplace environment that is unresponsive to women (Weinberger 2004; West/Ross 2002); the perception that information technology thrives in a competitive atmosphere as opposed to a collaborative one (Werner/Hanks/McDowell 2004); the field's lack of engagement with social discourse (Weinberger 2004; Wilson 2003) and the masculine teaching methods and stereotypes associated with the field (Clegg 1999; Fisher/Margolis/Miller 1997; Wilson 2003; Clegg/Trayhurn 2000).

Pair programming as a teaching-learning strategy grapples with the above-mentioned issues by displacing the masculinised notions of an emotionally detached autonomous self with a feminist approach to science that promotes collaboration (Hanson 2007). Within a 'pair-oriented culture' (Werner/Hanks/McDowell 2004: 6), gendered interactions are no longer located in male-dominated power hierarchies but rather in social relations (Hanson 2007). We argue that pair programming may assist women in their career development in science because it creates an environment that is conducive to the formation of support networks and the establishment of an 'identity of competence' (Irani 2004: 195). Given that professional software developers spend about 70% of their time working with one or more people (DeMarco/Lister 1987), peer programming promotes good practice as 'team-oriented activities in the classroom mode[l] real-world teamwork in industry' (Williams et al. 2002: 199). This kind of inclusive culture encourages the development of the social interaction skills necessary for collaborative activities. Furthermore, these support networks create a space for women to develop feelings of competence in working with computers, which consequently enables them to identify themselves with computer science and to create a sense of belonging in the SET fields.

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The Scientific Culture in Electrical Engineering: An Insider's Reflection

Sabah Badri-Höher[1]

1 Introduction

In the last few years, the interrogation of gender equity in different scientific fields such as medicine, physics, chemistry, mathematics and engineering has been the focus of various academic studies (see, for example, Alpay et al. 2010; Brecher 1989; Huyer/Westholm 2007; Miroux 2011). However, deeper studies and analyses of the reasons for the large differences in gender equity between engineering and other disciplines have not been addressed in detail. Alpay et al. (2010), Bell (2009), Cascade (2009), European Commission (2005; 2009) and Sonnert (1999) have, for example, conducted research on the career development paths of women with respect to gender equality.

The focus of this article is on gender inequality in higher education and on the career development of women with a particular focus on the field of Electrical Engineering (EE). Certain issues related to the culture of engineering are addressed based on the conducted research.

This article is written from the personal perspective of a professor of EE, who is the only female professor in her department. The article discusses the motivation for a study in the EE field of academic study and the culture in EE, as well as female career development in EE. The paper concludes with a summary and reflection.

2 Motivation for a study in the EE field

In higher education, the motivation for selecting a specific field for academic study differs from country to country. In general, the school, friends or family

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environment has a major impact on the decision about what to study. In Germany, for example, the number of female students in the first semester in EE is 5 to 11% of the total number of first-year students and at some universities it is even less. In the case of programmes that include a combination of technical and economics modules (Industrial Engineering [*Wirtschaftsingenieurwesen*]), the percentage of female students is higher and can account for 40 to 50% of the total number of first-year students.

These numbers indicate a severe gender gap, which tends to increase in later semesters (cf. Huyer 2004). Huyer (2004) undertook a comparison between different countries in Europe and elsewhere and found that, in Europe, male graduates tend to outnumber women graduates in science, mathematics and computing programmes, except in Belgium and Spain, as well as in engineering programmes. The average percentage of women graduating in science, mathematics and computing in the EU is 35.7%, while national percentages range from 25.5% in the Netherlands to 49.8 % in Portugal. Germany has the lowest proportion of women engineering graduates with 11.8%, and Italy the highest proportion with 34.4% (European Commission 2003).

In the associated countries of the EU, the percentage of science, mathematics and computing graduates shows wider variations, ranging from 9.1% in Norway to 66.7% in Cyprus. Most countries are in the 40% range. For engineering, the percentages are lower, from 13.9% in Norway to 28.6% in Latvia (with Bulgaria and the Czech Republic close behind at 27%) (European Commission 2003). In comparison, Huyer (2004) found that in other selected countries, like Turkey (24%), Lebanon (21%), Israel (24%), Costa Rica (28%), Korea (28%) and Brunei Darussalam (38%), the gender gap is lower in the field of engineering.

With regard to gender and science and technology, as viewed from an international perspective, Huyer (2004) concludes:

- Poverty is a major factor in countries with high levels of gender disparity in school enrolments. Where gaps are closing, have closed or are reversing, gendered perceptions and stereotypes continue to direct choices.
- When having opportunities for education, women benefit from it and perform well.
- The low performance of boys in some countries is indicative of certain negative effects of masculine gender roles.

- Where education systems move towards gender parity and improved quality, girls tend to perform better than boys.

The percentage of female students in the field of engineering in Germany compared to the percentage in Turkey, Costa Rica and Brunei Darussalam demonstrates an inverse proportionality between the economy and the industrial development of a nation and the interest of female students in the field of engineering. This observation is even applicable to the EE field, despite the fact that Germany is one of the leading countries in the world in technical products and innovation.

Based on this observation and going back to the motivation aspect of academic study choices, the question then is whether the family or the school environment is more responsible for the negative image of engineering. In fact, the family has a minor influence on such perceptions; even if one of the parents is an engineer, the likelihood that daughters make such a study choice is minimal. This means a role model as a factor of influence is irrelevant for academic study choices in this case. By contrast, in medicine family role models play an important role. The majority of medical students come from families where parents and/or grandparents did the same or related studies. Also important to know is the fact that technical devices at home (e.g. smartphones, digital cameras, navigation systems), which we use daily, do not evoke any positive response with regard to academic study.

Even the technical equipment successfully used in medicine (such as electroencephalography (EEG), electrocardiography (ECG), operating robots etc.) does not minimise the negative image of engineers in German society.

School environments, on the other hand, do not display a positive image of engineers either. The curriculum in secondary schools includes scientific modules such as mathematics and physics without any connection being made to applications in the engineering field. The structure of different profiles in secondary schools in Germany (school profiles are, for example, sciences, languages or sports) is not optimal with regard to the academic study of engineering. Even if secondary schools have as many females as males, and both show the same performance, good females choose medicine, biology, chemistry, physics or mathematics for their studies.

In the last ten or so years policymakers have initiated a number of programmes to encourage females to take up academic studies in engineering; for example, Girls' Day, MINT-Lab, Girls-Lab and others. These programmes are offered by universities, research institutes and industry. During these activities, girls are given an opportunity to participate in the development of a small technical project with the support of supervisors. However, there is neither an arrangement with schools in the planning and realisation of these projects, nor is feedback to the schools included in these activities. In fact, it would seem that the number of women who undertake academic studies in EE has not been significantly influenced by these programmes.

The main points that can be concluded from this analysis are the following:

- Engineering work and innovation do not have as much impact on the family environment as, for instance, do medicine or related fields. The presence of role models, for example when the father or mother is an engineer, does not influence the study choices of daughters as it would in medicine or related fields.
- The structure of the profiles of secondary schools is not optimal in terms of encouraging students to take up studies in EE.
- Motivation programmes offered by universities, research institutes and industry have not had an impact on the number of female first years in EE. Such programmes should also be offered and organised by schools.

3 Academic study and EE culture

Female students in EE study programmes represent a minority in their institutes or departments. In general, they attend the same lectures, exercises and labs as their male classmates and most courses are offered by male lecturers.

Hacker (1981), in giving an impression of the culture in engineering, describes her engineering institute as follows: The buildings were large and austere. The place was quiet. Dominant elements appeared to be mechanical and physical rather than social.

In fact, female students coming directly from secondary school are not able to compare their surroundings with other alternatives. Thus, they accept the environment of engineering institutes and departments, and try to identify themselves with that environment.

In the same paper, Hacker writes:

> *Engineering faculty ranked technical expertise more valuable than knowledge of social relations ... At the Institute, I found that fields within engineering were also ranked, informally, along an 'earthy-abstract' continuum. Electrical engineering (EE) carried more clout and status than, say, civil engineering. The former was considered 'cleanest, hardest, most scientific', the latter far too involved in physical, social and political affairs. Most engineers agreed with the stereotype of EE,*

> *although those outside that field resented its power and status, merely because the field was closer to abstract science.*

In general, those EE students who have completed their academic studies successfully with a bachelor or master's degree feel in the first semesters that their education requires time and hard work, and there is no difference between males and females in this regard. In research conducted Leonardi (2003), most of the EE students interviewed indicated that they had consciously sacrificed their social life in order to achieve success as an engineer. One participant's comment illustrates this: '*I have no social life now because I have to stay in the components lab – like, until eleven and that night I got out early. Usually I stay until two or three*.'

Leonardi (2003) found that participants were reluctant to admit defeat on any projects in which they were engaged. One participant commented in this regard: 'I would say more or less the thing that helps me the most in this class is being rather bull headed, actually. Not really giving up until the problem is solved.'

Another participant commented: I'm very idealistic, so I won't stop with an assignment when it's just done and just doing a few things, but I also pound on it a little longer until I think it's perfect.

These comments closely match my own experiences during my studies and my experiences with female students. Most female students in EE work hard during their studies and do not wish to be perceived as different or as being treated differently from their male fellow students. One example here is the laboratories, where groups of students work together with hardware components and do different tests and measurements. The idea of forming groups of females only in one of my labs in the past was completely rejected by the female students. Indeed, female students in EE are often the group leaders in such exercises.

Furthermore, it is important to note that female students in EE institutes and departments are generally very satisfied with the environment, and achieve their bachelor or master's degrees with good grades.

In summary, we can conclude that

- although female students represent a minority in EE academic study, their method of working and learning is no different from their male fellow students
- female students do not accept that they should be treated differently from their fellow students

- female students' satisfaction in EE institutes and departments is high, and they do not experience any gender discrimination
- most female students complete their studies with good grades.

4 Female career development in EE

In the EE field, where the number of female graduates is smaller than in other scientific and technical disciplines, it is very important to integrate such graduates into both the academic and the industrial labour market. Huyer (2004) highlights that the number of female senior managers in the information technology industry in particular is lower than in other industries: 'In the United States (US) where the managerial positions of females is more than 45%, females hold only 9.3% of board seats at technology companies.' Huyer (2004) explains this effect by a lack of female mentors and role models. The culture of intense work includes late nights and weekend work as well as ad hoc meetings. The analysis done by Huyer in the US is also applicable to Europe. In Germany, the number of female senior managers in information technology companies is even lower than in the US and the same effect can be observed in the area of research. In research enviroments, where mobility, publication rate in journals and the presentation of papers at conferences, and acceptance from the EE research community is very important, female reaserchers experience more difficulties than their male colleagues.

In fact, the majority of female postgraduates in the EE field have been in the minority through their entire academic education, and this phenomenon continues into employment, where both the industry and the research environments are male dominated. However, this is nothing new to female postgraduates.

The EE field offers graduate students different opportunities for work. With a bachelor or master's degree, various opportunities are offered in industry, in development or even in research. For higher positions, such as a professorship at a university or a group leader at a research institute or an industrial company, a PhD is generally required. A PhD degree in the EE field usually takes between four and five years. In Germany, the age of PhD candidates is approximately between 25 and 28 years. However, this age is also generally the time for another new step in life, that is, planning to have one's own children. Therefore, in this stage at least a distinction should be made between males and females. For male

PhD students no significant change in their career development takes place; however, for female PhD students radical change can happen. During this period women find it difficult to progress significantly in their work, because they have to divide their time between research work and their responsibilities at home. For mothers in particular, these years are a challenge. It is at this time that a significant proportion of women interrupt work for months, years, or even forever. This break in work automatically means a break in their career and, consequently, a loss of significant highly educated technical human capital.

This example of a career break can be generalised to other situations (not only PhD work) and environments (companies, research institutes, universities).

In Europe and other countries, different programmes and efforts have been initiated by government policies, various institutes and organisations that aim at enhancing and optimising female career development. However, these programmes can probably only serve as good practice examples. The fact is, today, we have only a small number of females who have succeeded in developing their careers in parallel with their family life. The success of these females is individual and needs constant optimisation for each female.

In a report by the European Commission (2009) on women in science and technology, the statements of senior managers would seem to confirm the preceding argument:

> Women senior manager: *It's really ... related to your environment, your own situation at home ... It is the circumstances, your husband, it's the company, it's so many sections that would influence and make it very personal. That's why some women really struggle to make success by themselves. I know one of the very ambitious women working here worked part-time but her husband was not willing to do anything at home, cleaning or whatever. No time to pick up the kids from the kindergarten in the afternoon. She almost went mad after six or eight months. She stopped, she couldn't handle it. It was too much. And of course if you have no support from home, that counts for men as well if they're around, if you have no support it is impossible to develop a career.*

> Women manager's comment: *I'm not available on Friday. But I have my phone, and my computer, and if needed I can do something, send a document, answer a call, or something. But some of the time my Friday is off, it's time for me. The counterpart is that during other days, I work and I never rest*!

> Women scientist's comment: *If I were ready to get more involved and work longer, I could (advance)… But if you also want to take care of your personal life it's more difficult.*

What if you are a father?

Then you should have a good wife!

It is important to recognise that the difficulties in and obstacles to career development for females in the field of engineering in general (including EE) is a global social problem. The actual efforts and programmes initiated by government policies and others do not really help to prevent such career breaks or the loss of highly educated female technical staff. The following are needed in this regard:

- A change in the infrastructure in both the private and the business world.
- Job sharing in terms of home responsibilities should be optimised (globally and not individually).
- The male-dominated culture of the technical work environment should be changed.

If this is done then we can probably create a setting where women can develop and optimise their career. What is also necessary is a modification of the rules; for instance, the composition of appointment committees and other boards should be changed in order to allow women's voices to be heard.

5 Conclusions and main points

This article reflects the problems and obstacles of women in engineering, particularly in the EE field. Therefore, various research results were contrasted with my own experiences. I began by looking at the motivation for academic study in the field of EE by focusing on the factors that encourage females to choose to study EE in higher education. Apparently, technical devices at home and elsewhere do not have a particular influence on the image that society (and especially women) has of engineering studies.

Moreover, the structure and profiles of secondary school courses do not encourage females to choose to study in the engineering field, and the programmes offered, such as Girls Day and MINT-Lab, have not changed the negative image of EE (i.e. the number of female first years has not increased over the last ten years). Therefore, programmes promoting such studies should be jointly organised by schools and other institutions (e.g. universities, research institutes, industry).

The female students who do start an EE course identify themselves with the male-dominant EE culture. They do not have any problems with being a minority in class and they often graduate with good grades.

However, the career development of female graduates differs significantly from that of their male colleagues. Time sharing between career and home responsibilities often delays or ends women's career advancement or even their careers. Female engineers with children are therefore faced with the inevitability of a career break.

And so, the programmes and efforts that have been created to minimise career breaks must consider the global environment, including the structures of family life. Accordingly, government policies should propose new regulations and propose initiatives for optimising the reconciliation of family and work life on a global scale. German society, in particular, should learn from good practice examples in order to change the negative image of female engineers with children. A change in regulations would help to make women more visible on boards and committees and, consequently, create more role models.

6 Lessons to learn for women in science

Compared to other scientific fields the interest of women in an academic education in the EE field is very low. Programmes that have been introduced by government in secondary schools to encourage young women to take up a career in the engineering field have not increased the number of female students in the EE field significantly. One way of achieving more success in this regard might be to integrate the programmes offered officially into the secondary school curriculum. In addition, teachers should be involved more strongly in organising recruitment programmes together with other academic organisations.

My observation of other women in similar situations to mine has given me some idea about the reasons why the women in my group have been successful in terms of career development: Firstly, we have developed a strong competitive attitude. Secondly, we have adapted to the male-designed structures and environments as we have found no other alternative for advancing our careers.

For some years now, we have observed in Europe and in other countries worldwide, efforts to promote women's career development. These efforts are, however, based on the existing, male-optimised structures. When young female scientists show an interest in a professorship, for example, they will be advised as follows: Join a leading university in another country, publish a large number of conference and journal papers, and wait before you have your family.

A lesson to learn here is that we should break these male-based thinking patterns and create new structures for female career development, especially in the area of research. The efficiency and work quality of female scientists should be evaluated differently from that of male researchers.

This does not mean that women should work less than men, but given that the women's situation may change during or at the end of their tertiary education if they start a family, then at this time career development and family responsibilities should merge. We should stop thinking in one way, '*shift the family planning or break the career development*'.

Some suggestions to support this idea are:

- Women in the same situation could share one research position without any financial disadvantage. Working together could produce high quality research results.
- Offer more facilities in the form of support from undergraduate and master's students.
- Women who are involved in teaching could offer their courses in form of video conferences.

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Careers Paths of Women in Science

Carrots or Sticks? A Study on Incentives to Attract and Retain Women in Science, Engineering and Technology in South Africa

Elaine R. Salo, Felix Liersch, Lieketseng Mohlakoana-Motopi, and Marinda Maree[1]

1 Introduction

The study reported on in this article examines the way incentives can be used to attract and retain women and, subsequently, enable them to re-enter the diverse fields of Science, Engineering and Technology (SET) in South Africa. The study was commissioned by the Science, Engineering and Technology for Women (SET4W) committee, which is a permanent national advisory committee of the National Advisory Council on Innovation (NACI) in South Africa. This study interviewed 45 interviewees located within corporate institutions, government ministries in SET as well as in SET fields in tertiary institutions. The study contributes to a small but growing body of research in the field of women and gender in SET in South Africa and sheds some light on the gendered features of education and the workplace that enable or alienate women in this field.

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2 The lie of the land: a profile of gender policy and of women in SET in South Africa

Since the onset of the democratic era in South Africa, gender equity has been a central ideal of the Bill of Rights of the South African Constitution (1993). The South African state has committed itself to gender mainstreaming as a policy strategy to realise gender equity in all arenas of governance, including access to SET education to ensure a greater human resource base (Department of Science and Technology 2009). The Research and Development Strategy of 2002 noted that South Africa faces a problem in human resources because ‘the scientific workforce in South Africa is shrinking and growing older’ insofar as ‘black and women scientists, technologists and engineers are not entering the academic publishing ranks and that the key research infrastructure is composed of people who will soon retire’ (cited in National Council on Innovation report 2009: 4). South Africa has emerged relatively recently from a deeply racist history that favoured whites and men’s access to public resources such as education and ensured job reservation in the professional well-paid SET sector. The effects of this legacy continue to echo in the contemporary period. The Departments of Higher Education and Science and Technology have made concerted efforts since 1994 to encourage women to follow academic and professional careers in SET. Although the numbers of women in this sector have increased steadily, this has been off a very low base. In addition, when we take race into account white women still remain the majority of women in SET, whilst the numbers of black[2] women in SET remain small albeit with a steady increase in number.

The basic education statistics of the Department of Education indicate that gender parity at primary and high school levels has been reached, as approximately equal numbers of girls and boys have access to maths and science at primary and high school level (Department of Basic Education cited in bsp Business Environment Specialists’ report to National Council on Innovation 2011: 8), whilst women’s enrolment in the SET sector of higher education has increased significantly. Subotsky (2003) reported that women’s enrolment figures at the universities of technology range between 48 and 52%. This increase must be examined in relation to the diverse SET areas of study. Although the proportion of women doctoral graduates in the field of engineering sciences and applied technologies increased from 12 to 19% between 2001 and 2005 (NACI report

2 I use black here to encompass women who were classified Indian, coloured and African by the apartheid racist dispensation.

2009), the biological or life sciences and agriculture remain the preferred domain of study for women scientists The bsp report indicates the following trends in female doctoral graduates: 'In 2005 the majority of female doctoral graduates were in the Biological Sciences (37%), followed by Agricultural Sciences and Chemical Sciences. Compared to 2001, the most noteworthy increases in female doctoral graduates were in the Agricultural Sciences (from 7% to 15%), and Biological Sciences (32% to 37%). The percentage of female doctoral graduates in the Chemical Sciences dropped from 29% to 14% in 2005. Information, Computer and Communication Technologies produced the least doctoral graduates for both sexes' (NACI report 2009:18). These figures do not take account of variation by race or geography, but Mouton, Ritter and Boshoff report that white women dominate in doctoral studies comprising 57% of the total number of women enrolled in PhD programmes in 2005 (NACI report 2009). Subotsky (2003) indicates that in university enrolment figures overall, women, and African women in particular, continue to be concentrated in the social sciences and humanities.

Subotsky (2003) has indicated that it is not enough to expand enrolment figures in scarce skills areas such as SET if these do not translate into successful graduation and employment rates in the SET sector in South Africa. A report by the Council on Higher Education (2007) indicates that less than 50% of students enrolled in bachelors or national diplomas were likely to complete their studies, whilst drop-out rates for men and women in first year across tertiary institutions were high. The report however indicated that women were more likely than men to complete their degrees in all fields of study. Research examining whether the growing enrolment figures of women in higher education translate into successful graduation rates and employment in SET in South Africa indicates a consistent loss of women along this continuum with the greatest loss occurring at the nexus between undergraduate and postgraduate studies. In addition, research also indicates that the quality of the academic and workplace environment requires a great deal of improvement to ensure that a gender-sensitive, enabling environment for attracting and retaining women in SET is created.

The study below is located within and provides further nuances to the broader context of women in SET provided above. Our study set out to examine the factors that contribute to attracting and retaining women in SET across the private, state and education sectors in South Africa. The research was conducted in two phases, namely, a preparatory phase, which consisted of a review of the relevant literature in the field which informed the research questionnaire, as well as identification of the participants. This was followed by a set of qualitative research interviews using an open-ended questionnaire as well as the analysis of the data, which informed the findings presented below.

3 Study research design and data collection

Data were collected primarily through interviews conducted with a sample of 45 respondents working in academic, parastatal and private corporations in the broad SET sector. The sample of institutions was constituted to ensure that we obtained information from a range of diverse professional sectors in SET, as well as from the private and public state employment arenas. We also had to ensure that the sample included the voices of white and black women in this field. The majority of informants from private SET corporations were white women. The parastatal companies, such as the state electricity company ESKOM, as well as government ministries such as the National Zoological Parks and a diverse set of universities, were targeted because they were more likely to adhere to the constitutional requirements for racial equity than the private sector. In addition, this sector was more likely to accommodate women's re-entry to the SET field than the private sector which is more driven by profit margins in the short term. We conducted interviews at seven universities of which two were historically white universities, three were historically black tertiary institutions, and two universities had been constituted from mergers between historically white and historically black universities (HBUs). In addition, the specific perspectives of the HBUs were considered to be an important window on the challenges that black women face as academic researchers and postgraduates in this field and what they would consider as appropriate incentives to attract and sustain a critical pool of women in SET.

We also sought to obtain the statistical data from the universities to establish the enrolment and throughput of women in SET studies. This was met with mixed success, with most institutions being unable to provide us with the necessary statistical data.

The interviews were conducted by a team of four researchers in three provinces, namely, Gauteng, KwaZulu-Natal and Western Cape. Appointments with all 45 respondents were secured via email or telephonically. Four interviews were conducted electronically and two interviews were conducted telephonically, owing to the interviewees' busy schedules and the lack of time for face-to-face interviews.

Researchers explained the aims of the study to the interviewees and sought written consent to conduct the interview and record it using audio tape recorders. Interviewees were assured of confidentiality and all identities in this study remain anonymous. The interview questionnaire sought information on the following broad themes:

- Demographic information (described in the graphs above)
- Women's representation in the SET workplace
- Women's contribution to the SET workplace
- Incentives to attract and retain women in SET
- Assessment of cost of women's employment to company

Interviews were transcribed and analysed, using the qualitative data analysis programme Atlas ti 5 to code interviews and identify the thematic patterns contained in them.

Profile of research sample

The following table describes the academic institutions as well as the parastatal and corporate organisations from which informants were drawn.

Table 1: SET institutions

Type of institution	Number
Academic[3]	7 (30%)*
Government ministry	2 (7%)*
Parastatal	11 (41%)*
Private corporation	7 (26%)*
Total	27 (100%)*

* indicates percentage has been rounded to the nearest whole number, so the total is more than 100%.

3 Of these academic institutions, two are historically advantaged institutions (HAI), three are historically disadvantaged institutions (HDI), two are institutions constituted from mergers between HAI and HDI institutions, and one is a distance education institution.

Figure 1 indicates the representation of interviewees across race and gender.

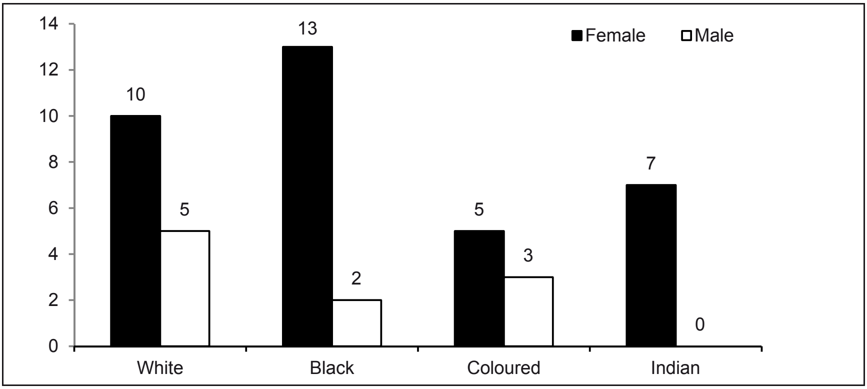

Figure 1: Interviewees' race and gender

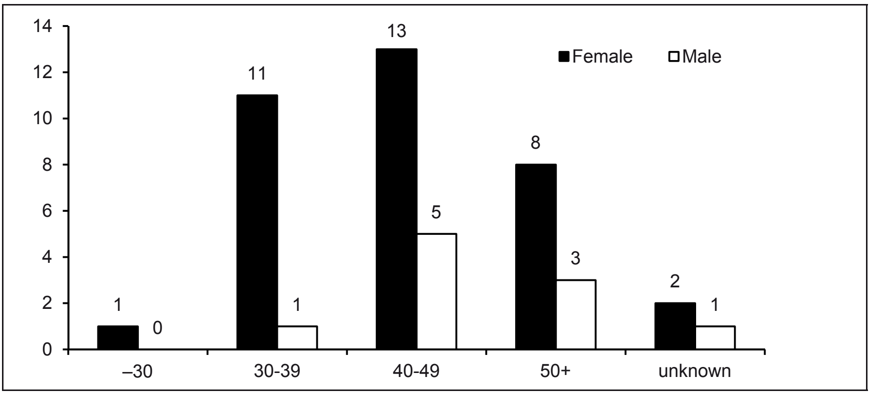

Figure 2: Interviewees' gender and age profile

Interviewees were divided into two categories, namely, key informants and general informants. Key informants consisted of men and women in senior and middle-level managerial positions across academic and corporate SET institutions. General informants consisted of women employees working in middle and entry-level positions across the SET sector in academic institutions and corporations. Figure 3 illustrates the roles and responsibilities of the interviewees, whilst Figure 4 indicates the roles and responsibilities of interviewees by gender. The sample was skewed in favour of women's representation in the sample and of academic professionals based at universities.

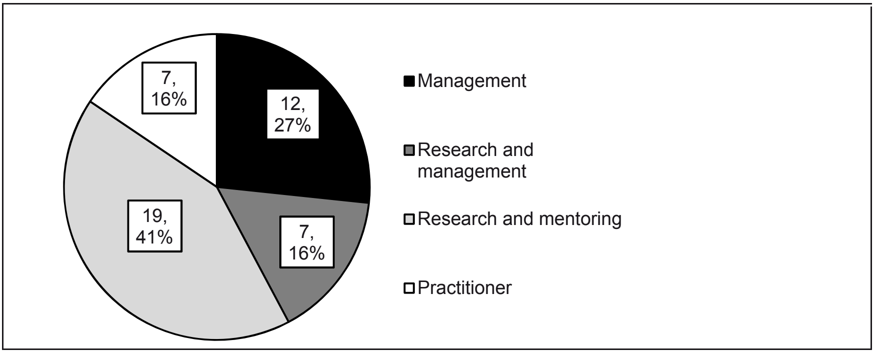

Figure 3: Interviewees' job profiles (job roles and responsibilities)

Management is defined here as those in senior decision-making roles in private corporations and parastatals, such as chief executive officers, human resource directors, and so on. Research and management is defined as the responsibilities of individuals located in tertiary education institutions who are in senior or middle-level decision-making roles and concerned with their individual and organisational research outputs. Research and mentoring refers mainly to the responsibilities of employees in tertiary institutions charged with teaching, mentoring students and research, whilst practitioners refer to employees in private corporations and parastatals, who practise their professional skills only.

Figure 4 describes interviewees' roles and responsibilities by gender – however, this table merely describes the sampling bias of the study and does not provide a basis for making a gendered comparison of the results.

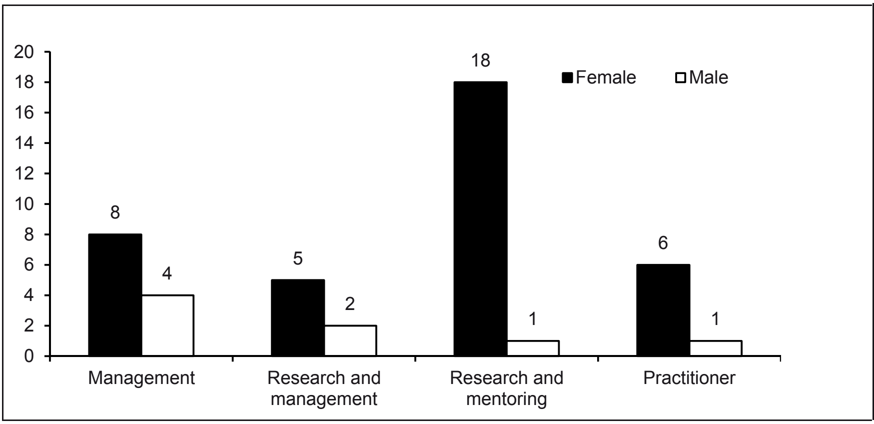

Figure 4: Interviewees' job roles and responsibilities by gender

4 Research findings

4.1 Representation of women in institutions

Most (23%) of respondents thought that women were not adequately represented in their respective organisations. Approximately 5% of respondents said that there were too few women in their organisations, while 14% of respondents said that the representation of women depended on the gendered nature of the particular sector within the organisation and the type of work done. These respondents implicitly assumed that various sectors in the SET field are gendered and recognised that the representation of women in the SET workplace would be significant in gender appropriate roles such as administrative positions, as well as in the 'clean' sectors of nuclear and energy regulation and engineering, such as management, or electrical and chemical engineering, and the auxiliary sectors of health science such as nursing, physiotherapy and so on. These respondents highlighted women's absence from the technological side of their respective fields or in the 'dirtier' fields of engineering such as civil engineering, mining and construction. Approximately 5% of responses could not be categorised. It is notable that at least 11 (24%) respondents said that there was a significant increase in the numbers of women in their respective organisations.

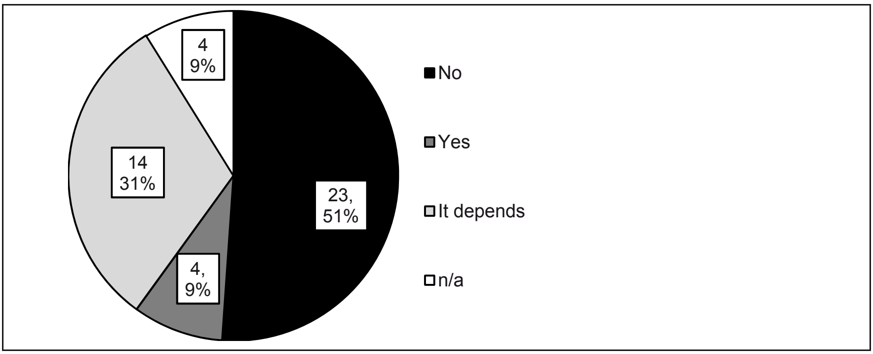

Figure 5: Interviewees' perceptions of the extent of women's representation in their organisations (Are women adequately represented in your organisation?)

They said that the improvement in women's representation was seen at middle-management administrative levels, and in certain fields that are considered gender appropriate in the SET field (such as molecular and cell biology; nursing and adjunct medical professions such as physiotherapy and occupational therapies; general practitioners), but very few women were represented in the mining sector and the technological side of nuclear science, energy and engineering.

Those respondents who said that they saw an improvement in the representation of women in their particular sectors were from parastatals or public universities. These state-funded institutions are most likely to implement state policy requiring gender equity. At least three informants (7%) thought that women's representation was not an issue for their organisations. All these respondents were from the private sector. One respondent (a human resource manager from the pharmaceutical and beauty retail industry) said that the individual skill mattered most, regardless of gender. One respondent from a small firm of quantity surveyors said that women and men were equal in the workplace; whilst another thought that the particular industry he was based in (mining) was completely unsuitable for women to work in, and that the women who worked there 'could not be called ladies'.

The majority of respondents from all the academic institutions (51% of total respondents) said that there were too few women represented in SETs in their respective institutions or that the representation was uneven with women concentrated in the gender-appropriate SET fields, such as biology, health sciences, geography and so on. They also indicated that women were more likely to be found in lower and middle-level positions in the field. These respondents pointed to structural factors that obstructed women's recruitment into SET. These factors included the historical scarcity of women in SET due to the apartheid legislation that reserved employment within the state-run SET sector for men and for whites only, as well as the gender blindness within the workplace environment and the active gender hostility of educators.

Most of the professional SET organisational ethos was acknowledged to be dominated by a masculine organisational culture in SET. This organisational culture did not allow women who were employed in these institutions to achieve a good work-life balance. Respondents also referred to the lack of women role models in SET and the idea that women employed in these sectors were considered 'unfeminine' or unattractive. They referred to the unsafe 'dirty' nature of work in fields such as civil engineering and mining that were considered inappropriate careers for women because they conflicted with dominant ideas of femininity. Three respondents in the sample said that the under-representation of black women in SET needed to be addressed urgently. Respondents acknowledged that due to the structural shortage of women in SET, competition exists between private industry on the one hand and the academic and public sector on the other to recruit black women from a very small skills pool. One research specialist said: *'The only thing is that the market – if there is nothing in the market – that is the problem. In the South African market there is no supply of engineers, where are they going to get engineers? Do you see my point? If they want scientists and women are not there, they would get the next best scientist who is a man.'*

One individual in management at a tertiary institution said that the sector had to be proactive in addressing the shortage. In response to the recruitment of women and particularly black women into engineering, a dean of the engineering faculty at one of the country's leading universities emphasised that a targeted recruitment strategy has to be implemented aggressively. He said that

> *We have now moved into an equity plan and we also have made our appointments mechanism more aggressive. I said there is no use getting to the stage where you have got a short list and then you suddenly realise there aren't any designated groups on the short list. Because, if there aren't, then the possibility of appointing someone in that post is zero. So I then said well, if your traditional routes of getting the advertisement out don't yield a fully constituted short list then you must either do it again or you must go target an individual. This will not guarantee necessarily that you will change the profile. In the South African context you look at South African blacks specifically in the engineering profession, and the same challenges (are faced) in industry – they also want to have those people. If your pool is generically small then industry is going to have a higher probability of getting people from that pool because they can attract them with far higher salaries. So we also have a 'building our own timber' programme and I have now negotiated with some industry and other sectors where they assist in building academia.*

He identified a number of actions such as targeting individuals and paying higher salaries that his university was considering to address the recruitment of women in the short term. He identified the 'build our own timber' strategy to address the problem of gender equity in the long term. However, he acknowledged that this required political will, a commitment of scarce material resources such as bursaries, as well as careful monitoring and evaluation of such programmes to ensure that an enabling environment for women is sustained.

The unequal histories of historically advantaged white universities and historically disadvantaged black universities also inform the racial diversity of women and recruitment strategies employed at these institutions in the recent past. However, in order to assess this representation effectively we needed to obtain the employee profile of all these institutions and compare the data. We faced a considerable challenge in this regard, as the various HR directors were reluctant to provide us with the information, or indicated that it was unavailable. We were only able to obtain the employee statistics from three academic institutions, namely, the University of Limpopo, the University of Pretoria and the Cape Peninsula University of Technology.

The following set of graphs illustrates the representation of women at these institutions by qualification. The data are not comparable across institutions because the datasets used different variables. The University of Pretoria provided a single dataset for women staff across all the SET faculties, by race and qualifications. The University of Limpopo provided the datasets for men and women staff in SET, namely, the Faculty of Health Sciences and the Faculty of Science and Agriculture. These datasets were not differentiated by race.

Actual representation of women in SET at HAIs: University of Pretoria

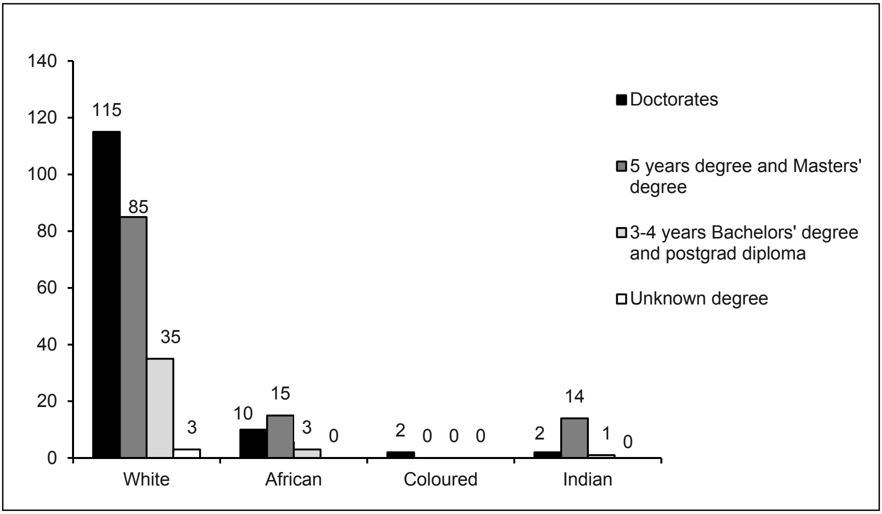

Figure 6: The representation of women in SET by race and academic qualification at the University of Pretoria, 2010

The dataset for the University of Pretoria indicates that while the representation of white women, especially with doctorates, is encouraging, the representation of black women at this institution remains woefully poor. This is due to the history of the university which was established in 1908 for white, primarily Afrikaner students only. Black faculty was appointed at the university for the first time in the democratic era. In addition, most of the black women employed in SET here have master's degrees or five-year equivalent degrees (such as MB ChB), with a small number having doctorates. In this instance the university has to provide a careful mentoring environment that is not only sensible to gender discrimination but that also provides a supportive anti-racist environment for the few black women present, to ensure that they obtain doctorates. At the same time, the recruitment of more women and more black faculty at this university to increase diversity remains urgent if it is to become considered as a supportive learning environment for women from all race groups.

Representation of women and men in SET at HDIs:The case of the University of Limpopo

The University of Limpopo presents an excellent case to contrast with the University of Pretoria because it exemplifies the black university located in the rural periphery. The university was founded in 1959 as the University of the North. It originated as part of the apartheid policy providing separate ethnic institutions for black students and it was provided with fewer material resources compared to previously white universities such as the University of Pretoria. The institution continues to be perceived as an inferior institution with primarily black faculty members who are not as well qualified as their colleagues at historically white advantaged institutions. The data presented below capture the profile of women scientists at this university located in the rural margins of the country.

The data from the University of Limpopo indicate that in the Faculty of Health Sciences, the overwhelming majority of staff, regardless of gender, has master's degrees or an equivalent five-year qualification. However, a larger percentage of women have the basic entry-level degree (37%) compared to men (13%), with a smaller number of women holding a five-year, master's degree (52%) or higher qualification compared to men. Only 10% of women hold doctorates compared to 21% of men.

Most of the women holding doctorates are concentrated in the Department of Nursing, a traditionally feminine sector. Here the challenge to mentor women to complete higher degrees is also imperative, whilst also assisting men who hold similar qualifications.

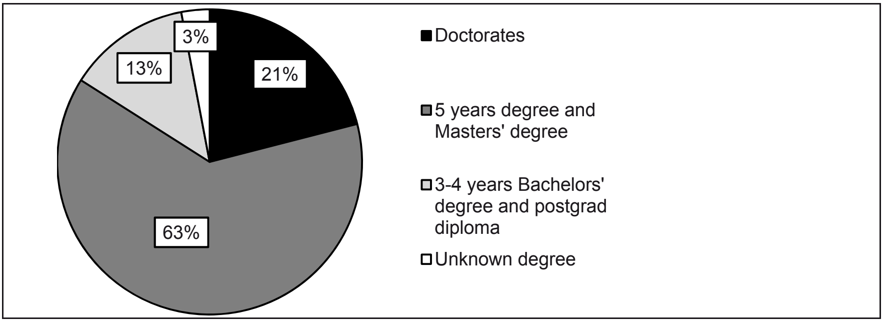

Figure 7: The representation of men by qualifications in the Faculty of Health Sciences, University of Limpopo

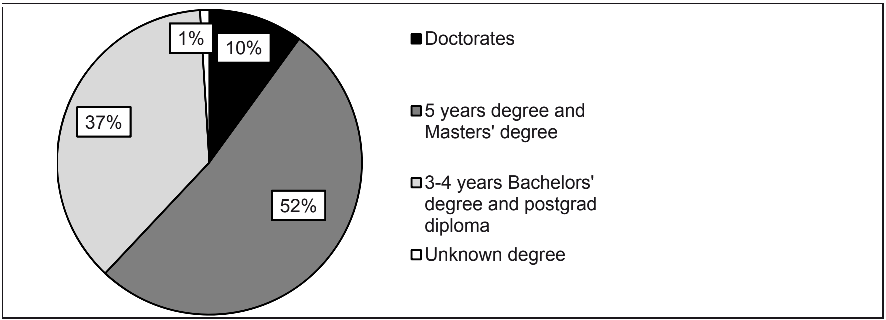

Figure 8: The representation of women by qualifications in the Faculty of Health Sciences, University of Limpopo

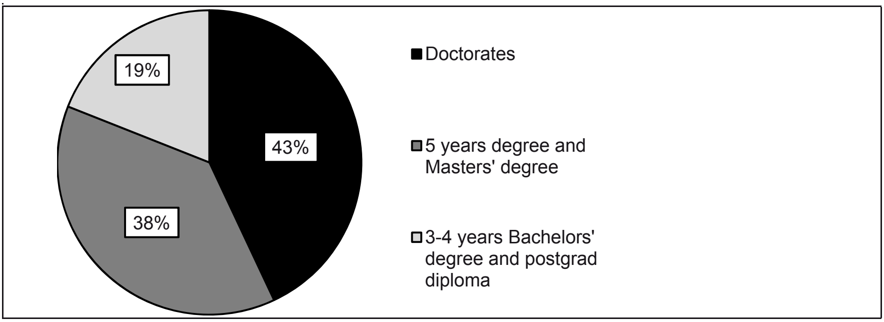

Figure 9: The representation of men by qualification in the Faculty of Science and Agriculture, University of Limpopo

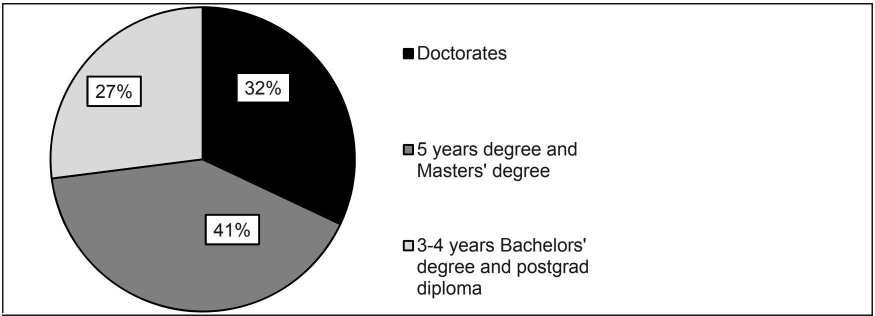

Figure 10: The representation of women by qualification in the Faculty of Science and Agriculture, University of Limpopo

In the case of the Faculty of Science and Agriculture, the data are more promising. Data reflect an increase in the numbers of women and men holding doctorates as compared to the Faculty of Health Sciences. However, once again, women tend to be less qualified than men in this faculty, with over a quarter (27%) holding entry-level degrees and diplomas, compared to only 19% of men. When respondents at this institution were asked what steps could be taken to increase the representation of women, they indicated that a more supportive mentoring environment should be put in place for women to enable them to reach the required standards in their field, while more women should be recruited to fill senior positions. However, when these responses are considered in relation to the data presented above, it is clear that more women need to be supported to complete doctorates and be encouraged to publish in their respective fields.

The profile of women faculty members' qualifications at the University of Limpopo indicates the need to provide a supportive environment for women to complete higher qualifications as well as to be mentored into the rigour of research and publication.

4.2 The importance of legislative frameworks to support gender parity in the SET sector

The majority of respondents in this study, who worked in the private sector, the parastatal companies or at universities, said that there was a marked increase in the general awareness of the legal requirement to employ more women in the workplace. Their critical consciousness can be ascribed to the requirements of legislative framework that requires institutions to set in place gender mainstreaming and employment equity practices as a means to achieve diversity in the workplace.

The majority of respondents (57%) from private companies said that women were under-represented in their organisations. The reasons they gave included structural factors such as the scarcity of women in the labour pool for SETs; the difficulty women experience trying to sustain a balance between work and reproductive responsibilities; and the lack of political will to actively recruit women, despite the awareness of the need to do so. Two respondents (4% of total sample) said that women were adequately represented in their respective fields (accounting and quantity surveying firm) although the occupation (accounting) was really gender appropriate for men as it required long working hours. However, respondents from the small quantity surveying firm said that the firm was unusual because it was owned and run by women.

4.3 Organisational culture and women – hostile work milieus and the importance of qualitative environmental incentives

Employees' perceptions of what their respective organisations have done to accommodate women in the workplace serve as an important indicator of the relative gender-sensitive SET organisational culture or lack thereof. Consequently, respondents were asked whether their respective working environments could be considered to be supportive of women. The responses below provide a cumulative reflection of employees' perceptions. Their responses point to the great importance that transformed gender inclusive environments play in attracting and retaining women in these workplaces.

A minority of respondents (11%) said that the organisational culture of their respective workplaces were already supportive of women. Two of these respondents cited the increasing transformation of the workplace through the increased representation of women; one respondent said that the private retail corporation he worked for assisted women by allowing them a degree of flexibility around their work schedules if they requested it, and provided a wellness programme for women; another senior human resource manager in an accounting firm said that senior women were provided with flexible working schedules to assist with childcare; however, one respondent said that she did not think that organisations needed to accommodate women's specific needs. These responses should be read against the representation of women in these organisations. However, these figures were not made available to us.

The overwhelming majority of respondents (89%) said that they thought that the organisational culture at their workplace could improve to attract and support women in the SET environment. When asked what they thought needed to be done to improve the organisational culture in the workplace, 53% said that the SET workplace should be more closely monitored and evaluated in terms of making incremental changes to improve the gender-sensitive environment of the workplace. Their respective workplaces could also ensure that women were appointed mentors who could assist them in meeting the required goals to ensure success in their careers. All these respondents said that their respective SET workplace had a male-dominated work culture. They said that this masculine organisational culture was represented by various practices that included the lack of acknowledgement of women's worth as productive workers, a generally hostile work environment that eroded women's confidence, men's refusal to acknowledge women's authority (in the context of mining and civil engineering), and authoritarian male leadership that expected women to fulfil traditional gender roles as support staff.

One respondent who had conducted independent research on women physicists in South Africa said that her findings indicated that '*they [women physicists] leave because of the hostile environment*'. By this she implied that the hostile environment incorporated lack of support or acknowledgement for work done and lack of mentorship. The various responses from respondents point to the widespread, multifaceted nature of the 'hostile environment' being referred to frequently. One respondent said: '*Yes, definitely organisational culture impacts on women. A positive environment will contribute to women staying in the job. More acceptance and flexibility will assist women in making an effort to stay.*' Here acceptance and flexibility refer to the acknowledgement of women's physical presence in and contribution to the workplace, as well as acceptance of their potential need to meet or fulfil the reproductive need to have children.

Women's exclusion from professional social networking that is key to information required for career advancement was noted. One respondent mentioned that '*the corporate world is like a boys' club*'. Some male colleagues' lack of respect for women and their demeaning expectations of women's professional roles and responsibilities were identified as a salient feature of the hostile environment. One junior lecturer in a statistics department said that her male head of department expected her to run mundane errands on his behalf such as collecting books from his car. He was also her postgraduate research supervisor, so she felt that she could not protest his discriminatory attitude towards her. She said that she was very relieved when he left the university. Another senior associate professor said that she was subjected to a trumped-up investigation of fraud by her male head of department when she raised and managed more research grant funding than other members of her department.

Eleven percent (11%) of respondents said that they wanted their respective work environments to be more supportive of them in their efforts to balance work and other life responsibilities. Their requests ranged from a change in the organisation of work to allow greater flexibility of the physical workplace, to flexible arrangements for working hours. At least three respondents said that they thought that the request for flexibility could be facilitated by the ease of electronic communication. At least one respondent suggested that an alternative career track that included a permanent part-time career track being created for those who required it to accommodate employees with caregiving responsibilities. Interestingly, despite the perception that women would cite nurturing responsibilities as an overwhelming concern, and would therefore cite the need to create a work-life balance, this was not the overwhelming requirement that interviewees identified as the key incentive to attract and retain women in the SET workplace. This finding is in keeping with that of international literature (see literature review above).

The overwhelming number of respondents identified the need to create a nurturing, gender-sensitive and supportive environment for women employees to reach the necessary standard required of them. Respondents considered the visible lack of women in the SET workplace as a powerful indicator of the organisation's gender-blind working culture. More importantly they attributed this lack of representation to benign neglect of, or active hostility, to women, as well as the lack of necessary supportive career planning. Twenty-five percent (25%) of respondents said that their workplace could improve through the recruitment of more women, and more senior women. Potential women employees, especially black women employees, regard women's, and specifically black, women's presence in the workplace as a key indicator of a welcoming, supportive work environment. Some respondents' unhappiness in the workplace is an indicator of the direct, though invisible, cost of gendered and racial diversity. One senior black (African) woman manager in a nuclear research parastatal spoke poignantly of her loneliness as the sole black woman in her field for a long time. She attributed her willingness to continue working in the organisation solely to her strength of character and sheer stubbornness. Her relief was evident as she spoke of the organisation's recent recruitment of more women.

These respondents emphasised the importance of women's visibility as role models in the SET workplace. A few respondents noted the significant contribution that women, especially those from previously excluded racial groups, made to diversifying and improving the organisational environment. At least two black women and two senior academic managers (deans) said that they would like to see more recruitment of black women as a means of gendering the organisational environment. In the section below we examine the ingredients identified in this study for creating such a supportive environment. These factors can be used as indirect incentives that would support women's employment in the various SET workplaces.

4.4 Career mentoring

The recruitment of women and particularly of black women is only one part of the solution to gendering the workplace – new recruits especially from excluded groups would continue to experience a qualitative sense of exclusion. In order to ameliorate and negate the effects of such perceived alienation, the necessary support structures, such as mentors, should be set in place together with a careful system of monitoring and evaluation. The importance of career mentoring and guidance both as an indirect incentive to attract and retain women in the SET environment, as well as increase gender diversity, cannot be overemphasised here. One respondent noted this point emphatically when she said that she would like to see better monitoring and evaluation of mentoring processes as a key aspect of equity policies. The black woman dean of research at one tertiary institution said that the assurance of a 'safety net' or guiding framework of mentoring practices to guide new or returning employees to the SET environment is an important means of improving the organisational culture of the workplace for women.

The commitment to invest financial resources in these indirect incentives as a means of attracting and retaining women in SET is therefore recommended here.

4.5 Employment benefits that improve the SET work environment for women

Interviewees were asked to select from a given list of benefits that they would rate as most important for improving the SET environment. These were

- flexitime
- maternity benefits
- work from home
- crèche or care for children
- conversion of full-time employment to part-time employment
- training opportunities
- leadership or other motivational courses for women
- career flexibility such as no loss of position and salary after re-entering
- other benefits including mentoring.

We provide broad brush stroke images of interviewees' responses to this question here, due to the fact that many interviewees identified a mix of benefits, thus preventing a statistical comparison. The majority of the respondents identified flexitime, training opportunities, career flexibility, mentoring and maternity benefits as the key benefits that they would like to see in the workplace and that would sustain women's presence in SET environments. The identification of training opportunities, mentoring, leadership and motivational courses for women, as well as career flexibility, alongside the needs for flexitime and maternity benefits, are instructive. The first four benefits strongly suggest that women are interested in pursuing lifelong careers in SET, whilst the latter two factors suggest a consciousness of the need for work-life balance. The identification of crèches as an important benefit was dependent upon the interviewees' workplace environment (a crèche was considered unsuitable in SASOL or the Pebble Bed Modular Reactor workplace).

Academic women's concern for mentoring and financial support in the form of scholarships or bursaries for further training and studies was elaborated on by women interviewees in particular, regardless of race or institutional affiliation. One interviewee, a senior white woman academic, noted that financial support through the provision of scholarships for women is the most important factor.

Financial support was only an aspect of the support structure, however. The age limitation placed on prospective applicants for scholarship was found burdensome for black women in particular who re-entered postgraduate studies in

SET later on in the lifecycle after childbirth and childcare. A black woman academic said that whilst the National Research Foundation[4] (NRF) provided financial support, she found the age limitation of 45 years especially restrictive. This was true for women who entered their career tracks only after childbearing. A large number of black women often completed their reproductive cycle in their twenties and thirties and returned to university to further their postgraduate studies in their late thirties and early forties. They would require research funding then. The loss of this potential skills pool was emphasised by another older respondent. This older white woman academic also noted that the lack of career flexibility during childbearing for women in the SET sector carried hidden structural costs for the country. She said

> *... you have got a woman with her doctorate, with potentially 30 years of career ahead of her; and she is dropping out (due to lack of childcare in the workplace) so what does that cost society? So if you had a structured system that ... women get their compulsory maternity leave for 4 months then say they go on 20 hours week for the next 8 months or so (she could return to a permanent position when the child is more independent).*

4.6 Questionable effects of direct financial incentives paid to SET companies by the state

When asked whether direct financial incentives paid by the state to SET companies would encourage more employment of women, more than half of the respondents (56%) said that financial incentives would not be a solution in this regard. One respondent considered the incentives as an insult to women's ability and expressed her annoyance by stating

> *You know, that is a difficult question because I think if an organisation needs tax incentives to employ more women they (the state) should not insist. Because there is something wrong that you have to buy the openness of really getting women in. It might help, but all I am asking myself is what type of organisation has such a mentality?*

Another female participant indicated that the driver for women to follow a career in SET should be their individual motivation and passion. She said that '*The money is not the issue; the issue in any career is whether you want to follow that*

4 The National Research Foundation (NRF) is the major research foundation for academic institutions in South Africa. It is supported through public funding from the state.

career?' Another female respondent argued that the qualitative improvements in the workplace environment to assist women meet their work-life balance are far more important in supporting them in the SET sector. She said that

> *'I think it is those practical things in terms of maternity leave and all that, those are we call it fringe benefits that will help them, not tax incentives'.*

These responses indicated that state incentives paid directly to companies as incentives to hire more women were considered a form of offensive tokenism by women who considered their careers to be an important aspect of their respective identities. A few respondents (15%) said that financial incentives might encourage organisations to employ more women. However, they considered the indirect incentives such as greater gender sensitivity in the workplace as well as subsidised training for individuals to be more important in this regard. Two of these respondents also mentioned that tax incentives should be used to address practical issues in the company such as building day care facilities for the children of employers.

Only 12 respondents (28%) were convinced that direct tax incentives to companies would encourage companies to employ more women.

4.7 Gender budgeting and the cost of hiring women

When company human resource managers were asked whether they thought that the cost of employing women was more than employing men, 88% of the sample indicated that they did not think that this was the case. However, the same number of respondents indicated that they had never really calculated the cost of hiring women for the company. Interviewers were required to explain to these respondents that such costs included dedicated budgets for training courses that allowed women to re-enter the workplace after time away on long maternity or childcare leave. Only 13% of company resource managers said that they had budgeted for the reskilling of women employees who re-entered the workplace after long leave or time away. This finding is encouraging but also supports suggestions from the literature that South African SET companies have not provided a budget for or calculated the cost of reskilling and retaining women in their employment.

Two of the companies that provided a budget for employing women said that the fund is part of their employment equity programme to employ individuals from previously excluded groups such as black South Africans and women.

One company indicated that the gender of prospective employees was weighted positively in selection interviews and that women were given preference in the selection of employees.

The majority of companies did not have re-skilling training programmes for women, although the minority indicated that they do and that they budget for this programme. A company that has re-skilling programmes does this for its core business and they consist mainly of refresher courses as well as international exposure through workshops and conferences.

Table 2: Cost of employing women

	Yes (%)	No (%)
Does employing women incur more costs than employing men in your company?	0	87.5
Has this been calculated?	0	87.5
Does your company distinguish between male and female employment costs?	12.5	62.5
Does your company have any policy for employing women?	37.5	50.0
Do you have a re-skilling programme?	12.5	75.0
Do you budget for this programme?	12.5	62.5

We also asked respondents whether a company would consider financial incentives paid directly to women beneficiaries. Their responses with regard to incentives are instructive and indicate that respondents wanted these incentives as a means to improve the quality of the working environment, not as an end. They emphasised the need to acquire further training or equipment that would assist them in meeting personal career goals.

Most of the respondents said that incentives should go to the individual worker/employee to augment her opportunities for progress and promotion and to improve the workplace environment. It was suggested that these incentives could include bonuses, opportunities to attend training and skills courses, and funds to obtain mentoring or to acquire equipment for laboratories. These responses support individual interviewees' emphasis on the need for financial support for training, skilling and mentoring in the workplace and highlight the importance of indirect incentivisation that inspires women to reach for higher

employment goals. The emphasis on legal commitment to gender diversity, together with flexitime and promotional possibilities for women, indicate that respondents are aware that incentives have to be used systemically. Incentives were not only financial but also indirect, in keeping with legal requirements, awareness of the need for diversity, the importance of women's careers as well as the need to find a work-life balance. Where financial incentives could be used they should be used indirectly to assist individual women beneficiaries. However, incentives should be accompanied with well-conceived systems of monitoring and evaluation. One respondent said that '*money is not the only motivation. People need to be motivated intrinsically. The organisation needs to show caring for personal development as career woman, making it the employer of choice*'.
The negative aspect of direct incentives was also identified. One respondent felt that incentives lead to tokenism. She mentioned: '*And as long as things are tokens they are going to say we have bought you and you are just a resource. People are not resources, people have capabilities, people have got energy, a resource does not have energy, unless it's an electricity resource.'* Another respondent said that research is needed before incentives are applied, *'maybe greater research around financial incentives should be done because this may drive the wrong behaviour'*.

Again several of the black women respondents in tertiary institutions mentioned the need for time and financial support for further training and research opportunities would be considered as an incentive. One overworked particularly harassed black woman academic scientist stated the value of time:

Interviewer: *And yet you have three publications in peer-reviewed journals?*

Respondent: *Yes. But that was during my postgraduate studies ... It was easier at that stage because I did not do much teaching. Now when the teaching comes into your life, and students need extra support and the university still expects you to do research and publish ... but where is the time? And I am a single person ... how do married people with children cope? It is virtually impossible I think.*

She, together with other women respondents, emphasised that mentoring and training programmes were key qualitative incentives that would encourage women to stay in the workplace.

Respondents urged us to think about incentives in a more creative manner; as rewards for transformation rather than as carrots to encourage change. The importance of a change in organisational culture was emphasised because the action that would earn tax breaks as rewards for improving the workplace culture. One respondent said: *'So I would rather work on the internal culture of the organisation and for the organisation to earn that incentive, they need to change their culture.'*

This study has raised a number of questions and highlights gaps in the research on the cost of hiring women in the SET workplace. We examine some of these assumptions here.

4.8 Begging the question

The assumptions embedded in the notion of the costs of hiring women in SET

The use of incentives as an inducement to the tertiary education sector and to companies to hire and retain women, especially black women in the workplace, assumes that the employment of women is an inherent cost to these organisations. However, we do need to examine what we mean by the term 'cost' in relation to hiring women. The inherent assumption in this phrase is based upon the supposition that women invariably interrupt their work careers to fulfil reproductive responsibilities such as childbearing, childrearing and care of dependents, incurring an absolute cost to the employer due to disruption in the workforce, disruption in the individual career that the employer has invested in, in the form of training, as well as the cost of recruitment and hire of new employees. These costs, that are both quantifiable and qualitative, need to be assessed over the short, medium and long term, over the lifespan of the organisation and for the nation. Little or no economic research exists in this area, especially in the South African context. However, it is important to consider the meanings of cost and benefit related to hiring women in the SET sector.

The loss of women's skilled labour during their reproductive cycle, with absences related to parental leave, exist in the short term. However, these costs need to be weighed against the cumulative costs to a company and society over the medium and long term if skilled women are lost to the sector entirely. We do not know what the quantifiable costs to corporations are in the medium term with regard to absolute loss of a skilled employee if the latter is not allowed or cannot return to work. Most corporations invest in employees' training and re-skilling as they may move into the diverse arenas of the workplace. If an employee is lost to the corporation then the cost of training and re-skilling investment in her is not maximised. Secondly, we do not know the quantifiable costs to society, over the long term (structural costs), of not hiring women in SET. However, we do know that the society suffers an absolute qualitative loss of the investment already made in these women's education, as well as the loss of potential accumulative 'interest' of their skills input. In addition, the country suffers further loss where the potential benefits of diversified personnel in SET are not realised in a globalised context where, increasingly, organisations and nations gain the competitive edge by diversifying their labour force. Costs, whether quantitative or qualitative, such as the initial cost of career and labour force disruption in the short term, have to be balanced by gains such as a woman employee's productivity and commitment to a specific organisation over the medium to long term, and an improvement in quality of life for the woman and her dependents over the long term. Later in this review, we will examine this scenario more closely (that the employment of women is a cost) to indicate that these apparent costs and therefore the notion of financial incentives are not as simple as they may initially appear to the reader.

Employing women: a cost or a benefit to the company and society?

The implications of incorporating women into the workplace fall into the broader debates about the costs and benefits of diversity in an organisation's labour force, and whether such diversity provides a competitive advantage. Until recently, these debates have been confined to northern multicultural contexts such as the United States and Canada, and focused mainly on the rather fuzzy notion of 'valuing diversity' (Cox/Blake 1991). As indicated above, the need for diversity in organisational contexts in South Africa is driven by different imperatives, namely, racial and economic redress, efficient economic utilisation of human capacity in a developing country context and the value of a diversified labour force. The debate about the value of diversity is emergent, but is often side-tracked by the argument that racial and gender redress does not allow for the employment of the most skilled personnel. Again, research which examines the costs and benefits of redress and the purported 'loss' of skilled personnel who are overlooked because of racial and gender redress needs to be done. The most dominant argument presented both by disgruntled previously entitled members and individual academics of all races on the left is that redress (erroneously termed 'affirmative action' in South Africa) lowers performance standards in an absolute sense (see Benatar 2007, unpublished inaugural address, University of Cape Town); or that it is the same type of social engineering used by the apartheid regime in the past.

Studies done in northern contexts examining the cost of hiring women indicate that costs are difficult to determine (Cox/Blake 1991) and studies on this issue vary in terms of their findings. Schwartz (1989) indicates that, apparently, the cost of employing women is much higher than that of employing men. This is due to the apparently high rate of career disruption among women as they take time out to attend to gender-specific reproductive careers such as childbearing and rearing or care of dependents. However, he argues that these costs should be measured against the yet unquantified gains to companies if they facilitate women's attempts to balance their career ambitions with reproductive careers. These unquantified gains include employee commitment and loyalty to the company over the long term, and increased job satisfaction. In addition, the cumulative national benefits of utilising women's skills over the long term in this sector remain unexamined. Similarly, Richard (2000) argues that most organisations tend to perceive diversity that includes recruitment of women and minorities in the context of the organisation as a human resource cost, rather than an asset to be fostered.

We would add that these studies do not suggest means for conceptualising or quantifying the social assets that women and minorities bring to the workplace, such as the cultural intelligence that enables them to communicate across sociocultural boundaries, thereby facilitating efficiency and creativity.

5 Conclusion: lessons learnt

The current study highlighted the following issues:

- Incentives must be implemented in the SET sector in a general drive to allow women professionals to advance in their careers and to improve gender sensitivity in the SET organisational culture.
- Incentives available in the SET higher education and corporate sector should be used to increase gendered and racial diversity to meet South Africa's constitutional and legal requirements. Our findings indicate that senior executives acknowledged that there is a dearth of black women in the South African SET sector. They acknowledged that they have to attract and retain black women with the necessary skills at senior management level because this is a legal imperative in South Africa. Sectors such as mining, civil and electrical engineering face an invidious problem in attracting and retaining women professionals due to the small pool of skills, the competition between public and private sector for this small pool of skills, as well as the

strenuous work environment. This recruitment process has to be well planned over the short and long term using multiple strategies. In the short term, women who possess aready suite of requisite skills are targeted while junior women who are recruited or employed within the company are mentored to acquire these skills. This is necessary to prevent a backlash against the women and to set them up for successful career trajectories. The women interviewees in our study insisted that they did not want to be regarded as less competent workers than their male counterparts because they accessed parental leave to balance work–family responsibilities.

- Indirect incentives should be used in multiple ways and in consultation with women employees to improve the workplace environment for women employees. Such action will ensure that they have a realistic possibility for promotion and career success. Multiple indirect incentives could be used to provide women with more time and financial support to obtain further training and qualifications, as well as to buy time out from administrative and teaching to increase research publication output.
- Incentives should be used indirectly to acknowledge the work of individual women and reward companies for improving the SET environment for women, especially women from racial minorities in the sector. The most efficient use of these incentives differs across the various SET work environments and between corporate, parastatal and academic sectors. How these incentives should be applied within these sectors should be further investigated.

In developing societies such as South Africa, we can ill afford the costs of *not* hiring women in SET for two reasons. Firstly, we would be under-utilising our human resource capacity and this would stymie innovation; and secondly, we would lose the opportunity to increase diversity in the workplace and social cohesion in a society that continues to wrestle with the legacy of the divided racial and gendered past.

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Female and Male Physicians in Academic Medicine: Is Work-Life Balance still an Issue?

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1 Introduction

Over the last few decades the number of female students enrolling to study medicine has been constantly rising (e.g. Hamel et al. 2006: 310; Buckley et al. 2000: 283; Crompton/Le Feuvre 2003: 38-43; Nonnemaker 2000: 400-401). However, barriers for women in medicine still exist and are reflected by the smaller numbers of women in higher positions (Hamel et al. 2006: 310-311; Buckley et al. 2000: 284; Carnes/Morissey/Geller 2008: 1455-1456; Nonnemaker 2000: 401-404) and the unequal distribution of men and women within one profession (sex segregation), for example women are more likely to be in primary care (Burgess et al. 2012: 508).

In this article the concept of gender will be used to illustrate the interactions and interwovenness of social and organisational factors that hinder the advancement of female physicians in academic medicine. In terms of obstacles in the careers of female physicians the focus is set on organisational factors (women are less often promoted than their male counterparts, lack of mentors and role models) and work-life balance (children and compatibility of family and career).

1.1 Obstacles for women in medicine

The smaller numbers of women in senior ranks or leading positions in medicine are supposedly connected, but not limited, to sexism in promotion, gender role constraints and lack of role models (Yedidia/Bickel 2001: 456). Gender stereo-

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types may contribute to the sex segregation of men and women, resulting in fewer numbers of women in senior ranks or the unequal distribution of men and women in specialties (see also Pratto et al. 1997: 50-51). A large number of publications and projects as well as cooperation in both areas are essential in academia. In total, women are less involved in research than their male colleagues (Hochleitner 2003: 97; Hamel et al. 2006: 311). In numbers they are equally often first authors, but less often co-authors than their male colleagues (Delgado et al. 2011: 3-5). When comparing men and women with children, women are less often seen to be authors of peer-reviewed publications (Carr et al. 1998: 535). Delgado and colleagues (2011: 5) connected these results to a lesser degree of cooperation on projects. Other studies found that even though the number of female authors (especially being first author or senior author) has significantly increased, there is still a gender gap in authorship (Jagsi et al. 2006: 283-285). This gender gap has contributed to the obstacles women are facing in academic medicine and the smaller number of women in higher positions in academia.

1.2 Work-life balance

Female physicians named the compatibility of professional (i.e. research) and private life as most difficult (Hochleitner 2003: 226-228; Töyry et al. 2004: 215-217). Along this line of argument, the extent to which career decisions by women are influenced by family factors can be hypothesised (e.g. household chores, childcare). A study of female physicians demonstrated that neither having children nor the age of children massively influences career motivation. Instead, the perception of motherhood and a supportive home–work culture particularly contribute to motivation for career pursuit (Pas et al. 2011: 498-501; cf. Bathmann/Müller/Corneließen 2011: 146-149). Taking this consideration into account, Bathmann, Müller and Corneließen (2011: 117-122) showed that after giving birth to the first child focus shifts either to a more traditional or to a rather egalitarian model of childcare and career. In the traditional model attention focuses on the career of the male partner, and therefore the career of the female partner is interrupted or neglected. This derives from traditional concepts of family and a disapproval of resorting to external help for childcare (Bathmann/Müller/Corneließen 2011: 117-122). The egalitarian model as described by Bathmann, Müller and Corneließen (2011: 137-139) depicts an egalitarian role allocation between the parents regarding child rearing and advancement in the (academic) career of both parents. Moreover, external help for tasks in child rearing (e.g. a nanny) and household were utilised when women followed a ‘male-orientated’ career model (Bathmann/Müller/Corneließen 2011: 131-137, 146-149). Interruptions in the mother’s employment for the purpose of childcare were restricted to a short period of time to ensure a continuous employment biography for the female partner. However, sufficient financial resources are a premise in this model. The perception of motherhood and the expectations how mothers should or should not be influence these models.

Being a parent has a negative impact on career development and work-life balance, which especially affects women with children (Buddeberg-Fischer et al. 2010: 3-4). Furthermore, it was found that women who became a parent at the beginning of their career encountered a greater loss in career success than did their male counterparts. New mothers with partners who work full-time are more likely to reduce working hours than are new mothers with partners who work fewer hours or that are single mothers (Abele/Spurk 2011: 230-231). Indeed, being a parent at an early stage of a person's career was seen to be an indirect predictor for less objective career success. It is also noteworthy that this finding was true for women but not for men (Abele/Spurk 2011: 230-231). Shollen and colleagues (2009: 90-93) found that women spent more time on household chores, but had fewer children than did men. Studies of physicians have reported that women less often had help with household chores and child rearing than did their male colleagues (Fox/Schwatz/Hart 2006: 231-232; Shollen et al. 2009: 90; Gjerberg 2003: 1331-1332). Achieving a work-life balance is not only dependent on the flexibility of the job, but also on other family members (e.g. the ‘other’ parent), childcare facilities such as kindergarten, school and after-school care and a myriad of other factors. Job security, the opportunity to reduce total working hours or to eliminate working hours that are not conducive to child rearing (Fox/Schwatz/Hart 2006: 230-231) are only a few examples of the possibilities for balancing private and professional life (cf. Shollen et al. 2009: 93).

The working situation for physicians in (university) hospitals entails specific aspects that have to be taken into account when talking about possibilities and restrictions with regard to work-life balance. Aspects involved in working in (university) hospitals include long working hours (Gjerberg 2003: 1338-1339; Heiligers/Hingstman 2000: 1235; Walsh et al. 2005: 990-991), unpredictable work demands (Walsh et al. 2005: 990-991), weekend and night shifts (Gjerberg 2003: 1330; Heiligers/Hingstman 2000: 1237; Walsh et al. 2005: 990-991), being on call (Gjerberg 2003: 1339; Walsh et al. 2005: 990-991) and compulsory presence on site. Patient care is a year-round task that makes no exceptions for public holidays. Strict working hours and the necessity to unexpectedly fill in for colleagues are additional factors that ensure fluent hospital processes. With this in view, a hospital physician's work-life balance is particularly dictated by work demands (cf. Walsh et al. 2005: 990-991; Gjerberg 2003: 1339).

Overall, studies have focused on how to achieve gender equality in academic medicine. Recommendations for women in academic medicine include social, personal and organisational factors for the purpose of tackling the advancement of women in academia. Such recommendations focus on providing information on socialised gender differences (e.g. gender stereotypes, gender inequality, constrained gender roles) (Carnes/Morrisey/Geller 2008: 1459; Yedidia/Bickel 2001: 464), institutional support (e.g. mentoring programmes, policies, enhanced promotion and funding of research on sex differences) (Carnes/Morrisey/Geller 2008: 1459; Yedidia/Bickel 2001: 464; Verlander 2004: 334) and improvement of work-life balance (e.g. childcare facilities, job security, status of women in academic medicine) (Carnes/Morrisey/Geller 2008: 1459; Yedidia/Bickel 2001: 464).

2 Methods

2.1 Study design

Two studies were conducted on physicians at Innsbruck Medical University Hospital. In 2002 the first study aimed to depict the situation of female physicians at university hospitals. Ten years later the second study was performed and included both female and male physicians. This second study highlighted changes in the situation of female physicians and aspired to contrast men and women in (academic) medicine. Participants were recruited from the physicians employed at Innsbruck Medical University Hospital. For both studies questionnaires were distributed to physicians from all departments at the hospital. This study examines differences between female and male physicians in terms of academic achievement and the social environment in which they live. Moreover, it provides the opportunity to compare women from the two studies with regard to academic achievement and social environment. As has been shown in other studies, children are seen to be an influencing factor in (academic) career pursuit by women.

In 2004, Innsbruck Medical University implemented its Women's Affirmative Action Plan with the aim of increasing the number of women on all organisational and hierarchical levels to a minimum of 40%. Moreover, this affirmative action plan included mentoring programmes, gender budgeting, promotion of women in science, gender-specific content in medical training and further education (Medizinische Universität Innsbruck 2004: 147, 150-152, 155-157). Therefore, comparison of the 2002 sample before implementation and the 2012 sample after implementation of the Women's Affirmative Action Plan will also show what aims have been achieved to date. The 2012 study illustrates the situation of female physicians in academic medicine today and compares it to that of their male counterparts as well as to that of female physicians ten years ago.

2.2 Data collection and survey instruments

In 2002 the questionnaires were sent out as a pen-and-paper questionnaire to 352 female physicians at the university hospital in Innsbruck, Austria. Participants were asked to return completed questionnaires to boxes positioned at various locations in the hospital. In 2012 the same procedure was applied, with the questionnaire being given to 1 202 female and male physicians at the same hospital. Participation in both surveys was anonymous and confidential. Physicians at Innsbruck Medical University Hospital are employed either by the Medical University or by the operating company Tilak. Those employed by the Medical University have to pursue scientific research as part of their job. For this reason, this article will focus solely on participants from the Medical University.

2.2.1 Instruments

The questionnaire was created in 2002 to assess the specific needs and wishes of female physicians at university hospitals. The design of the questionnaire was based on the experience of the Working Group for Equal Treatment, interviews with female physicians and the experience of women concerned with the promotion of women. The aim of the questionnaire was to depict short-, intermediate- and long-term issues that are changeable. Initially, the purpose of the questionnaire was to investigate the need for women's promotion (Hochleitner 2003: 17). The questionnaire consisted of four areas: (1) 13 items on the respondent's personal situation (socio-demographic items, childcare, housekeeping, etc.), (2) five items on information about the study of medicine (academic qualification, working during studies etc.), (3) 23 items related to the respondent's job (career goals, work stress etc.), and (4) five items on gender-specific aspects (discrimination). The questionnaire was adapted for the 2012 study to integrate thematic topics found to be lacking after the evaluation of the 2002 study. Questionnaire reliability and quality control are described in detail in Hochleitner (2003: 17-19).

2.2.2 Statistical analyses

For statistical analysis, frequency distributions, means and standard deviations were used to describe the characteristics of the samples. Analyses were clustered in three areas: socio-demographic variables (marital status, gender, age, being a parent), social variables (time of childbirth, use of and wish for childcare facilities, household chores) and career-related variables (academic qualifications, career motivation, discrimination experiences and career perspective). Continuous variables (household chores and motivation for career choice) were coded from 1 (do not agree) to 4 (agree completely). All other variables (excluding age and number of children) were categorical data and were coded 1 (no/disagree) or 2 (yes/agree). Women in the 2002 and 2012 studies were compared, as well as women and men in the 2012 study. For comparison between these samples we used the Mann-Whitney U test for continuous variables (due to non-normal distribution) and χ^2 for categorical data. Differences were deemed significant when $p < .05$.

3 Results

The response rate for the 2012 survey was 22.7% (273 physicians), of whom 34.4% were employed by the Medical University, 30% by Tilak and 35.6% did not name their employer. We excluded all participants who were not employed by the Medical University as well as all participants who did not state their employer. Finally, 94 physicians (36 women, 58 men) were included in the analysis of the 2012 study. In 2002 a response rate of 76.99% was achieved (271 of 352 female physicians), of whom 43.5% were employed by the Medical University and 56.1% by Tilak, leaving 118 female physicians for inclusion in the analysis of the 2002 study.

3.1 Female and male physicians 2012

Mean age of female physicians in 2012 was 39.7 years (SD 8.9) and of male physicians 46 years (SD 10.4), indicating a significant age difference between men and women (U 605.5; z -3.4; $p < .05$). Of the male physicians 74.1% were married as compared to 41.7% of the female physicians. Of the male physicians 65.5% had children, as compared to 50% of the women. Of the female physicians 38.9% were specialists in training, and 55.6% had already completed their training as specialists. Of the male physicians 82.8% were specialists and 8.6% specialists in training.

3.1.1 Household chores and children

In 2012 significantly more women were single/unmarried than were men (Fisher's exact test $p < .05$). However, this may have been due to the age difference between men and women. In the sample we found significant age differences for married and single persons (U 535; z -2.6; $p < .05$). However, we did not find any significant differences when splitting the sample into men (U 194.5; z -0.9; $p > .05$) and women (U 89.5; z -1.7; $p > .05$). No significant difference was seen between men and women with children ($\chi^2(1)$ 2.2; $p > .05$). Participants were asked if their children were born before they started to study medicine, during their studies, during their rotation, during their training as specialists, or later. Significantly more men than women reported becoming parents during their specialist training ($\chi^2(1)$ 7.8; $p < .05$). Women and men differed in their child-raising practices (alone, with a partner, with other family members, external help, childcare facilities). Overall, 92.9% of the parents in this study raised their children with their partner. However, significant differences in childcare were seen, namely, that men used childcare facilities less often than women (χ^2 (2) 13.1; $p < .05$) and women cared for their child/children alone more often than men (Fisher's exact test $p < .05$). The desire to have specific childcare facilities such as toddlers' groups, kindergarten and after-school care for school children was stated by half of the parents (between 44.7 and 55.3%), revealing no gender differences. Regarding household chores, no differences were found between men and women. Female and male physicians stated that they made a major contribution to household chores (mean 1.9; SD 0.8), showing no significant difference (U 978.5, z -0.5; $p > .05$). The same was seen for paid household help:

women and men equally reported employing paid household help ($\chi^2(1)$ 0.11; $p > .05$).

3.1.2 Motivation for career in medicine and academic achievement

Concerning the motivation to pursue a career as a physician, we asked about helping, interaction with others, prestige, science, income and family tradition. Men and women differed significantly in terms of interaction with others (U 803.5; z -2.5; $p < .05$), which was named more often by women, and science (U 588; z -3.8; $p < .001$), which was named more often by men. Overall, helping (mean 3.7; SD 0.6), interaction with others (mean 3.4; SD 0.8) and science (mean 3.1; SD 1) were the most important motives for studying medicine.

Of the female respondents 66.7% and of the male respondents 50% held a PhD. Of the male physicians 80.7% already held *venia docendi* as compared to 39.4% of the women. Of the women 36.4% and of the men 18.2% were currently working toward *venia*. In terms of academic achievement no differences were seen between women and men with regard to having a PhD or working toward *venia*. However, there was indeed a significant difference in already holding *venia docendi* ($\chi^2(1)$ 15.8; $p < .001$). More men already held *venia* than did women. This may also be confounded with the age factor. However, after splitting the sample into age groups (up to 29 years, 30–39 years, 40–49 years, 50–59 years, 60 years and above), we did not find any evidence in support of this. When splitting the groups into males and females with and without children, significant differences were found in those persons working toward *venia* (Fisher's exact test, $p < .05$): more mothers were seen to be working toward *venia* than were fathers, and more fathers already held *venia* than did mothers (Fisher's exact test, $p < .05$). Having no children did not seem to have any significant effect on physicians working toward *venia* (Fisher's exact test, $p > .05$), but was seen to be a factor in holding *venia* (Fisher's exact text, $p < .05$), thus indicating that more men acquired *venia* than did women. Women more often attended fewer than five conferences per year than did their male counterparts (Fisher's exact text, $p > .05$), but men and women did not differ in their reasons for not attending conferences (clinical work, family, financial reasons). Women less often went abroad to do research than did men ($\chi^2(1)$ 12.7; $p < .001$).

3.1.3 Harassment

Physicians were asked about gender discrimination and harassment during their studies and in their job as physicians at university hospitals. The overall percentage for experiencing gender discrimination and harassment was below 20%. No significant differences were found in most discrimination sections when comparing male and female physicians: 25.8% of the female physicians had the impression that they were given hiring preference over their male counterparts, compared to 14% of their male colleagues (χ^2 (1) 1.8; $p > .05$). Of the female physicians, 11.8% agreed and 14.7% agreed somewhat that children were a restricting factor in their career, while 12.4% of the male physicians made the same statement (Fisher's exact test, $p > .05$). Of the female physicians, 17.1% felt discriminated in their studies, as did 17.5% of men (χ^2(1) 0.002; $p > .05$). About one quarter (26.5%) of the female physicians and 14% of the male physicians experienced discrimination at their workplace (χ^2 (1) 2.2; $p > .05$). A significant finding was detected in terms of the experience of obstacles in their job on the basis of being a woman/man: 55.9% of the women and 19.6% of the men experienced this (χ^2 (1) 12.5; $p < .001$).

3.2 Female physicians 2002 and 2012

A detailed description of the 2002 study results and population can be found in Hochleitner (2003: 24-27, 58).

3.2.1 Household chores and children

The mean age of female physicians in 2002 (mean 35.3; SD 7.9) and 2012 (mean 39.7; SD 8.9) differed significantly (U 1561; z -2.4; $p < .05$); namely, in 2002 participants were significantly younger than in 2012. Of the women in 2002, 60.2% were unmarried/single and 37.3% married, as compared to 50% unmarried/single and 41.7% married women in 2012, thus showing no significant difference between these two groups (χ^2(2) 3; $p > .05$). Furthermore, the two groups show no difference with regard to having children (χ^2(1) 3; $p > .05$). However, women in 2012 (mean 0.8; SD 0.9) had a larger number of children than did women in 2002 (mean 0.4; SD 0.7) (U 1638, z -2.4; $p < .05$): 66.1% had children in 2002, 50% in 2012. Women who were parents differed in the time at which their children were born. In 2012 more women had children later, that is, after completion of medical training ($\chi^2(1)$ 23.8; $p < .001$). During the ten years between the two studies the pattern of childcare changed in some aspects: in 2012 significantly more women raised their child alone (Fisher's exact test; $p < .05$) or with the help of a kindergarten ($\chi^2(1)$ 6.2; $p < .05$). Significant differences were observed in the desire to have childcare facilities in terms of toddler's groups ($\chi^2(1)$ 6.6; $p < .05$). In 2002 fewer women mentioned the wish for a toddler's group than in 2012. There were also changes regarding household chores: in 2002 fewer women had paid household help than in 2012 ($\chi^2(1)$ 6.6; $p<.05$), but in 2012 women stated that they made a greater contribution to household chores than in 2002 (U 1573.5, z -2.5; $p < .05$) ($mean_{2002}$ 2.4; SD 1.3; $mean_{2012}$ 1.8; SD 0.8).

3.2.2 Motivation for career in medicine and academic achievement

The main group of female physicians in the 2002 study comprised specialists in training (64.4%). Working with people ($mean_{2002}$ 3.9; SD 0.4 $mean_{2012}$ 3,7; SD 0.6) and helping ($mean_{2002/2012}$ 3.4; SD 0.9 in 2012 and 0.7 in 2002) remained the most important motives when choosing a career in medicine. The number of women who had completed their PhD was significantly larger in 2012 ($\chi^2(1)$ 9.4; $p < .05$). In 2002, 37.6% of the female physicians stated that they had finished their PhD, as compared to 66.7% in 2012. Women also differed significantly in holding *venia docendi* ($\chi^2(1)$ 18.9; $p < .001$), but not in working toward *venia* ($\chi^2(1)$ 2.1; $p>.001$). In 2012 more female physicians held *venia docendi* than in 2002. No increase or decrease in the rate of conference attendance was observed.

3.2.3 Harassment

In 2002, 17.9% of the respondents believed that they enjoyed a hiring preference over their male counterparts ($\chi^2(1)$ 0.9; $p > .05$), 47.5% reported experiencing obstacles in their job because of their gender ($\chi^2(1)$ 0.7; $p > .05$), 22.9% experienced sexual or gender discrimination at work ($\chi^2(1)$ 0.2; $p > .05$), 10.2% agreed and 16.1% somewhat agreed that children were a restricting factor on their career ($\chi^2(1)$ 0.01; $p > .05$) and 25.4% of the sample reported experiencing sexual/gender discrimination during their medical studies ($\chi^2(1)$ 1; $p > .05$). As can be seen from the analysis, no significant differences regarding gender discrimination were observed between women in 2002 and 2012.

4 Discussion

In academic medicine women are still under-represented in senior ranks, even though an increasing number of women are starting to study medicine (e.g. Hamel et al. 2006: 310; Buckley et al. 2000: 283). Our study findings show that differences between women and men occurred at the stage of achieving academic qualifications beyond a PhD, and that women less often went abroad for research and less often attended conferences. Fewer women had received *venia* than men. However, in comparison with 2002 the increased percentage of women holding *venia* illustrated the greater effort by women to achieve academic qualifications equal to those of their male colleagues. Dividing the sample into age groups to detect age-related influences brought no clarification of this phenomenon. When comparing physicians with and without children we found that having children had an effect on working toward *venia* and having received *venia*. In this respect, men with and without children were more likely to have received *venia* than were women with and without children. Moreover, it was seen that more mothers were on the *venia* track than were fathers. It can therefore be hypothesised that when on parental leave women start working toward *venia* or plan to start, but more often ultimately do not acquire *venia docendi*. This effect was not found in fathers. These findings may also reveal that women are more often responsible for childrearing tasks and/or household chores, which are factors that cause a delay in achieving postdoctoral academic qualifications. Another finding was that women without children were less further along the *venia* track than were their male counterparts. Our study found no possible reasons why women without children are delayed in achieving postdoctoral academic qualifications. We suggest this as the subject for a future study.

Helping and interaction with others are still motivational factors in choosing a career in medicine in both women and men. While these are obviously leading reasons for studying medicine, less importance was ascribed to prestige and income. Science was more reported by men. To date there is no evidence that these motivations are changing in women. One assumption regarding the motivation to study medicine is that helping and interaction with others may be differently understood and perceived by men and women and therefore have different meanings for women and men. This may be related to the finding that even though women are entering universities in greater numbers they largely have not been able to achieve the same postdoctoral academic qualifications as men. One reason for this could stem from gender-specific differences in the meaning of motivation, while another reason might be found in gender-specific obstacles that cause unequal distributions of women and men in specific areas within one profession (cf. Burgess et al. 2012: 508).

Obstacles to attaining higher positions in academia are, on the one hand, attributed to women's lack of mandatory qualifications and their lesser investment in academic pursuits (research abroad, attending conferences). On the other hand, the question remains: Why do women not achieve these qualifications to the same extent as men and what are the causes of delays in achieving academic qualifications beyond a PhD? One explanatory assumption based on the findings of our study is connected to different responsibilities in non-paid work (i.e. child rearing and household chores). Women and men did not differ in terms of being a parent. However, they differed in the time at which they became parents. Women had children at earlier stages of their lives than did men. This would mean that women were responsible for child-rearing tasks parallel to their training as specialists and the achievement of academic qualifications. Moreover, as compared to men, women were more often single parents. Seen in this light it is self-explanatory that women had a greater desire for childcare facilities for smaller children, but also for school-age children. A woman's wish to have childcare facilities for toddlers is connected to her desire to have equal opportunities to pursue the intended career in academic medicine. Moreover, the use of childcare facilities increased with the increased opportunity to access these facilities at all and as a consequence of the increased need to use childcare facilities because fewer women raised their children jointly with a partner in 2012. The issue of childcare continues to be a female one. Male physicians have the opportunity to shift childcare responsibilities to their female partners. The lack of equal allocation of childcare and non-paid work responsibilities still exists in Austria, and even now non-paid work is closely associated with women. Impediments such as having children and the incompatibility of family and career are central topics for female physicians and much less important topics for men. The importance of work–family balance has to be seen in the light of the specific job characteristics, such as long working hours, being on call, unpredictability of work (e.g. substitute for colleagues), weekend and night shifts and compulsory presence on site. In this context childcare facilities and support in child rearing and household chores are highly influenced by work demands and are issues in urgent need of investigation.

In addition to the obstacles posed by having a family, gender discrimination and harassment are present in (university) hospitals. Women perceive discrimination in their job because of the fact that they are a woman. These findings are consistent with the literature comparing minority groups in male-dominated areas. Women in academic medicine are a minority group, especially in higher or leading positions. Therefore, the perception of being discriminated against because of gender may be balanced if more women hold academic qualifications and positions comparable to those of men and if men no longer constitute a majority group in academic medicine. However, the implications of our findings agree with the recommendations of others (e.g. Carnes/Morissey/Geller 2008: 1459; Yedidia/Bickel 2001: 464).

The empowerment of female physicians in academic medicine calls for intensified social and organisational improvements. Improvements in the area of work-life balance that include but are not limited to childcare facilities are needed to create the opportunity for women to shift childcare responsibilities. Mentoring programmes for women as well as role models are known to attract more women for higher positions. Moreover, the promotion of studies on sex differences in medical topics raises the awareness for gender-specific differences in diagnosis and treatment, but also leads to the perception of men and women as equals. Surrogates when going on parental leave as well as gender-specific topics in curricula and advanced training have also been implemented at Innsbruck Medical University. The number of women in all organisational and hierarchical levels should rise to at least 40%. In the long run these strategies will empower women and thus do away with their status as a minority group in academic medicine. So far, improvements in the achievement of academic qualifications by women and slightly changing patterns in child rearing can be observed. However, the advancement of women in academic medicine is still in the early stages, and there is an urgent need to intensify the efforts made to enhance the number of women on all hierarchical levels.

5 Lessons to learn for women in science

The question arises as to what women can learn from research on academic careers. The conclusions drawn from our findings demonstrate the necessity of focusing on both the employer and the employee. The advancement of women should be initiated by the employer. The employer should provide mentoring programmes, gender budgeting and support for mothers on parental leave and should support the ability to return to work after parental leave (e.g. through childcare facilities adapted to the needs of the employer, flexible working models such as starting with fewer working hours and being able to constantly increase these hours, having access to resources during parental leave such as computer programs, databases etc.).

Childcare and work–family compatibility are still issues that affect mainly women. The advancement of women in science should focus on creating and shaping possibilities for women to remain in science after childbirth. On the employee side, we found patterns in childcare, household chores and academic achievement to be undergoing change; however not only in favour of women. Women constantly show greater effort to achieve postdoctoral academic qualifications equal to those of men, but are still delayed in achieving these qualifications. The causes of this delay remain unclear. We speculate that the delay is due to the demands of non-paid work, the desire to start a family, a lack of support for a scientific career from the social environment (e.g. partner, superiors) and women's low priority for the achievement of academic qualifications beyond a PhD. Using resources such as toddlers' groups and other childcare facilities and employing household help is one way to free up a woman's capacity to pursue a career in science. Motivation for women to study medicine lies in helping and interacting with others. These findings point to a lack of selfishness. Accordingly, it is necessary for women to demonstrate self-interest and a willingness to pursue a career in science and demand the creation of possibilities to do so. Prioritising academic qualifications and the demands of a career in science (e.g. publications, collaboration on projects, attending conferences) must be pursued uncompromisingly.

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Sustainability of Women-Owned Construction Enterprises in South Africa: 'A Burning Issue'

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1 Introduction

The dawn of democracy in South Africa brought recognition of building skills in the market as having an impact on the broader economic growth of the country. As expected, this recognition introduced the need for the transformation and regulation of the construction industry in order to enable greater participation by historically disadvantaged individuals (HDIs). Furthermore, these efforts saw an influx of women who established their own construction enterprises, hoping that they too could contribute meaningfully to the economic development of the country. Despite women's rich indigenous construction knowledge, substantial growth and an increase in women-owned construction businesses in the Construction Industry Development Board (CIDB 2012) register of contractors, the businesses remain almost static in terms of their grades. The myths and misconceptions that women contractors are incapable of understanding technical issues within the construction industry continue to hamper women contractors' opportunities to grow and sustain themselves within the sector. Promoting women's participation and ensuring their sustainability in the construction industry in South Africa and globally is still a burning issue. Women-owned construction businesses have not advanced as well as they should. Various studies in South Africa, Swaziland and Europe reveal that there are numerous challenges facing emerging contractors. These include a lack of capacity building, a lack of awareness creation about what is expected of women contractors, a lack of technical and entrepreneurial skills, a lack of management skills, a lack of marketing,

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inadequate information, and a lack of capital and access to financial assistance. However, there have been insufficient explanations of factors specifically contributing to the lack of women's growth and sustainability in the construction sector. A study into the common reasons affecting the growth and the competitiveness of women contractors shows a largely inadequate understanding of the development needs of women in construction (Haupt/Fester 2012: 52-71).

In South Africa there is excellent legislation, policy frameworks and incubation programmes initiated by government to empower women. However, the opportunity for women-owned construction businesses to sustain themselves remains contested. This is so because the pace of transformation within the construction industry is very slow and the implementation of programmes and initiatives to accelerate women's development in the sector has been found to lack strategic and coherent approaches. Without a clear development model and women-specific programmes by government and implementing agencies, women contractors will remain in the lower CIDB grading ranks and ultimately face closure or liquidation.

This chapter addresses reasons why, despite the most progressive constitution and women empowerment frameworks, women-owned construction enterprises in South Africa continue to lag behind in terms of business growth and advancement. It also explores the reasons why women-owned construction enterprises are not sustainable and what lessons women can draw from this in order to increase their capacity to grow beyond CIDB grade 2. Furthermore, the chapter seeks to open a debate around issues holding up the growth and sustainability of women-owned construction enterprises and provides lessons for women in science and the built environment. A theory-generative research design using a qualitative approach was used to collect data from key informants in the construction industry. The data were drawn from the experiences and views of the captains of the industry as key informants. Finally, this chapter concludes by making recommendations for the promotion of women in science and the built environment in the future.

2 Theoretical framework

In this study a capability approach, which views people as participants and agents of decision making (Duraiappah/Roddy/Parry 2005), was followed. This arises from the notion that when women contractors are effectively involved in their own development, they can have more influence and control over issues that affect their lives. In this study, the growth and sustainable development of women in construction are mainly dependent on an adequate understanding of their capabilities and specific needs.

3 Materials and methods

The study employed a theory-generative design, using qualitative research methods. This approach provided the researchers with an opportunity to explore the experiences of the participants.

3.1 Study focus and site

This article focuses on the results of the initial phase of the study which entailed interviews with the captains of the industry as key informants and also in-depth interviews with selected women in construction. The participants comprised the chief executive officers of the construction entities (the Construction Education and Training Authority, the Independent Development Trust and the Council for the Built Environment Agrément South Africa), who all report to the Department of Public Works, and a woman contractor owner-manager.

3.2 Sampling procedures and data collection

Purposeful sampling was used in selecting the participants. Semi-structured individual interviews were conducted to gather data. These interviews were recorded and transcribed verbatim.

3.3 Data analysis

Data collection and analysis were done simultaneously. Tesch's (1990: 142) eight steps were employed for data analysis in order to formulate themes. These steps are as follows:

1. Carefully read through all the transcripts.
2. Make notes of ideas that come to mind.

3. Select one interview and read it to get the meaning in the information.
4. Arrange similar topics in groups to form unique topics.
5. Abbreviate the codes that emerge.
6. Describe wording for topics and convert them into categories.
7. Arrange each category and the codes alphabetically.
8. Organise and analyse the data material belonging to each category.

4 The results

The sustainability of women-owned construction enterprises is affected by a number of factors which include rigid policies and cumbersome procurement systems, lack of construction-related technical skills, lack of women-focused interventions, a low capital base and a poor foundation for women contractors. Therefore, a deficiency in structured planning, mentoring support and nurturing, as well as in continuity in the development of rural women contractors, poses a threat to the sustainability of women-owned construction. The results are presented according to the themes that emerged.

Common reasons affecting the sustainability of women-owned construction enterprises in South Africa

Table 1 lists emerging themes and concepts relating to the reasons affecting the sustainability of women-owned construction enterprises in South Africa.

Table 1: Emerging themes and concepts

Themes	Concepts
▪ Subsistence construction business management	▪ Rationale for starting the business
▪ Rigid systems, policies and procedures	▪ Cumbersome, tedious tendering systems, late payments
▪ Lack of construction-related technical skills	▪ Lack of entrepreneurial and construction skills,
▪ Low capital base	▪ Lack of access to finance, poor profits
▪ Lack of women-focused interventions	▪ Slow transformation, lack of synergies
▪ Poor foundation of women contractors	▪ Poor incubation, poor educational training and development, lack of business drive

4.1 Subsistence construction business management

The results show that most women-owned construction businesses are fundamentally unsustainable and, as a result, are likely to operate 'at subsistence levels'[2] because they do not have access to work opportunities that will enhance their upward mobility.

In response to the question of how they would describe the current situation of women in construction in terms of entry into the sector and their rationale for starting construction businesses, comments by the participants included:

> *A large proportion of women contractors enter the industry because of boredom, some are job-seekers and not entrepreneurs.*
>
> *Once they have entered the industry, they lack commitment, confidence, strong individual involvement and willingness to take the risk and passion to compete.*

Most of the participants mentioned that women enter the construction businesses in the hope that their household economic situation will improve. However, as a result of several major constraints, they find themselves running their construction enterprises for subsistence purposes, rather than profit. The findings show that, in general, women entrepreneurs tend to see the establishment of a productive business as a means to improve their quality of life, as well as to serve their communities by creating employment opportunities. However, their lack of preparedness to face the opportunities and challenges within the construction industry play a big part in whether they experience accelerated growth or not. According to Ludwig/Roodt (2012: 210), construction in particular is believed to be one of the sectors suitable for skills and sustainable enterprise development. However, the official statistics by Statistics South Africa (Stats SA 2008) on liquidation and insolvencies reveal the highest number of liquidated or insolvent entities to be in the construction sector. Moreover, most of these entities were found to be women-owned construction enterprises. According to Kganyago (2004), this casts doubts on development programmes aimed at empowering emerging contractor enterprises, and in particular those that are women-owned.

2 Subsistence construction business management is a hand-to-mouth type of enterprise management style in terms of which the entrepreneur never gets to make enough profit to run her enterprise comfortably.

4.2 Rigid systems, policies and procedures

On the question of what participants think the common factors that contribute to a lack of growth beyond CIDB grade 2 are, the following statements were made:

> *The ability to put a business proposal together, the ability to put up the right documents, the ability to express yourself, now I am not even talking about verbal expression, but putting the right documents in that part of the tender documents. That is something that is already working against them.*

> *Tendering and understanding the procurement processes is the big part of the game.*

> *Women contractors are forced to remain in the lowest works capabilities and cannot make any profit, because they do not understand the procurement and tendering system.*

4.3 Lack of construction-related technical skills

When asked what requirements are important in developing women in construction, the participants had this to say:

> *Without the requisite technical knowledge and skill base, women contractors will continue to face marginalisation within the construction sector.*

The supply and availability of skills underpins the ability of the construction industry to transform. Other comments by the participants included the following:

> *Although a lot of attitudes have changed in the industry, it still seems women continue to be striving far below men. If you look at many organisations or companies, women directors are all HR, finance, IT, etc. They are designed never to be commercial, technical, divisional managers. That needs to change.*

> *The foundation or preparation phase for women's entrance in the sector needs to be part of the organic process, right from education and training level to industry level.*

Therefore, it is evident that transformation within the industry cannot proceed at the levels we desire without restoring the skills supply line at all levels and across all sectors of the construction industry. In the end, the gender inequalities in the access to and provision of education need to be addressed urgently, and both the Department of Basic Education and the Department of Higher Education and Training are key government departments in this regard.

4.4 Lack of women-focused interventions

With regard to the question of why, despite all the empowerment and support by government, women-owned construction businesses remain in the lower CIDB grades, comments from participants included the following:

> *The incubation is so fragmented that the incubation programme has lost its purpose of capacitating the potential and advancement of women in construction.*
>
> *It does not say that we are targeting women that are at this level, that have shown this potential, and who have these needs and we are just going to provide this intervention that addresses needs. It is like they say give those projects to women, they will sort themselves out ... This gives credence that if your identity document (ID) says you are a woman, it is like you get empowered because you are a woman ... And at the end of it we are not going to look tomorrow whether after that project anything new shall have happened with you, it is just you know we can tick our box to say at the end of the year so many women got jobs.*

In South Africa, women contractors enter the market at the lower end and only in the general building contracting category, a sector that is extremely competitive and unsustainable. Given this fact, women have not emerged as significant players in the industry both in terms of size of contracts and volume of contracts.

The findings show that currently there is a lack of women-focused intervention programmes. Moreover, the various forms of interventions and programmes by government have not improved the advancement of women-owned construction enterprises. The preliminary study shows that currently the incubation programmes are playing the numbers game. In this regard women contractors are forced to compete with everybody because all these initiatives are a 'one size fits all type of programme'.

As such, women-owned construction businesses continue to grow slowly as compared to their male counterparts. Consequently, women entrepreneurs are often unable to establish and sustain successful businesses. Eventually, their economic and social transformation within the construction industry remains unimproved.

4.5 Low capital base

In response to being asked about the challenges facing women in construction, the participants made the following statements:

A major challenge for women contractors is the low capital base.

Women contractors experience low capital base which results in lack of access to finance and credit due to the fact that there is lack of continuity of work. Again most women contractors rely mostly on government contracts. Government uses a roster system which is accessed by a large pool of well-established contractors, which makes it difficult for any contractor to jump the queue.

The situation is even worse for some of us who are based in far rural areas communities because banks are not keen to support business ventures based in rural areas.

In most, if not all instances, women's access to development opportunities and further growth remains compromised. So, in order to enhance the sustainability of women in construction, the participants indicated that there is a need for a finance strategy to enable women to access finance and credit. Currently, women contractors are forced to use up their resources and are unable to invest in their businesses. This finding draws parallels with those of Bates (2002), who confirmed that most projects that women tender for require a performance guarantee of at least 10%, which in most cases cannot be raised.

4.6 Poor foundation for woman contractors

In response to the question of what would make women contractors grow and sustain their construction businesses, participants commented:

Women contractors should rather be treated as 'contractors',or 'entrepreneurs', and not as 'women contractors'.

A contractor, not a woman at that level ..., Thandi[3] *is not a woman; she is a contractor and not a woman contractor, because the woman thing is .... that is why I say we need to look at ... what is required to be a contractor, it does not matter whether you are woman or not if you are a contractor, a business owner and not a labourer, you have to comply to same standards that a man comply to. The slight difference is if you were to look at the profession is that within the profession there are small things like site conditions that will impact on women as a sissy girl who will not like the language and therefore they may affect women differently as compared to men.*

Ideas on what would define a well-developed or progressive woman contractor included:

3 The name 'Thandi' is used to epitomise a successful woman contractor.

> *Women contractors should work as hard as their counterparts, get involved in construction to make profit and not for 'subsistence purposes'. The issue of being self-driven, passionate, determination, tenacity and the drive to succeed are very important in building up a progressive woman entrepreneur in the construction industry. The women contractors need to start working as entrepreneurs, as real contractors, and must shy away from operating as job-seekers or under the shadow of their husbands.*

One participant‘s view in relation to what should be done to support women to advance to the higher grades was:

> *The development of women in construction is not properly coordinated. In fact, it is more about playing the numbers game. Currently in South Africa there is no single well-coordinated women-specific programme. As such, as women contractors we are forced to compete with their experienced male counterparts. So, it is time development of women contractors become part of the organic process.*

Clearly all the participants believed that a holistic development approach to women's empowerment in the construction industry is critical. The participants' experiences indicated that currently the foundational context in which women are prepared to enter the male-dominated construction arena is not focused on women.

5 Discussion

The findings show that women-owned construction enterprises are disproportionately affected by the adverse effects of cumbersome regulatory processes, rigid procurement systems and delayed payment processes by clients. Once in the construction industry, they experience discriminatory practices and fierce competition from their male counterparts. This is in agreement with Thwala/ Mvubu (2009), who postulate that the emerging contractor policies intended for black economic empowerment (BEE) are not being properly implemented, but rather used for job creation opportunities, which contribute to the overcrowding of the emerging market. The finding that women tend to enter the construction business industry without the requisite construction-related skills supports the fact that their chances for accelerated growth are limited. Ludwig/Roodt (2012: 210) support this finding when they claim that without the technical skills to face the challenges within the construction industry, sustainable development will remain a dream. The official statistics by Stats SA (2008) on liquidation and insolvencies reveal that the highest number of liquidated or insolvent entities is in the construction sector and that most of these are women-owned. This is a clear indication that women-owned construction enterprises are struggling to sustain themselves, despite several government attempts to empower women in this regard. Kganyago (2004) casts doubts on development programmes that aim to empower emerging contractors, in particular women-owned enterprises. It is not surprising that most of these entities are found to be women-owned construction enterprises; hence, they end up doing subsistence construction for survival only.

Furthermore, there is a need to improve women's access to information and training on procurement and tendering methodologies. This is vital to increasing women's participation and their sustainability in the construction industry. To mitigate the risks of rigid and cumbersome procurement processes, public procurement must be driven towards the empowerment of the historically disadvantaged and the creation of productive work opportunities for women-owned construction businesses. It is important to carry out an assessment of women-contractors' business development needs in order to address the barriers to their start-up, growth and development. This assessment should take into account the specific needs of women contractors. This is in agreement with Powell et al. (2007), who assert that two specific ways of strengthening women's capacity to sustain their construction enterprises are through mentoring and networking. In addition, this mentoring process should be able to match a mentor with a mentee and be based on the feminist mentoring model that encourages a collaborative environment in which the mentee is empowered. Interestingly, Putshe et al. (2008) also state that the feminist mentoring model benefits both the mentor and the mentee by providing cognitive and emotional development opportunities and personal satisfaction.

Despite the fact that government continues to support women-owned construction enterprises through existing contractor development programmes, the findings show that more coherent and systematic efforts to provide potential and lower-grade women-owned construction enterprises need to be prioritised. This is in agreement with the CIDB (2012), which maintains that it is essential to adopt a holistic developmental approach if the country is to make a significant impact on the success and sustainability rate of these contractors.

The findings show that the low capital base is the result of a lack of continuity in accessing work opportunities. This means that if women contractors do not get work or tenders regularly, they cannot build up their capital base. Consequently, their chances of borrowing money get slimmer, because banks rely on a solid balance sheet. This is supported by Eyiah (2001:513), who argues that lack of access to finance and credit negatively affect the chances of women contractors in accessing work opportunities. This is so because the kind of work they can access does not always allow them to make profits to build up enough of a capital base. Therefore, increased work opportunities play a big part in the profitability of women-owned construction enterprises. Even though there has been various empowerment legislation enacted to encourage women's participation in the industry, the participants in this study highlighted the fact that current conditions are not yet conducive to enhancing the integration of these construction businesses.

It is important to create special bodies to strengthen support for women-owned construction enterprises. These bodies should focus strictly on the dissemination of information critical for the sustainability of such enterprises. The preliminary findings reveal that facilitating a network service of learning workshops to promote sharing and discussions of best practice approaches is significant to sustaining these enterprises.

In order to improve the survival rate of women-owned construction enterprises, the participants emphasised the need for mentorship programmes. Women entrepreneurs tend to see the establishment of a productive business as a means to improve their quality of life and to serve their communities by creating employment opportunities. This is important, as Tshivhase/Worku (2012) have argued that since women are previously disadvantaged, they experience a poor business foundation and compromised accessibility and development at education and training levels; thus, they continue to experience barriers to their competitiveness within the industry.

6 Conclusion

The findings presented in this study are significant in a number of ways. Firstly, they suggest that transformation of the construction industry is very important if the participation of women in construction is to be increased and improved. Secondly, the sustainability of women in this industry is a burning issue. Although the South African government has some remarkable policies and programmes in place, there continues to be a gap regarding the sustainability of such initiatives. Thus, this report presents the construction industry, the construction education and training authority and the government with an opportunity to re-examine the approach to developing women in construction. This claim is based on the fact that women-owned construction enterprises continue to play second fiddle to their male counterparts. Given this scenario, it means that without proper support systems in place, unsustainable and ineffective women-owned construction enterprises will remain an issue. Thus, as revealed by this study, it is of paramount importance that issues of low capital base and lack of access to finance, women-specific programmes, technical skills and a proper foundation for women entering the sector be prioritised. For this reason, the argument is that for the sustainability of women-owned construction enterprises to be realised, capacity-building programmes, mentoring, coaching, monitoring and evaluation should be implemented without compromise. This includes the need for government to visit women-owned enterprises on a regular basis as part of the monitoring and evaluation framework to support such enterprises. This will eventually accelerate the growth and economic development of women in the construction industry.

7 Lessons to learn for women in science

This study reveals that women entering the construction industry appear to have a lack of the requisite skills. Consequently, women in construction should strive to acquire the technical, business management and marketing skills needed to increase their competitiveness in the sector.

The lesson highlighted is that the notion of introducing generic, ‘one size fits all’ type programmes to develop women in construction is not effective. Therefore, the success of government policies and programmes depends entirely on the degree to which women-specific development needs are considered. Furthermore, various types of support system are crucial to the advancement of women in construction. There is therefore a need to expand training provision for women in construction significantly. In addition, high priority should be given to the development needs of, and management training for, women in construction.

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The Influence of Career Planning, Career Strategies and Organisational Conditions on Gender Disparities in the Career of Mathematicians and Physicists

Bettina Langfeldt[1]

1 Theoretical background and leading questions

Despite a long tradition of desegregation, the German labour market is still characterised by horizontal and hierarchical employment segregation for women and men (cf. GWK 2012). Whereas horizontal segregation is understood as under (or over) representation of a certain group in occupations or sectors, hierarchical segregation describes the under (or over) representation of that group at the top of occupation-specific career ladders. Compared to other European countries Germany has a medium score on the IP index of gender occupational segregation (cf. EGGE 2009). From 1992 to 2007 Germany experienced a decline in gender segregation due to an increase in mixed occupations and a decrease in male-dominated occupations (cf. EGGE 2009). Measures of desegregation policy such as Girl's Days and other diverse attempts by public and private players have contributed to raising the number of women studying science, technology, engineering and mathematics (STEM). Yet, although STEM degree holders have good job prospects, young women are less likely than their male counterparts to study STEM disciplines and to work in STEM occupations later on.

Gender-related labour market segregation is usually coextensive with the undervaluation of women's work and wage discrimination. As a consequence, occupations or sectors with higher feminisation often correlate with lower comparative pay (Reskin/Roos 1990). The gender wage gap in Germany has remained stable over the years. In 2012 it was about 22% for unadjusted and 8% for adjusted data (cf. Statistisches Bundesamt 2013a). With regard to high-paid occupations in academia and business, women are not only underrepresented, but even in leadership positions they earn considerably less than their male col-

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leagues. In the STEM professions the gender wage gap is smaller than in the non-STEM area of employment, but not even the income argument seems to convince enough female STEM degree holders to enter this part of the labour market.

Gender-oriented research argues that those women who work in male-dominated occupations often experience harassment and isolation (Kanter 1977), which reduces their effectiveness and forces some of them to resign. Since Germany is currently facing a growing shortage of graduates and skilled employees, particularly in the fields of engineering and the natural and economic sciences, the need to exploit the existing potential of professionals will be further intensified by the demographic change so that market conditions force employers to compete for qualified women.

Reasons for gender segregation in employment are located on the individual, organisational and societal levels and are often interdependent. When examining related research findings a few sets of factors would seem to be mainly relevant for explanation: the choice of study field, the demand for flexible (and shorter) working hours because of the unequal care burden, and the hidden impediments and biases in organisational practices (cf. EGGE 2009).

One might think the choice of subject for study plays a minor role when considering gender disparities in the career of mathematicians and physicists because both subjects belong to the male-dominated STEM field. But there are subject-related differences which require an in-depth analysis: First, the proportion of female first years at German universities in 2011/12 was just 24% in physics compared to 47% in mathematics (cf. Statistisches Bundesamt 2013b). The higher figures in mathematics may be partly explained by the sizeable number of women studying to become teachers, because in many federal states mathematics represents a compulsory subject especially for primary school teachers. Nevertheless, compared to mathematics, physics as a subject has greater problems gaining female students. Secondly, women tend to experience more difficult career advancement in traditionally feminised disciplines such as the arts or the humanities than in the STEM disciplines. However, subjects within the STEM field also differ in this respect. In academia the leaky pipeline for female physicists appears not to be as marked as for female mathematicians. Although potential and actual shares of women with a doctorate, postdoctoral qualification or a professorship in physics are highly correlated, gender inequality manifests itself in more subtle forms such as an accumulation of small disadvantages in terms of lower wages, less equipment, and fewer awards and invitations as key note speakers at important conferences of scientific societies compared to their male counterparts (cf. Bessenrodt-Weberpals 2003).

Besides women's and men's self-selection into different fields of study, the gender-specific consequences of family formation seem to explain to a large extent the gender gap in career success in Germany, where motherhood reduces almost by half the probability of a woman holding a management position ten years after graduation from university (cf. Ochsenfeld 2012). To weaken this effect on the organisational level, a growing number of employers have implemented gender-sensitive career development activities, mentoring programmes, and flexible working (time) arrangements. Although these efforts have a smaller impact on the career advancement of employees with (or without) family responsibilities (cf. Ochsenfeld 2012), they are nevertheless not irrelevant in that context. On the contrary, interest in organisations and their equal opportunity measures has been growing since the European Union has started reporting that women are still largely outnumbered by men in positions of responsibility in business and academia and is requesting companies directly to attain the 40% female quota in non-executive board-member positions. Yet, when analysing the effects of the organisational environment on gender disparities in the careers of mathematicians and physicists, it is important to take into account the fact that organisations are not gender neutral but are shaped by gendered processes: 'To say that an organisation, or any other analytic unit, is gendered means that advantage and disadvantage, exploitation and control, action and emotion, meaning and identity, are patterned through and in terms of a distinction between male and female, masculine and feminine' (cf. Acker 1991: 167).

Career impacts at the individual level are at least as diverse as at the organisational level. One of them is career planning – an activity carried out by the individual to set goals, maintain self-determination, control his/her occupational development and direct career behaviour. Such planning influences the types of strategies individuals choose to reach their work-related goals (cf. Aryee/Debrah 1993). In turn, career strategies are understood to be the actions that individuals take to decrease the time required to meet specific career objectives. Well-known and often combined strategies include extended job involvement, visibility, professional development, and social networking within the organisation (cf. Henn 2012). Of all the possible career strategies visibility crystallises as being of greatest relevance. This strategy implies making one's own ideas, performances and personality visible, as well as networking in a one-on-one fashion with influential leaders, both inside and outside the organisation, so as to be perceived as a candidate for promotion.

Linked to visibility and just as essential is self-staging, because competencies have to be realised by relevant others (cf. Funken/Stoll/Hörlin 2011). As organisations are gendered, the acceptance and perception of career strategies is not gender-neutral but rather shaped by gender stereotypes (cf. Guadagno/Cialdini 2007). In male-dominated organisations in which competition and aggressiveness are rewarded, women often experience the dilemma of having to use dominant strategies of self-presentation to be professionally successful, while being negatively sanctioned by their colleagues because their behaviour does not conform to gender roles (cf. Martin/Meyerson 1998). Research findings prove the theory that there is not just a relationship between career planning and the use of career strategies but also a positive correlation between micro-political actions and career success (cf. Cornils/Mucha/Rastetter 2012), whereby the effectiveness of a certain career strategy depends on the type of job, the nature of work in a specific field of activity, and organisational characteristics.

The following sections attempt to answer these questions: Are gender disparities in the career of mathematicians and physicists in Germany based mainly on gender-related differences in using certain career strategies or do other factors – especially at the organisational level – have a greater impact on occupational success? To what extent do different fields of activity influence the choice of career strategies and eventually career success?

2 Study description

The project ‘Gender disparities in the occupational career of mathematicians and physicists within and outside traditional employment models’, which represents the empirical basis of the present contribution, is funded by the German Federal Ministry of Education and Research (BMBF) and the European Social Fund of the European Union (ESF).[2] It was designed as a mixed-method study with secondary analytical evaluations of educational and labour market data, expert interviews (qualitative preparatory study), and a structured online survey addressing mathematicians and physicists who received their degree before 1 January

2 The original title in German: ‘Geschlechterdisparitäten in Berufs- und Karriereverläufen von MathematikerInnen und PhysikerInnen innerhalb und außerhalb klassischer Beschäftigungsmodelle’; funding code 01FP1076/1077/1078/1079.

2011 (quantitative main study). The questionnaire for the online survey was developed on the basis of gender-sensitive sociological theories, the current status of empirical research, and outcomes from the above-mentioned expert interviews. The survey collected information from the respondents concerning individual, organisational and other factors influencing occupational advancement and it also measured some of their work-related attitudes.

The online survey (field period October 2012 to February 2013) was announced by several relevant scientific societies and professional associations as well as by equal opportunity commissioners of universities, universities of applied sciences and non-university research institutes that employ and/or educate mathematicians and physicists. The National Pact for Women in MINT Careers – 'Go MINT!' also placed an invitation to participate in the survey on its website. In terms of statistical representativeness the findings have to be considered as being approximately representative for mathematicians and physicists who are members of scientific societies or professional associations. Because official statistics usually do not differentiate between mathematicians and physicists, but treat them as natural scientists, our data is extremely valuable and offers the opportunity for an assessment of the interrelationship between gender, the study subject and the actual field of occupational activity.

Even taking into account that the latest German microcensus estimates that there are more physicists than mathematicians in the population, physicists are overrepresented in our sample (Table 1). The distribution of sexes within the study subjects deviates substantially from the distribution in the population insofar as we have, especially among mathematicians, a significantly higher proportion of women. To be sure that gender and not age effects are described, most analyses have to be controlled for age and study subject, because the average age of our male respondents (43.5 years) is higher than that of our female respondents (37.8 years), which is mainly caused by the many young female physicists who took part in the survey. The discrepancy in age is also one explanation for the fact that the percentage of women who are still working on their doctoral thesis is bigger than that of men in the sample. If the percentages of persons with a doctoral degree and those who are still working on it are added, gender differences decrease to 6 percentage points. Referring to the next qualification step, the habilitation (professorial thesis), which in the past was a prerequisite for attaining a professorship at a German university, gender differences among the respondents are more significant: 20.5% of male mathematicians and physicists have finished their habilitation thesis compared to 11.5% of their female counterparts. Since other postdoctoral qualifications are becoming equivalent to the habilitation thesis in Germany, the quota of habilitation theses is losing its significance so that looking at the percentage of men and women who are actually preparing their habilitation thesis does not explain gender inequality in science adequately.

Table 1: Distribution of specific characteristics of the sample (n = 5174) by sex

Characteristics	Men		Women	
Mathematics (study subject)	(n = 254)	47.65%	(n = 280)	52.4%
Physics (study subject)	(n = 3470)	77.8%	(n = 992)	22.2%
Mathematics and Physics (study subject)	(n = 111)	62.4%	(n = 67)	37.6%
Average age		43.5 years		37.8 years
Finished doctorate		72.3%		57.6%
Still working on doctoral thesis		14.2%		23.5%
Finished habilitation		20.5%		11.5%
Still working on habilitation thesis		4.1%		3.6%
Working full time		78.6%		64.5%
Working part time		9.9%		26.0%
Not working		9.8%		4.7%
Actually working in the economy		41.3%		30.3%
Actually working at a university		34.5%		45.2%
Self-employed		12.7%		8.9%
Living together with a partner		72.7%		67.5%
Having children		51.8%		41.0%

The figures concerning the distribution of employment status by sex in our sample are hardly surprising: More men (78.6%) than women (64.5%) are working full time and analogously the share of women with part-time jobs is higher than that of men. The relatively high proportion of men working part time (9.9%) is as a result of the German system of higher education where jobs at universities and non-university research institutes for further qualifications are usually part-time jobs. The distribution of the sample concerning the field of occupational activity shows that about 18.5% of all respondents are currently working at a non-university research institute, but significantly more male respondents are employed in private business (41.3%) than women (30.3%), and fewer of them at universities or universities of applied sciences. The specificity of our sampling procedure finds expression in a) the high proportion of respondents who hold a professorship (19.7%), and b) the fact that no gender difference occurs in this respect. More comparable with the distribution in the German population is the gender-related disparity in the percentage of self-employed mathematicians and physicists, with lower figures for female respondents than for male respondents.

As a result of the age structure of our sample – with 52% of women who are under the age of 36 – fewer women (67.5%) than men (72.2%) are living together with a partner or are having children (41%). A more detailed look into the fertility rates by age cohort shows that women in older age cohorts with a leading position are more likely to be childless than male executives in the same age cohort. Within the group of mathematicians and physicists aged 46 years and older in upper or top management positions only, just 10% of the male respondents (who might still biologically have the possibility of becoming a father) have no children compared to 45% of the equivalent female respondents.

3 Gender disparities in the occupational career

The dependent variable 'occupational career' represents a complex theoretical concept which has to be operationalised for empirical research purposes. In this regard our research project largely follows the career definition of Abele and Wiese (2008), who distinguish between three facets of career success: objective career success (pay, occupational status, promotions etc.), self-referent subjective success (career satisfaction), and other-referent career success (comparative judgement). In particular, objective career success is defined in the literature by verifiable attainments, which have long been considered to be adequate proxies for success and are universally valid (cf. Heslin 2005). However, certain professions offer generally little advancement and in others fixed, performance-independent salaries are paid so that promotions and pay do not always allow a useful comparison of the occupational advancement of two different people; one being employed in the private sector of the economy and the other in the public sector.

Careers in academia, on the other hand, follow different rules to most careers elsewhere in the labour market. Because the majority of implicit assumptions in the career success literature fit the situation in business and the economy, it is important to discover 'objective metrics that are meaningful within particular career contexts beyond the managerial and professional spheres' (Heslin 2005: 114). In the online survey we collected common objective indicators such as length of time from finishing studies to starting the career, and from starting the career to getting the first leading position, occupational status, type of contract, hierarchical level of leading position, number of subordinates, wage and so forth. For a better evaluation of careers in academia, additional indicators, namely, degrees (doctorate, habilitation) and length of time from finishing doctorate to attaining a professorship, have been measured.

Subjective career success is frequently operationalised as either job or career satisfaction (cf. Heslin 2005). Job satisfaction might contribute to career success, but conceptually both constructs are distinct. We asked for job satisfaction to get better insight into the respondents' current employment situation. As an indicator of career success some limitations and disadvantages are also linked with this operationalisation: For example, people who think that they have had a highly successful career until now will not change this opinion even though they might recently have started a job that they find dissatisfying. The question referring to career satisfaction is part of the online survey and was intended a) to obtain information concerning the respondent's subjective perception of his/her occupational development, and b) to correlate this career success indicator with job satisfaction and the objective indicators mentioned above. Both the job and the career satisfaction question represent self-referent success measurements. They inherently take recourse to individual career-related standards or career aspirations. Meta-analysis shows that objective career success and self-referent subjective success are positively interrelated (about 0.30) but not interchangeable (cf. Dette/Abele/Renner 2004). Although these measures generally have acceptable levels of internal consistency, 'such characteristics are not necessarily sufficient to validly assess each respondent's subjective career success' (Heslin 2005: 117). Therefore, Heslin (2005) suggests comparative career success judgements (other-referent career success) by asking for the evaluation of one's own career relative to the outcomes achieved by others or to their expectations. We indirectly followed that recommendation by collecting data on personal experiences of diverse types of discrimination during the working life. This data will not, however, form part of the following description of similarities and disparities in the occupational career of male and female mathematicians and physicists.

The early academic career of male and female respondents in our sample developed in a relatively similar fashion. Among the physicists, about 77% of both sexes were institutionally embedded in research projects or other working groups during their doctoral phase. This applies to only 69% of the mathematicians however. The disparities in terms of publication and lecturing activities during the doctoral phase are greater between subjects than between men and women as well. Physicists are more likely to have published articles and presented papers at national and, especially, international conferences than mathematicians. The time needed to finish the doctoral or the habilitation thesis was found to be the same for both men and women, but physicists of both sexes needed significantly longer than mathematicians for their doctorate. Another subject-related, but not gender-related, divergence occurs in relation to a stay in a foreign country during the postdoctoral period, which is frequently more established in physics (61%) than in mathematics (49%).

After finishing their studies the female respondents in our sample started their career earlier than the male respondents, but it took almost the same time for both sexes to attain a leading position. On the other hand, holding a leading position represents the most significant gender disparity in the occupational development. With regard to the current employment situation more men than women have a leadership role. Additionally, the number of subordinate staff is also higher for leading men than for leading women (Table 2).

Table 2: Gender disparities in career success

Objective and subjective career success indicators	Men	Women
Leading position at current job	48.3%	33.9%
Number of subordinates at current job	39.9 persons	15.3 persons
Permanent contract	67.7%	52.0%
Gross monthly pay (full-time employment)	€5.754	€4.611
Number of career breaks due to parental leave	0.0133	0.1494
Number of career breaks in total (for diverse reasons)	0.0980	0.2226
Self-evaluation of career success (1 = not successful – 5 = successful)	4.03	3.89

Even if controlling for age, because of the positive correlation of age and the likelihood to attain a leadership position, the gender-related difference remains and is more obvious within the older age cohorts. With regard to the study subject we find significantly more physicists (56.1%) than mathematicians (47.3%)

with managerial responsibility. By contrast, the gender discrepancy disappears when the leading level applies to the reference category. Within the group of mathematicians and physicists who actually perform managerial or leading tasks, there are as many men as women in lower, middle, higher and top positions.

Another gender difference, which declines but remains significant when controlling for age, can be reported by looking at the type of contract: 67.7% of men versus 52% of women have a permanent position.

The gender wage gap, mentioned in the introduction, can be confirmed with our data: Even when only those respondents who are working full time are included in the analysis (and we additionally controlled for age effects and the influence of the field of activity), men receive higher pay than women. Conversely, the number of career breaks, which usually has a negative impact on occupational development, is on average higher for women than for men. The measurement of self-referent subjective success shows no significant gender difference in relation to job satisfaction, but does to career satisfaction. Women chose lower scale points than men and, therefore, evaluate their career as being less successful than men. This gender effect is especially marked in older age cohorts, while the study subject seems to be irrelevant in this context.

4 Gender disparities in career planning and the use of career strategies

As career planning and career strategies are – as a result of structural changes in work – no longer restricted to the job entry phase, the way in which employees manage their careers proactively has become of increasing interest in the literature (cf. King 2004).

4.1 Career planning

Based on theoretical assumptions, we have formulated two items to measure career planning. A principal component analysis confirmed that those two variables load on one component and consequently reflect one theoretical dimension so that we were able to construct an additive index. All other indices that will be mentioned in this chapter are also validated by principal component analysis.

Table 3: Gender disparities and similarities concerning career planning and career strategies

Indices measuring career planning and career strategies	Men (Mean) (Std.)	Women (Mean) (Std.)
Career planning	2.149 (0.919)	2.274*** (1.012)
(Academic) visibility (only those working at universities or non-university research institutes)	2.809 (0.916)	2.825 (0.982)
Self-marketing	2.676 (0.775)	2.667 (0.797)
Leading and shaping motivation	3.914 (0.681)	3.878 (0.684)
Socialising	3.472 (0.695)	3.728*** (0.681)

Index scales: 1 = does not apply at all – 5 = strongly applies; *** = significant on the < 0.000 level

The comparison of means (*t*-test) shows that in our sample men and women differ with regard to career planning. Women agree more strongly than men that they have fixed career goals and follow a career plan. This gender disparity is maintained when only the group of respondents with a leading position forms part of the analysis, even though their mean values are higher. Such a finding is interesting because both sexes do not differ in terms of their career aspirations. Moreover, the study subject plays a minor role with regard to career planning practices, but the gender difference within the group of physicists seems to be a little stronger than within the group of mathematicians. This subject-related effect is confounded by the field of occupational activity, which has explanatory power because the large number of men working in private business seems to be actively planning the career significantly less than male and female respondents working at universities or female respondents who are employed at non-university research institutes.

4.2 Career strategies

Making your ideas visible within an organisation or the scientific community involves communicating them in writing and presenting them at conferences, both in national and international contexts. We have operationalised that kind of career strategy by formulating four items that constitute an additive index called '(academic) visibility'. This career strategy seems to have been adopted more in academia than elsewhere in the labour market. Therefore, respondents who belong to the private economic sector have very low index scores on '(academic) visibility' and diverge significantly from those who are working at universities or non-university research institutes. Gender differences within academia appear on the level of detailed group comparisons (analysis of variance, ANOVA) only: female physicists have higher index scores than female mathematicians, while the remaining subgroups are similar in their answering behaviour, so that the less differentiated analysis, which does not consider the study subject (table 3), shows no significant gender-related disparities.

The second career strategy under investigation, 'self-marketing', follows, in our operationalisation, several behaviours which in King's (2004) terminology are similar to either 'positioning behaviours', that is, those concerned with making sure one has the contacts to achieve the desired career objectives, or to 'influencing behaviours', that is, those aiming at actively influencing the decisions of key gatekeepers. The four variables that create the additive index of this career strategy cover facets of self-marketing such as trying to be acknowledged, selling one's own achievements well, and actively seeking out contact with decision-makers both inside and outside the organisation. Among the mathematicians and physicists in our study no gender-related or subject-related differences could be found with regard to use of a self-marketing strategy. Even a differentiation by field of occupational activity did not reveal any variations in the respondent's answering behaviour.

The third career strategy is formed by a collection of three items that measure work-related orientations, such as the importance of being able to shape things within an organisation or to bear responsibility, and behaviours, such as trying to inspire colleagues and superiors with own ideas. This index variable represents a 'leading and shaping motivation' which has to be demonstrated, especially if managerial tasks are the aspired career objectives. Table 3 shows no gender disparity in the use of this career strategy. Both sexes reached the highest index values on this career strategy, which means that agreement with the underlying three items is the strongest compared to other items measuring the other career strategies. The study subject is again of no relevance, although the field of occupational activity is partially: men working in private business seem to exhibit a leading and shaping motivation significantly more than male and female respondents working at universities.

A fourth measurement issue focuses on the strategy of 'socialising' at the workplace, including four items on networking with colleagues, actively taking part in the social life of the organisation, and consulting others or asking them for advice. With respect to this behaviour the data disclosed highly significant gender differences: female mathematicians and physicists seem more likely to practise the career strategy of 'socialising' than their male counterparts. While the study subject has no impact on the use of this career strategy, a detailed comparison of means (ANOVA) with other subgroups shows that the only insignificant gender difference exists between male respondents working at non-university research institutes and female employees in the private economic sector.

If we include another explanatory variable in the analyses and compare respondents with and without a leading position, we find significant differences with regard to every single career strategy and career planning in the expected direction: mathematicians and physicists with leadership responsibilities seem more likely to use career strategies and career planning, but the gender disparities (and similarities) reported for the whole sample remain the same on the level of additive career strategy indices. When looking at the single items that constitute one or the other career strategy index, gender differences sometimes disappear when controlling for leading position.

4.3 The relationship between career planning and the use of career strategies

Career strategies are constructed as distinct dimensions of strategic behaviour to accomplish specific career objectives and are validated by principal component analyses – as mentioned above. Nevertheless, some career strategies occur together with others. The correlations between the career strategies among themselves and referring to career planning are documented in table 4. All correlation coefficients are highly significant, whereby the strongest interrelation exists between the strategy of 'self-marketing' and the strategy of showing 'leading and shaping motivation'. Career planning has moderate to low interdependence with career strategies.

Table 4: Correlations between career planning and career strategies

	Career planning	(Academic) visibility	Self-marketing	Leading / shaping motivation	Socialising
Career planning		Corr. .310*** Sig. .000	Corr. .386*** Sig. .000	Corr. .244*** Sig. .000	Corr. .151*** Sig. .000
(Academic) visibility	Corr. .310*** Sig. .000		Corr. .285*** Sig. .000	Corr. .148*** Sig. .000	Corr. .125*** Sig. .000
Self-marketing	Corr. .386*** Sig. .000	Corr. .285*** Sig. .000		Corr. .474*** Sig. .000	Corr. .362*** Sig. .000
Leading/ shaping motivation	Corr. .244*** Sig. .000	Corr. .148*** Sig. .000	Corr. .474*** Sig. .000		Corr. .278*** Sig. .000
Socialising	Corr. .151*** Sig. .000	Corr. .125*** Sig. .000	Corr. .362*** Sig. .000	Corr. .278*** Sig. .000	

Correlations (Corr.): Pearson's coefficients

Not surprisingly the aspect of socialising and networking at the same status level – instead of cultivating social and professional contact with superiors and decision-makers – has a weak correlation with career planning.

5 The influence of career planning, career strategies and organisational conditions on gender disparities in career success

Two linear regression models (ordinary least squares [OLS]), one with an objective career success indicator (wage), and one with a self-referent subjective success indicator (career satisfaction) as the dependent variable, serve to evaluate whether organisational conditions, career planning, the ambition to climb the career ladder, specific career strategies, or other individual-level influences represent stronger predictors for occupational advancement. Variables that proved not to be significant have been excluded from the analysis. The variables entered in the regression analysis at the beginning are, at the individual level, career planning, ambition to climb the career ladder, the four career strategies presented in chapter 3, gender (male as reference category), age, study subject, doctoral degree, field of activity (university as reference category), children, partnership, number of career breaks and, at the organisational level, the existence of transparent criteria for career advancement, transparent criteria for the judgement of performance, further professional training by employer, further training in soft skills by employer, possibility of gaining further qualifications (i.e. through sabbatical breaks), professional networks, support by superiors, male role-models, female role-models, career counselling by employer, individual career plan developed by employer, childcare services, gender equality measures, flexibility over time, and flexibility over space. The question in the online survey concerning this matter refers to the whole occupational life and not just to the current job, so that we have information on whether the respondents sometimes experienced the listed organisational conditions and career measures.

Table 5 documents the results for the OLS with 'wage' as the dependent variable. Most of the predictors on the organisational level have not been significant. In fact, only the existence of 'further training in soft skills by employer' and 'transparent criteria for the judgement of performance' positively influences career success in this model, although the beta coefficients are very low. Individual aspects, namely, age (being older), (having a) doctoral degree, and (having) a job in the private economic sector are much better predictors with a positive effect on the dependent variable. As expected, being female and having several career breaks has a negative impact on career success operationalised as 'wage'.

Table 5: Regression model (OLS) on objective career success 'wage'

Predictors	Beta	Sig.
(Constant)		.000
Career planning	.052	.002
Career strategy – leading and shaping motivation	.090	.000
Ambition to climb the career ladder	.061	.000
Age	.313	.000
Working in private economic sector	.266	.000
Doctoral degree	.129	.000
Sex (female)	-.061	.000
Having children	.072	.000
Number of career breaks	-.094	.000
Transparent criteria for the judgement of performance	.041	.008
Further training in soft skills by employer	.081	.000

Adjusted R-square = 0.338
Dependent variable: monthly gross wage, measured in euro
Independent variables: scales of career strategies, career planning, and ambition to climb up the career ladder: 1 = does not apply at all – 5 = strongly applies

The regression model also reveals that only the career strategy ‘leading and shaping motivation’ is relevant, with a positive but small effect on career success. The same applies to ‘career planning’ and the ‘ambition to climb the career ladder as high as possible’; and lastly, as a result of the regression model having children has a positive effect on career, which can be explained by our male-dominated sample. In the case of men, having a family is probably judged positively by decision-makers and interpreted as an indicator of stability, trustworthiness and a solid life style.

The results of the regression analysis with the self-referent subjective success indicator ‘career satisfaction’ as dependent variable diverge in some respects from the regression model with ‘wage’ as dependent variable. Firstly, the explained total variance (19%) is much lower. Secondly, the composition of respondents with high values on the dependent variable – namely, those who evaluate their occupational advancement as successful – differs from that of the other regression model, because more mathematicians and physicists working in academia belong to the group of subjectively successful people.

Table 6: Regression model (OLS) on self-referent subjective career success

Predictors	Beta	Sig
(Constant)		.000
Career planning	.046	.012
Career strategy – (academic) visibility	.095	.000
Career strategy – self-marketing	.064	.002
Career strategy – leading and shaping motivation	.171	.000
Career strategy – socialising	.110	.000
Age	.098	.000
Doctoral degree	.069	.000
Number of career breaks	-.145	.000
Transparent criteria for career advancement	.074	.000
Support by superiors	.083	.000
Further training in soft skills by employer	.053	.002
Possibility of gaining further qualifications	.032	.000
Professional networks	-.048	.006

Adjusted R-square = 0.190
Dependent variable: self-referent career success, scale 1 = not successful – 5 = successful
Independent variables: scales of career strategies and career planning: 1 = does not apply at all – 5 = strongly applies

Moreover, respondents at an early stage of their career might be satisfied with their achievements so far, but they do not belong to the high income groups yet.

The altered focus of the career indicator has consequences for the predictors that proved to be significant in the regression model. On the organisational level, the existence of 'further training in soft skills by employer' and 'transparent criteria for career advancement' has a positive but small impact on career success. 'The possibility for gaining further qualifications (i.e. through sabbatical leave)' is an additional positive predictor and extremely relevant in academia where the amount of undisturbed time to write the doctoral or habilitation thesis is decisive for career success. In accordance with this, the 'support by superiors' also represents a positive predictor in the model, and the existence of 'professional networks' in the workplace has a small, but negative, impact. A conceivable interpretation of this phenomenon might be that if an occupational environment is characterised by the existence of influential professional networks, not being part of them (for whatever reason) entails serious consequences with regard to career success; moreover, meritocratic principles are subverted to some extent thus making it more difficult to be promoted on the basis of good performance alone.

Individual influences of relevance in this regression model are age and doctoral degree, whereas sex, field of occupational activity, having children, and career ambition in terms of climbing the ladder as high as possible play no role. Career breaks, on the other hand, again show a negative effect on career success, here measured with a self-referent subjective success indicator. With regard to career strategies 'self-marketing', 'leading and shaping motivation', 'socialising', and '(academic) visibility' are significant predictors with a weak positive effect on career success. Career planning is also positively related to career success but also has very small explanatory power.

To answer the leading questions of this paper and to summarise the results we can a) conclude that career success has to be regarded as a complex theoretical construct and, especially in the case of self-referent subjective success, quantitative methods have difficulty in grasping this construct and explaining for example variances in career satisfaction; b) support (with these and former analyses of the data) the presumption that good organisational conditions are important for employees, even though compared with factors at the individual level their explanatory power for career success is low and often disappears when several individual factors are present in the analysis; and c) confirm that career planning has a positive influence on career success.

6 Lessons to learn for women in science

A crucial finding of our research project is that more female mathematicians and physicists than their male counterparts follow a career plan – even if the level of agreement with career planning is altogether rather low. This gender disparity might give evidence of the positive effects of official attempts to support women in their career ambitions by offering mentoring programmes and suchlike. Such efforts have helped young women in particular realise that career planning can be of assistance to them when it comes to anticipating potential obstacles in their occupational advancement and finding solutions for (often gender-related) problems early in the career. As a result of the currently positive labour market situation in the STEM professions, female mathematicians and physicists can choose whether they want to work in business or in academia, as both fields are looking for qualified young professionals. Yet, regardless of their choice, the female mathematicians and physicists are likely to be confronted with (the challenges of) gendered organisations, which will probably remain gendered in the foreseeable future. This is a hurdle that women have to bear in mind.

On the empirical basis of our survey data, gender differences (in total) can be observed only for one out of four career strategies of which the study subject (mathematics or physics) is of minor importance, while the field of occupational activity is often decisive. Although we have found quite similar patterns concerning the agreement to use certain career strategies within the three fields of occupational activity (private sector, universities or universities of applied sciences, non-university research institutes), the level of agreement differs. It appears as though the use of ‘self-marketing’ strategies and ‘leading motivation’ in business is regarded more favourably, while ‘(academic) visibility’ must be sought in academia. In consequence, women with career ambitions in science may be advised to learn as much as possible about the rules that are shaping the field of academia and adapt their career strategies accordingly. Because some scientific disciplines are inherently more ‘masculine’ in their structure, epistemology and methodology than others (cf. Blickenstaff 2005), career paths in these disciplines may be even more challenging for women, despite the fact that past experience has indicated that science can be improved by broadening the diversity of its practitioners across gender and ethnic lines.

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The German Business Enterprise Sector: Career Paths in Research and Development (R&D)

Sabrina Weber, Constantin Wiegel, and Ulrike Busolt[1]

1 Introduction

This contribution discusses aspects of career paths in research and development (R&D) in the business enterprise sector in Germany.[2] Women are underrepresented in the fields of Science, Technology, Engineering, and Mathematics (STEM) and this is especially true for the business enterprise sector in European countries (European Commission 2013a). Germany is one of the most robust economies in the European Union and performs well in terms of research and innovation. The country has high scores on both input (such as R&D human resources) and output (such as patents) factors (BMBF 2012; European Commission 2013b: 108-117; European Commission 2003b; cf. Figures 1 and 2).

However, there is an urgent need to make more efficient use of the female 'innovation potential' (EFI 2013: 9) to maintain and strengthen Germany's leading position in innovation (Deutsche Telekom Stiftung 2012: 6; EFI 2013; European Commission 2013b: 110). The German labour market is characterised by a high degree of both vertical and horizontal gender-related segregation. Women are underrepresented in leading positions and in certain fields, foremost in STEM (cf. the volume by Achatz (2010) for different dimensions of gender inequality in German companies; Schreyer (2008) for the STEM fields; BMFSFJ

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2 We present findings from a research project analysing female (and male) patenting activity and career paths in R&D in the German business enterprise sector. Running from 2011 to 2013, the project STAFF (Aufstieg und Aufenthaltsdauer von qualifizierten Forscher/innen in Forschung und Entwicklung) is funded by the Federal Ministry of Education and Research (BMBF) and the European Social Fund (ESF) under project numbers 01FP1121 and 01FP1122.

B. Thege et al. (eds.), *Paths to Career and Success for Women in Science,*
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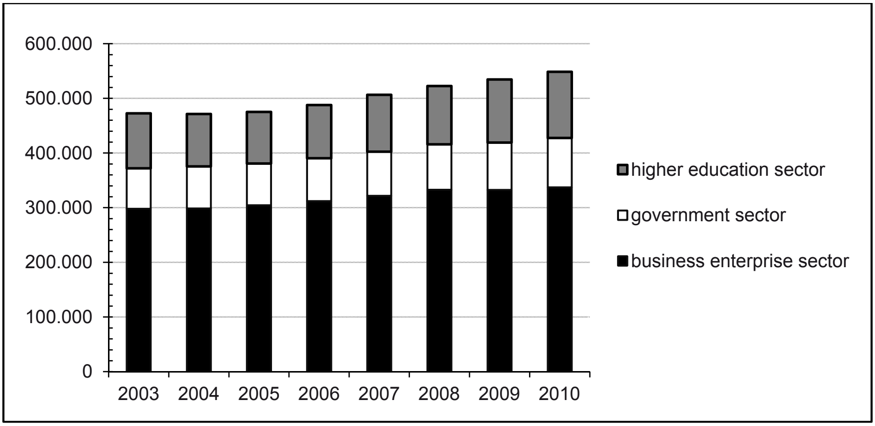
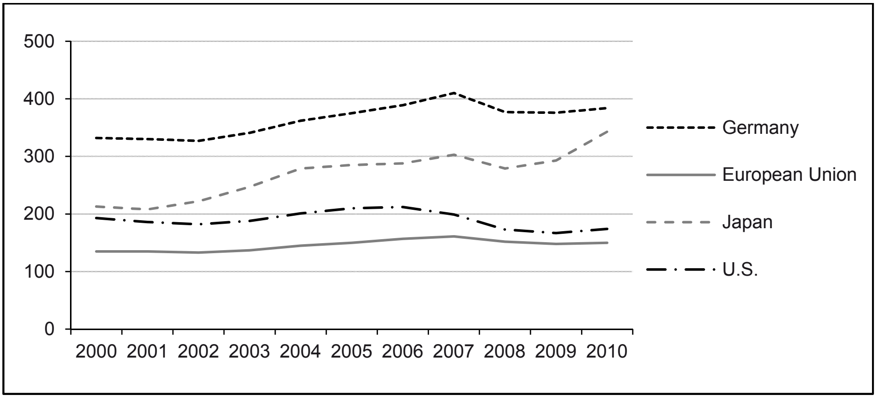
(2012) for gender inequality in education and working life in a life course perspective). Our focus relates to a specific group in the German labour market: women employed in research and development (R&D) in the business enterprise sector.



Note: Full-time equivalents.
Source/data: BMBF's Data Portal; own compilation.

Figure 1: R&D staff in Germany, by institutional sector

Central quantitative indicators to measure innovative power include *resources* (such as R&D expenditure and human resources, e.g. the number of researchers in a given country or industry) and *output* (such as the number of publications and the number of patents applied for). In the business enterprise sector, patents constitute one of the most important measurable outputs in the high and medium-technology industries (whereas, for example, in universities, publications are a much more important indicator). In this context, female researchers and female inventors became more and more a matter of particular (and public) interest (cf. European Commission 2003a; 2003b; 2006; 2009b for an overview). We will focus on researchers with a background in STEM and researchers are also potential inventors. In this contribution, we define inventors as persons who have been involved in a patent application to the European Patent Office (cf. section 2).



Note: Patent applications at EPO (European Patent Office) or WIPO (World Intellectual Property Organisation). Source/data: BMBF's Data Portal; own compilation.

Figure 2: Transnational patents per one million citizens

The article proceeds as follows: The next section will present some data on gender in research and innovation in the European Union. Section 1.2 will turn to the business enterprise and briefly discuss some characteristics. In section 2, we will present some data on female inventors in the European Union and in Germany, before we turn to the situation of R&D staff in selected industries in the German business enterprise sector. Section 3 focuses on the attitudes and expectations of STEM students concerning a career in R&D. We will then conclude by giving a brief overview of the implications and lessons to be learnt by women scientists.

1.1 The gender gap in science: researchers in the European Union and Germany

The most recent data available for gender and research and innovation in the European Union show country-specific and sector-specific gender gaps. In 2009, women represented 25% of all researchers in Germany, that is, in the higher education sector, the government sector and the business enterprise sector. Except for Luxembourg, where women represented only 21% of all researchers, Germany is at the bottom end of the EU-27, where on average one-third (33%) of all researchers is female. When taking a closer look at the different institutional sectors, the data indicate sector differences. Whereas women account for 35%

of researchers in the higher education sector in Germany (EU-27: 40%), this share decreases to 32% in the government sector (EU-27: 40%) and ends up with 13% (EU-27: 19%) in the business enterprise sector. Overall, compared to EU-27 countries, Germany performs below average (European Commission 2013a).

Furthermore, data for the higher education sector and the government sector indicate that women are under-represented in leading positions in research, and females are likely to encounter a 'glass ceiling' (European Commission 2013a: 86 et sqq.). Moreover, and related to this finding, female researchers are more likely to work part-time (European Commission 2013a: 40). Overall, gender imbalances increase with age and therefore a 'generation effect' (European Commission 2013a: 97) becomes apparent in the research population.

In sum, gender in research and innovation is characterised by vertical as well as horizontal segregation. There are some general patterns but also sector-specific and country-specific characteristics. The focus here is on the business enterprise sector in Germany.

1.2 Research and development in the business enterprise sector

Within the business enterprise sector gender-specific differences by industry exist. The percentage of female researchers is much higher in the chemical and pharmaceutical industries than in the engineering industries (European Commission 2009a: 62). Consequently, female inventors, that is, female researchers who are engaged in developing and filing a patent, are most present in the chemical and pharmaceutical fields. This finding holds true for European, US and national patents (cf. Frietsch et al. 2009: 595, Giuri/Mariani 2005: 8 for European patents; Greif 2005: 39 for national (German) patents; Ejermo/Jung 2012 for European patents by Swedish inventors; Mauleón/Bordons 2010 for national (Spanish) patents; Guzmán 2012 for US patents by Mexican inventors; Hunt et al. 2012 for US patents). Overall, these analyses of patents and inventors reveal a rather low percentage of female inventors in patenting. Reasons for this finding might be related to individual circumstances, such as parenthood (Whittington 2011), but also to organisational structures (Whittington/Smith-Doerr 2008).

The Organisation for Economic Co-operation and Development (OECD) provides international definitions in the area of research and innovation. Research and innovation can take place within three broad institutional sectors, the higher education sector, the government sector and the business enterprise sector

(OECD 2002). The business enterprise sector, which is our focus here, is defined as 'all firms, organizations and institutions whose primary activity is the market production of goods or services (other than higher education) for sale to the general public at an economically significant price'. It also includes '[t]he private non-profit institutes mainly serving them' (OECD 2002: 54).

R&D staff is defined as '[a]ll persons employed directly on R&D […] as well as those providing direct services such as R&D managers, administrators, and clerical staff' (OECD 2002: 92). R&D staff can therefore be further divided into three groups of R&D personnel:

- *Researchers* – 'professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned' (OECD 2002: 93).
- *Technicians* – 'persons whose main tasks require technical knowledge and experience […]. They participate in R&D by performing scientific and technical tasks involving the application of concepts and operational methods, normally under the supervision of researchers' (OECD 2002: 94).
- *Other* (supporting) staff – 'skilled and unskilled craftsmen, secretarial and clerical staff participating in R&D projects or directly associated with such projects' (OECD 2002: 94).

Typically, researchers are university graduates in the fields of STEM, overwhelmingly engineers and natural scientists. We are mainly interested in this group as they represent the 'core' group or main pool of human resources in R&D. Patents are mainly generated in R&D; therefore the low numbers of female inventors might be associated with either a low number of female researchers in R&D or with a short time span among females working in R&D. In terms of career paths, our study therefore includes a vertical dimension ('up', career advancement in R&D) and a horizontal dimension ('out', career continuation outside R&D). In the business enterprise sector, patents are usually a result of team work in R&D (e.g. Greif 2005). For career advancement in R&D or the promotion to top positions in the high-technology and knowledge-intensive industries, good patenting performance is indispensable.

An earlier study[3] by our research group focused on working conditions and cultures in R&D departments. These include a culture of long working hours and

3 Running from 2009 to 2011, the project EFFINET (Effizienz und Innovativität von homogenen und heterogenen Erfinder/innen-Teams) was funded by the Federal Ministry of Education and Research (BMBF) and the European Social Fund (ESF).

a need for overtime work in order to be able to pursue patent activities in many R&D departments. Our findings indicate that women often state a decrease in their innovativeness when becoming a mother. The burden of work–family conflict is still largely imposed on women. Women have to balance their professional work and care work (child care but also eldercare) which is often accompanied by time conflicts. This double debit directly affects their time resources in terms of patenting and an R&D career. Innovation management and human resources management that take issues of work-life balance into account may soften such conflicts to a certain extent (Schone/Kellermann/Busolt 2012). Moreover, recent data for the year 2010 indicate that both male and female researchers in the European Union were more likely to have children than the rest of the working population. This also holds true in the case of Germany (European Commission 2013a: 100).

2 Female researchers and female inventors in Germany

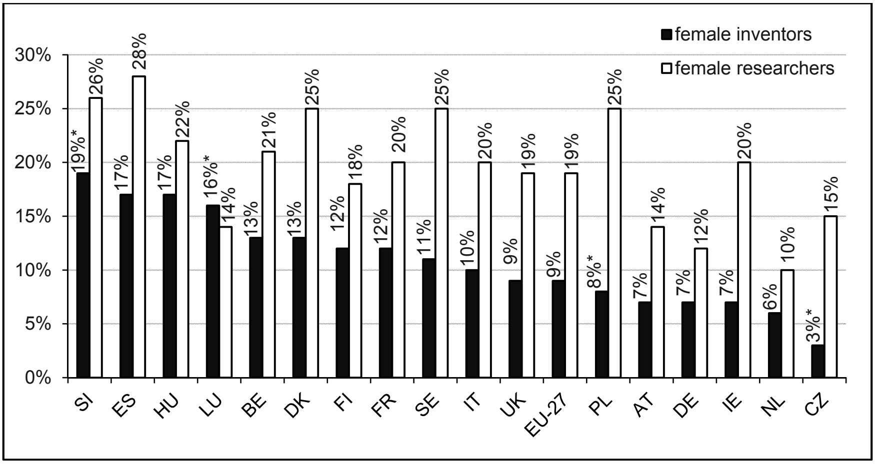
In this section, we address gender-specific aspects of patent activity and employment in R&D. We present descriptive statistics for (female) inventors and (female) R&D staff and (female) researchers in the business enterprise sector with a focus on Germany.

2.1 Gender-specific statistics on inventors

For gender-specific statistics on inventors, we use data based on European Patent Office data (Du Plessis et al. 2009; Magerman et al. 2009; Peeters et al. 2009). The data in the following section refer to the priority year 2006, which was the first date for filing a patent application to protect an invention. For the year 2006, our sample includes 131 430 inventors and 51 534 patents.

The European Patent Office does not register inventors' gender. Therefore, our research group applied elaborated gender assignment procedures to the patent data and were thus able to provide gendered patent statistics. Drawing on data provided by the European Patent Office, statistical analysis of patents showed that the low percentage of female researchers within the EU Member States is accompanied by an even lower percentage of female inventors (Busolt/Kugele 2009).

Figure 3 illustrates the percentages of female researchers and inventors in selected countries of the EU-27 in the business enterprise sector in 2006. Country assignment refers to inventors' residential address, not nationality. It has to be noted that success rates in gender assignment by applying country-specific first name databases (developed by Italian researchers, cf. Naldi/VanniniParenti 2002, plus further developed own databases) vary between countries.[4] For Germany, there is a high success rate in gender assignment by first name: for the year 2006 (cf. Figure 3), 99% of the names in the database could be classified as either male or female.



Note: Head count. *caution n < 30. 100% correspond to male and female inventors/male and female researchers. Researchers – exceptions from reference year 2006: DK, DE, IE, LU, NL, SE: 2005.
Source/data: Eurostat; own calculations.

Figure 3: Female inventors and researchers in the business enterprise sector, 2006

In the EU-27, the percentage of female inventors is 9%, whereas overall 19% of researchers in the business enterprise sector are women. As mentioned earlier, it is assumed that researchers constitute the main human resource pool for inventors. The figures for the United Kingdom correspond with the EU-27 average. Germany, however, is again below the EU-27 average. Only 7% of inventors of European patents in Germany are female.

4 For example, for some middle and eastern European countries, there are success rates below 70% of names in the database. These cases are excluded in Figure 3.

Additionally, we focused on the percentages of female inventors in the EU-27 and selected institutional sectors in Germany. Our data for the year 2006 indicate that the share of female inventors in the German business enterprise sector (7%) is half as much as in the higher education sector (14%). In the EU-27, the percentages amount to 9% (business sector) and 20% (higher education sector).

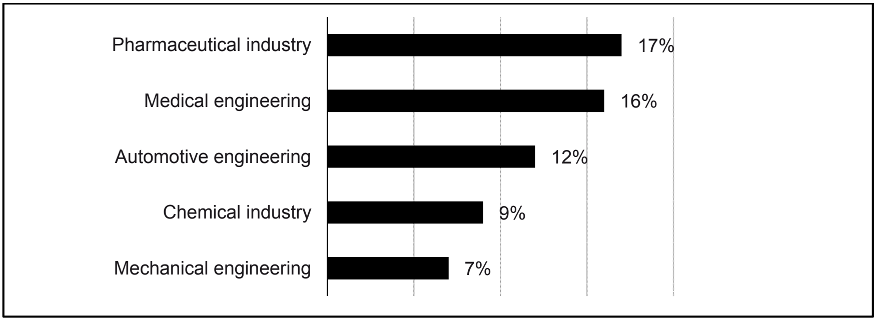
2.2 Industry-specific analysis of R&D staff

The data presented in the following arose from a special evaluation for our project by Stifterverband, the business community's innovation agency for the German science system. Stifterverband's 'R&D survey' includes 30 000 research-oriented companies. We selected five medium-high technology industries that are of great innovative and technological importance for Germany as a business location (European Commission 2013b: 108): automotive engineering, the chemical industry, the pharmaceutical industry, and mechanical and medical engineering.[5]

Figure 4 shows the R&D intensity of the five industries in terms of R&D staff in 2009. The percentage of R&D staff as a share of total staff is highest in the pharmaceutical industry (17%), followed by medical engineering (16%) and automotive engineering (12%). In the chemical industry (9%) and in mechanical engineering (7%), R&D staff accounts for less than 10% of the total staff.

As indicated above, R&D staff include three occupational groups. Figure 5 illustrates the findings for selected industries in Germany for 2009. The percentages of women among total R&D staff are highest in the pharmaceutical (48%) and chemical (40%) industries. In medical engineering, 15% of R&D staff is female, followed by mechanical engineering (13%) and automotive engineering (11%).

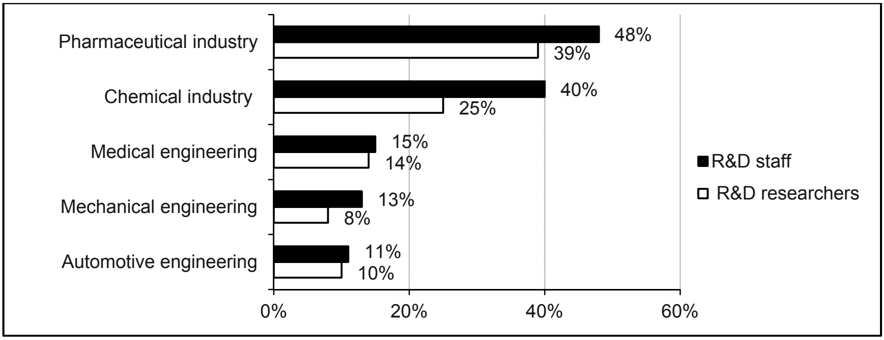
5 The five industries have been defined in accordance with the European statistical classification of economic activities (NACE Rev.2) as follows: chemical industry (C20), pharmaceutical industry (C21), medical engineering (C26.6), mechanical engineering (C28), automotive engineering (C29).



Note: Full-time equivalents. 100% correspond to total R&D staff.
Source/data: Stifterverband; own compilation.

Figure 4: Percentages of R&D staff in German industries, 2009

The white bars in Figure 5 illustrate the share of female R&D *researchers,* ranging from 8% in mechanical engineering to 39% in the pharmaceutical industry. The sharp drop in share from R&D staff to R&D researchers in the pharmaceutical industry (9 percentage points) and particularly the chemical industry (15 percentage points) could be explained by a high proportion of women in the occupational group 'technicians' (e.g. laboratory assistants) in these industries.



Note: Full-time equivalents. 100% correspond to female and male R&D staff/to female and male R&D researchers.
Source/data: Stifterverband; own compilation.

Figure 5: Female R&D staff and researchers, German business enterprise sector, 2009

The figures rely on full-time equivalents (not head count), that is, part-time work is counted proportionally.

2.3 Summary

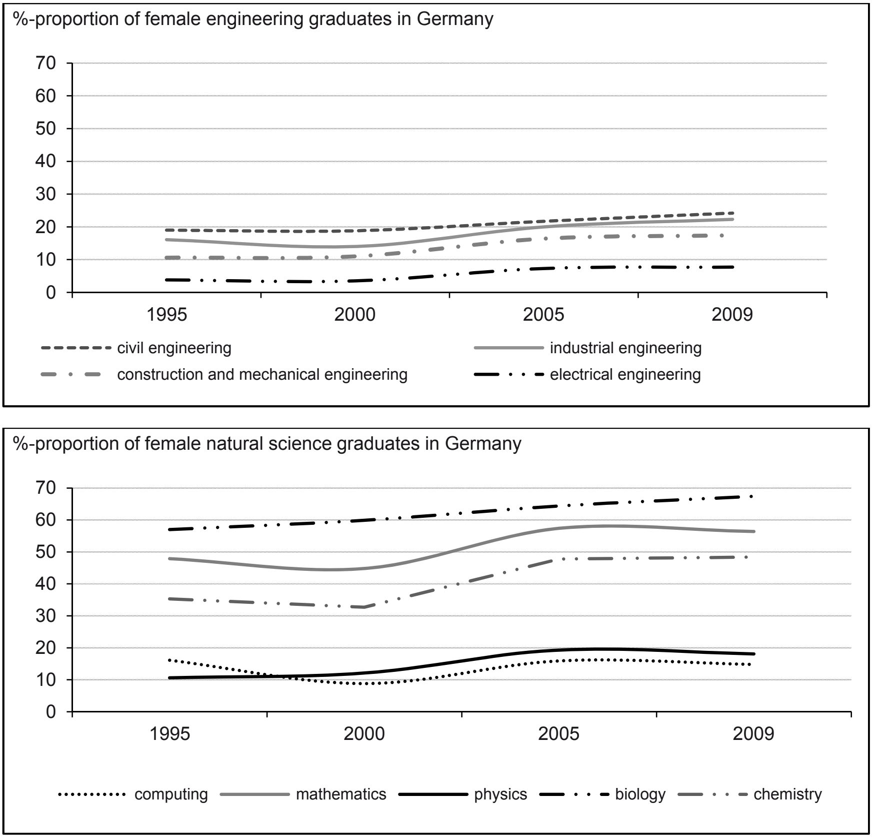
In sum, the data presented above illustrate that there is a gender gap relating to inventors and researchers in the business enterprise sector in Germany. When focusing on the situation in different industries, an industry-specific gender gap relating to R&D staff is revealed. Women have a higher presence in industries such as the pharmaceutical and chemical industries. The share of female R&D staff is much lower in medical engineering, mechanical engineering and automotive engineering. However, when it comes to the ‘core’ R&D personnel group, *researchers,* compared to the overall share of female R&D staff, the gap is much narrower in these industries than in the pharmaceutical and chemical industries. Here, the R&D personnel group, *technicians,* could account for the relatively high percentage of women in overall R&D staff.

What are the reasons for the under-representation of women in R&D, especially in the ‘core’ personnel group of R&D *researchers*? Do female researchers tend to leave R&D – or do female and male STEM students already have different career orientations with regard to working in R&D? The next section will present the findings from our survey of STEM students.

3 Online and paper-and-pencil survey of STEM students

In the fields of technology most inventors and researchers in R&D are professionals in engineering or natural science-related disciplines. In Germany, the proportion of female university and high school graduates differs a great deal. Although the proportion of female graduates has increased (slightly) during the past 15 years, engineering subjects are male dominated (cf. Figure 6). For example, the proportion of female graduates in 2009 in industrial and civil engineering was 24 and 22% respectively. The lowest female rate is found among electrical engineering graduates. The gender proportion among graduates in the natural sciences is mixed. In Germany traditionally more females than males study biology and mathematics and this trend increased between 1995 and 2009. During this period the proportion of female graduates in chemistry increased by 15 percentage points to nearly equal the number of male graduates (52%). In other subjects, for example physics and computing, the proportion of female graduates remains static at a level below 20%.

However, these data indicate that the pool of potential women working in R&D differs among the engineering and natural science disciplines, but does not shed light on the unequal proportion of female inventors among females working in R&D. To investigate whether this might be caused by gender-specific differences in job preferences we conducted a study among STEM students.



Source: OECD 2013, own calculations.

Figure 6: Female graduates in engineering and natural sciences, 1995–2009

3.1 Design and methodology

To interview STEM students we conducted online and paper-and-pencil interviews. We interviewed approximately 210 students at a technical university and a university of applied science by using paper-and-pencil interviews. Additionally, approximately 130 students from other universities were interviewed using computer aided web interviews (CAWI).

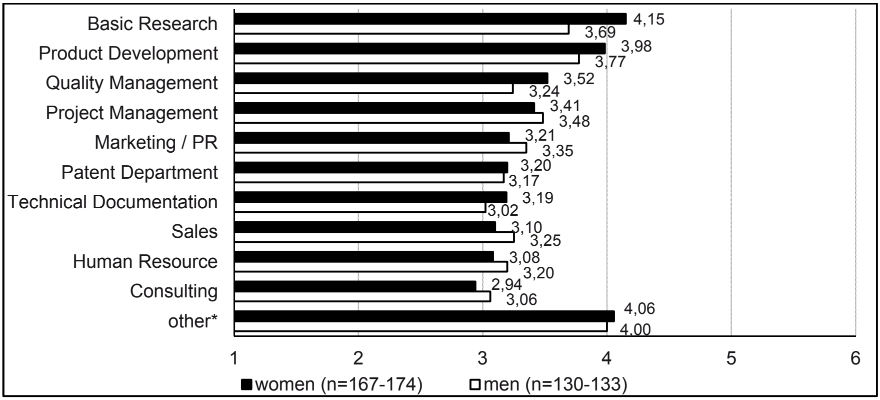
In sum, 335 students took part in our survey. The majority of the participants were studying at technical universities or universities of applied science (each 36%), while the other 28% were studying at other universities. The gender composition of our sample is nearly equal (56% females, 44% males). In addition, 46% of the respondents were younger than 22 years at the time of the interview, 48% were between 22 and 26 years and just 6% were older than 26 years. In line with the relatively young students, more than the half of the respondents were studying for a bachelors degree, while 23% were studying for a master's degree (other: 24%). The highest proportion of our respondents was studying at a faculty of mechanical engineering (52%) or at a faculty of natural sciences (20%).

In our survey we asked 15 questions about personal job preferences and individual plans according to future careers. To analyse significant sex differences we conducted *t*-tests for independent samples. In the following sections we will present some selected results.

3.2 Occupational areas

In order to ascertain the attractiveness of several occupational areas for graduate STEM students we asked the following question: 'How much would you enjoy working in the following fields – directly after graduating?'. Answers could range from values 1 (not at all) to 6 (very much).

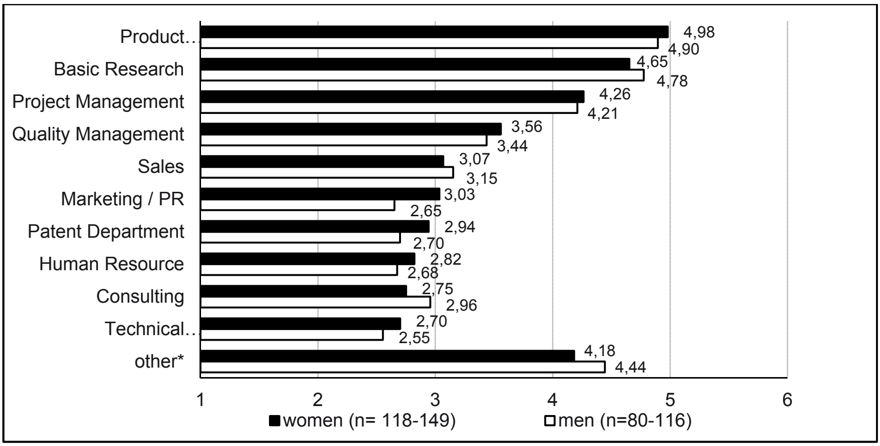
As illustrated in Figure 7, occupational areas which are closely related to R&D (basic research, product development) are very attractive to students for job entry, independent of sex. The higher preference of women to start their career in basic research is statistically significant at a level of $p < .05$.



Note: n for each item varies due to missing values; * caution: n < 30

Figure 7: Preferences about students' occupational area after graduation

We asked the same question in order to explore long-term preferences about occupational areas 10 years after graduation ('How much would you enjoy working in the following fields – 10 years after graduating?' – cf. Figure 8). In line with the first question, product development and basic research remain attractive fields for working in 10 years after graduation. Preferences to work in marketing/PR, the patent department or in human resources are somewhat higher for



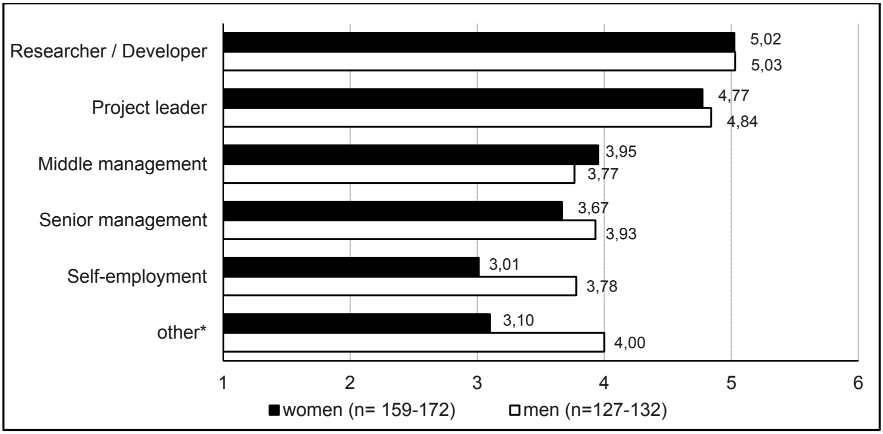
Note: n for each item varies due to missing values; * caution: n < 30.

Figure 8: Preferences for students' occupational area 10 years after graduation

females than males. However, only the difference according to marketing/PR is statistically significant at a level of $p < .05$.

3.3 Career orientation

We were also interested in students' career orientation, thus asking 'How much would you enjoy working in the following job positions – ten years after graduating?' (cf. Figure 9). This question yielded information on hierarchical job positions. Again we used a 6-point rating scale and answers could range from 1 (not at all) to 6 (very much).



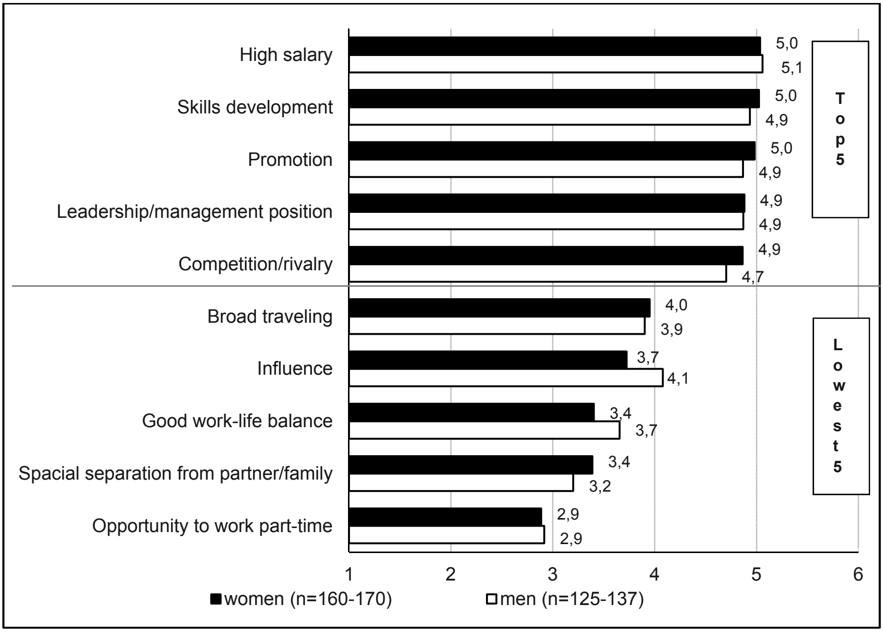
Note: n for each item varies due to missing values; * caution: n < 30.

Figure 9: Students' career orientation – 10 years after graduation

In line with the high preference to work in product management or basic research 10 years after graduation, positions as a researcher or project leader are most attractive to the STEM students in our sample. Females have a slightly higher tendency to prefer to work in middle management, while males, in contrast, have a greater preference to work as a senior manager 10 years after graduation. However, it has to be noted that those differences are not statistically significant. Significant differences between female and male respondents could be proved only for being self-employed ($p < .05$).

3.4 Career characteristics

To understand STEM students' beliefs about a career, we asked 'Which characteristics do you affiliate with 'career'? We asked them to rate 18 different characteristics that are often linked to what is meant by a 'career'. Again using a 6-point scale the students could rate every item by answering between 1 (not at all) and 6 (very strong). For clarity purposes only the highest and the lowest rated characteristics are shown in Figure 10.



Note: n for each item varies due to missing values.

Figure 10: Career characteristics (top 5/lowest 5)

Regardless of sex, STEM students associate monetary aspects (high salary), enhanced job-related skills (job development), and a high occupational status (promotion, leadership) with 'career'. In addition, competition or rivalry among employees is rated as among the five highest characteristics. Less strong, the students in our sample associate broad travelling as an inherent part of a career. Males also show a stronger tendency than females to relate to having influence on others when having a career (statistically significant at $p < .05$). For both sexes, a career orientation is seen as less compatible with good work-life balance or the opportunity for part-time work. However, separation from partner or family is not expected to be related to having a career.

3.5 Summary

In sum, our survey results indicate no gender-specific effects that would allow for an explanation of the relatively low proportion of female inventors among females in R&D in terms of different career preferences or expectations. Working in R&D (in particular product development and basic research) was found to be very attractive for both female and male STEM students. This holds true both for job entry and in the long term (10 years after graduation). Again, unrelated to gender, the students in our sample wished to do project work-related work 10 years after graduation (as a researcher/developer or project leader) rather than be in a management position (middle or senior management). This could be seen as a relatively moderate career orientation in STEM students. However, data obtained from students of other subjects would be necessary to prove this assumption.

Our respondents associate a hierarchical position, developed skills and a high salary overwhelmingly with a personal career. Additionally, competition and rivalry among colleagues was also rated among the top five associations. Furthermore, males associate influence over others more strongly with career than females do. From students' perspective a career is only weakly associated with flexible work models or a good work-life balance.

4 Conclusion

The field of research and innovation is characterised by both vertical and horizontal gender-specific segregation. In our article we presented findings from a research project analysing female (and male) patenting activity and career paths in R&D in the German business enterprise sector.

Our data on female researchers and inventors in various industries indicate a gender gap concerning inventors and researchers in the German business enterprise sector. Additionally, in the chemical industry, the pharmaceutical industry, medical engineering, mechanical engineering and automotive engineering, an industry-specific gender gap in R&D staff is revealed. Women are particularly under-represented in the core personnel group of R&D researchers. Updated analyses of patent data provided by the European Patent Office showed that this gender-specific researcher gap is accompanied by an inventor gender gap.

However, the findings from our STEM student survey indicate that this gap cannot be explained by different motivations to work in R&D or different career ambitions between female and male students. There is evidence to suggest that the gender-specific researcher and inventor gap is a result of organisational barriers and gender segregation in R&D. Further research is needed to investigate these mechanisms in more detail. Although there is agreement that innovative power could be and should be strengthened by achieving more (gender) diversity, concrete steps have to be taken at different levels to reach this goal. In the following section, we address implications for individuals.

5 Lessons to learn for women in science

What can women learn from the research for their career development in science? As the study results of our investigation of STEM students show, there are no significant differences in career preferences among females and males. For both, working in R&D is highly favoured for beginning a career, as well as for working in over a longer period (e.g. 10 years after graduation). In consequence, we do not believe that individual preferences or job expectations among career entrants result in the low proportion of female inventors among females working in R&D. However, further research is needed to focus on the transition from graduation to job entry and to ascertain whether this transition affects the job preferences of graduates in STEM.

Furthermore, job and career conditions in R&D have to be explored in terms of their function in interacting with the duties of females outside their jobs (e.g., household, childcare). Accordingly, enabling factors should be applied that maintain the work enthusiasm of female STEM students and their aspirations. Organised professional networks (e.g., alumni networks) may help female graduates to stay in contact and to exchange information relating to employers and organisations that provide access to a positive personal career.

Moreover, our findings indicate strong industry-specific gender gaps within the R&D workforce. The share of female R&D staff is much lower in medical engineering, mechanical engineering and automotive engineering than in the chemical and pharmaceutical industries. In these fields activities such as networking and mentoring are of particular importance to support women working in R&D. Last but not least, more women are needed to function as role models in order to attract more women into these male-dominated fields, thereby increasing the share of women.

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Black Girls are from the Future: Blogging as a Gateway to Information Communication Technology and Enterprise Development

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> *'Black girls are from the future! Looking at old school African and Harlem Renaissance pictures I see people who look like me who did amazing things that so few people know, I can do more' (Olivia, 27).*

1 Introduction

This paper is an affirmative exercise, set within African feminist discourse. Through ethnographic research I attempt to ascertain if and how bloggers interested in 'natural'[2] hair upkeep optimise information communication technology (ICT) to share knowledge and add value to technologically mediated and entrepreneurial endeavours.

The internet, computers and mobile technology are arguably the most prominent vehicles of innovation in the twenty-first century. ICTs are advancing at an incredible pace, with the numbers of device options and packages offered by different service providers growing to meet mounting consumer numbers and needs. The ranks of innovators are also expanding together with the tools they have come to work with; this number is, however, arguably unrepresentative of the global population. Whilst on the one hand we are witnessing great advances, on the other many parts of the world have inadequate access to computers and poor connectivity, and this is compounded by restrictive social norms which hamper access to ICT for many, especially in developing countries.

The large majority of the excluded often find themselves at the adverse junctures of class, gender, geography and race. We have not witnessed the

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2 The term 'natural' is contested in this regards and is used loosely to refer to African hair where minimal or no heat or chemicals is used to straighten.

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growth in numbers and influence of women in ICT; African women in particular are at the margins of the ICT landscape, barely represented. It would, however, be misleading to ignore the advances made by a few women who have cracked the proverbial ceiling. These advances are, however, not only in the spheres of formal employment or academic institutions.

2 Objectives of this study

This study of 'natural' hair blogs is part of an ongoing attempt to elucidate the benefits of bandwidth with a view to increasing access for and use by African and Diaspora females. The use and negotiation of social-technical capital takes centre stage in this critique. I seek to develop some measure of understanding about the ICT activities and needs of young African women with a view to gaining insight into potential ways to increase the interest and participation of women at all levels of ICT practice. I will then capture the best practices that can be replicated or adapted.

In the South African context, James and Smith write that 'only 0.9 percent of IT industry managers are African women with coloured and Indian women accounting for 0.6 percent and 1 percent respectively' (James/Smith 2006: 3). They also contend that the ICT industry is losing the 'richness and diversity of thought and perspective and can help alleviate the shortage of skills, which is exacerbated by [women's] lack of participation' (James/Smith 2006: 4). It is in view of this that I sought to document the cyber-exploits of African women in the domain of 'natural' hair blogging. Acknowledging the advantages these women have, the geographic differences and their distinctly middle-class positions as a first step, my goal was to record technical skills and their use to further entrepreneurial ventures. I did this in response to the question: How do African women on the continent as well as in the Diaspora maximise use of ICT and promote entrepreneurial activity through their blogging activities?

3 About blogs

A weblog is 'a cross between a bulletin board and an online community' (Oxford Reference 2010). It is composed of text, photographic and video posts intended to draw attention to particular subjects as well as provide platforms for discussion. Blogs are thus the amalgamation of new social medial and integrated media forms. They can be used to record, document, preserve, and safeguard and (re) produce knowledge.

Weblogs provide their authors with a personal space and, simultaneously, with a community space. They combine monologue and dialogue. Having communal and dialogic aspects (O'Donnell 2006: 9) they serve the individual and the blog community. Through interaction, I observed recurring themes, ways of interaction and varying uses of cyberspace.

Blogging has emerged as a sphere of communication through which ICT skills can be disseminated and interest garnered. ICT has been deployed in areas where women dominate through the production of content and by promoting media or products targeted at women with particular interests. I realised this when I ventured into the world of web logging in the pursuit of knowledge to tackle my seemingly impossible mane. Google searches and increasingly prominent threads led me to a plethora of pages devoted to the theme. I found spaces that engaged the political economy of a growing multibillion dollar hair product industry and actively rejected monolithic conceptions of the experiences of black women. In them I found multiple 'voices that curl the straight edges of history' (Mashile 2005: 7), rebuking linear conceptions of black womanhood. The 'natural' hair blogosphere consists of women in various occupations 'by day'; economists, actresses, housewives, nurses, students, fashion designers, graphic designers and entrepreneurs to name a few. Some blogs begin with a focus on the sharing of hair techniques but diversify that focus to include fashion, health, politics and other areas of interest.

The choice of analysing 'natural' hair blogs was partly informed by my experience of them as places of 'psychic safety' (Gqola 2009: 4) for black women; places where aesthetics and ultimately identity are asserted and affirmed. I do not argue that the practices seen on these blogs are unique to them, but merely propose that we learn from this particular space.

I argue that, as Resnick says, socio-technical capital matures in networks, and apply this to the networks found in 'natural' hair blogs. Given that hair is loaded symbolic material, that it is the centre of cultural practices and thus vested with meaning and value, it is no wonder that self-stylisation tops the agenda of social networkers and garners much interest. ICT is widely appropriated in self-stylisation; it requires considerable effort to use technology optimally. Some of the practices I found included photography, enhancement of pictures and uploading them; recording videos and then editing, mixing and adding music and text captions to them; linking blogs to social network sites including Facebook, Twitter, Instagram and Pintrest, among others; this involves setting up detail-oriented accounts increasingly enhanced by high-tech devices and applications. Attention is paid to the quality of photography and design of logos and templates; in some instances graphic designers are hired to do this work, generating income and expanding networks. Emphasis is placed on acknowledging the creators of work and links to their blogs/websites/social network profiles are often provided. Blogs regularly feature 'style icons' sharing their beauty regimes and endorsing their hair styles and techniques.

I have come to understand that this is not just about visual fixation, but also about expressing aspirations and sometimes even politics, albeit by advantaged individuals. Engendered in stylistic practices are defences and subversions of social constructions of beauty, style and ultimately representation. This is projected on social media platforms, where web pages are devoted to the refutation of beauty stereotypes. A cyber niche for these blogs has been carved by years of collective suffering under the labyrinth of the beauty myth by black women who have collectively spent decades chemically treating and hot-ironing hair into submission, being on the short end of 'racism's bipolar codification of value' (Mercer 1987: 35). The devaluation of a distinctly African aesthetic has provided the incentive for a booming beauty industry with numerous skin lightening products and hair straightening implements. This features heavily in the reasons given for starting these blogs and participating in their fora. However, this is not a singular position, for some the platform does not hold 'deep' reverence and is just a targeted resource as a blog hosting information on herbal remedies would be for instance. For numerous women these spaces are venerated and this often came up in sensitive discussions on race in particular.

By foregrounding the use of blogs to enhance a characteristic (hair) marked by class, race and gender I saw how practices of subversion and resistance emerge. This refutation of what is deemed 'good hair' involves cashing in on the symbolic currency of hair. By entering the 'natural hair' hash tag on Tumblr (a blog host) or Twitter (where most blogs have accounts) one can see countless pictures, text and videos of hair declaring love for curls. With each re-blog onto one's own blog or dispatch of blog posts to Twitter or Facebook, one uses their bandwidth to endorse the beauty of 'natural' hair. Members of one's own networks are encouraged to read and share these posts. This promotion is one of the reasons blogs were formed. Permalinks or blog-rolls encourage the audience or blog community members to visit other blogs. They add to each other's views and social technical capital at large. They share knowledge on whatever subject they take interest in, building a digital repository of said knowledge, and they circulate each other's work giving it more currency.

4 Challenges

A large body of literature is devoted to the challenges of inadequate access to the internet and the digital divide which inconveniences African women. This is largely due to insufficient disposable income for devices and privatised broadband. Another challenge where resources are available is the lack of time to explore technology and harness skills. For this reason the African continent continues to consume and not produce enough ICT.

Efforts to reverse the situation are hampered by an inadequate body of research to draw from and low retention of women in ICT careers. There is also need for multidisciplinary research approaches to promote broader interest in ICTs. The absence of female role models in the field has also been cited as problematic.

5 Blogging and socio-technical capital

According to Resnick (2002: 247), 'social resources like trust and shared identity make it easier for people to work and play together', as seen in this regard. The rarity of these networks, which one respondent referred to as 'natural swimming against the weave tide' propels individuals to pursue them vigorously. Technological aptitude, I argue, is spurred by recognising and 'cashing in on' socio-technical capital. Socio-technical capital, Resnick (2002: 249) argues, 'provides a framework for generating and evaluating technology-mediated social relations' – and innovation, I add.

Resnick's rationale is an offshoot of Bourdieusian thinking about capital as the 'skills, abilities and resources that allow an individual or group to wield influence and power. In later work Bourdieu recognized the need for an additional form of cultural capital, technical capital, to capture specific skills that a person develops through engagement' with ICT (Brock/Kvansy/Hales 2010: 1042).

Bearers and sharers of knowledge (a dimension of socio-technical capital) have the capacity to do and create more; this because knowledge is produced and enforced through interaction, it inheres considerable resources. Social technical capital is thus a (re)productive resource which can support the building of technical competency.

6 Representation and knowledge production

This study revealed in a new light to me the political economy of aesthetics and their potential to spur activism, nostalgia and enterprise. I was constantly reminded that the internet is a place where subjectivities are (re)produced. Women from multiple backgrounds converge on the web bringing different competencies and challenges.

Blogs become familiar spaces, revisited for more information on a particular subject. Upon joining a blog community, one subscribes to email lists getting a daily, weekly or irregular newsletter. Blogging software also allows for blog posts to be posted immediately to Facebook or Twitter accounts, adding to the blog's web presence. Comments allow for ongoing discussion. Because of the comfort one has in visiting them, the presence of familiar images and their assertive nature make blogs places where active knowledge seeking happens. Along with their ease of use, the desire to increase knowledge and to contribute to it has increased the popularity of blogs.

This project has shown me how a discursive space transcends from communication platform to collaborative exercise. This is all done through the emphasis of feminine and entrepreneurial identities as well as inventive use and expansion of existing knowledge. The subversive nature of blogging extends beyond mobilising around causes or interests; it permits individuals, groups and businesses to expand their intellectual, sociocultural and entrepreneurial horizons.

Often the capacity of agency which blogging permits is understated as one need not enter it through formal education or training. Blogging, I argue, is a significant pathway to the promotion of ICT agency and excellence, as most tools are user-friendly and easily accessible on most computers even if used for limited, intermittent periods – on campuses or in community centres for example. I sought to ascertain then catalogue the tangible gains of blogging; that is, financial accomplishments and the technological knowledge transfer endeavouring to extend them.

7 Innovation

The marriage of hair-weaving, braiding and combing techniques along with the alchemy of mixing oils to make hair remedies with computer wizardry is growing with the demands of women for 'natural' hair care. You Tube channels are matched in number by the growing number of product lines that include 'natural' hair care products. A cottage home industry has arisen to cater to 'naturals', forsaking the hair straightening chemicals dubbed the 'creamy crack'.

Hair butters, oils, conditioners, boosting ingredients like almond oil, shea butter, lavender and aloe amongst others are churned out by the gallon by this growing industry. Many of these products are sold through e-commerce routes, as seen with The Kinky Apothecary (Nigeria) as well as through meet-ups, that is, gatherings where women who ordinarily interact on the web exchange hair tips and potions. They are promoted as sponsors on videos instructing their audiences on how to style their hair in a particular manner. Orders can be taken days before the meet-up allowing the proprietor to make time in schedules that include other businesses, careers, family responsibilities and social activities; this can include filling in online order forms, linking to a resource such as Etsy or a simple inbox message to place an order.

8 Literature review

I looked at, but was not limited to, three broad bodies of literature. Firstly black/African women in ICT; secondly, the uses and benefits of blogging and other social networks, and thirdly, the potential of blogs to promote knowledge transfer as well as enterprise. I found three main approaches of research on black/African women in ICT: women-in-development (WID) approaches, women and development (WAD) approaches, which challenge the notion of women as automated beneficiaries of economic development as assumed in the Women in Development discourse. I also came across gender and development debates (GAD) which acknowledge the suffering of poor men and other marginalised people.

Much research on blogging as a tool for feminist consciousness has been done by Gajjala (1999: 617-637), Haraway (1991: 149-181) and Harding (2006), also focusing on the global South. The Jasmine Revolution also spurred much research. The prevailing internet access and use by middle and upper socio-economic classes surfaced in the literature review and is echoed in findings.

9 Methodology

I purposively sampled 12 blogs with an interest in uncovering the generative potential of blogging as a developmental platform. This was all done through cyber-ethnography (Rybas/Gajjala 2007: 2). I became a member of these blogs and dutifully observed numerous others; I received notifications of blog activity and visited blogs at least three times a week. This meant I had to be wary of my subjectivity and mindful of generalisations; the nature of web-based research as ever transient also warranted caution on my part in terms of research ethics. I was also attentive to protecting some identities and all intellectual property. Apart from conducting in-depth interviews with six African bloggers, I conducted discourse and textual analysis of web pages to deepen knowledge of all the blogs I came across.

I questioned the use and navigation of technology in terms of the programs and software used and the history of ICT use. I also observed the nature and extent of the monetisation of blogs, the effective use of available resources as well as the challenges faced. This brought to light the adaptable nature of the blogging interface and its various tools. This paper emerged as a treatise on the innovative nature and potential of web logging as a means of transferring and creating ICT knowledge. ICT tools are very flexible and usage varies according to the context.

10 Findings

I found similarities in the opportunities available to these women; sound educational backgrounds, the large majority either have or are currently pursuing college or tertiary qualifications. African-based bloggers tended to have access to computers from high school whilst their counterparts have been exposed to computers and the internet earlier. Computers were also not always present in their homes while growing up.

The construction of ICT knowledge as formally acquired and masculine in nature is part of the hindrance to its dissemination and optimal use. The individuals I spoke to had endeavoured to ‘up [their] blogging game’ by arming themselves with an arsenal of technological knowledge as well as learning to use various tools and software. They also noted the increasing ease of use of programs and attempts by industry to appeal to different markets. The drive for individuality and a blog which reflects this in content and quality spurred much innovation and knowledge searching by bloggers. Scholars are so fixated on the exclusion of African women that they miss the innovations and advances made by groups and individuals.

The functions I found bloggers to be adept at include

- creating, editing and distributing audio, video and photographic content
- curating web content and sharing it
- using polling software
- running ‘stores’ online
- producing mini-television programmes
- graphic design
- search engine optimisation.

11 Conclusion

Conducting this research revealed a myriad of possibilities to me as well as the enormous challenge faced in expanding access to and use of ICT infrastructure. Nonetheless, I found that ICT tools like blogs give their users power to negotiate the digital divide and widen spaces. Respondents echoed the literature review in their complaints about universal access to infrastructure, but other suggestions included a curricular focus on computer literacy, capacity building as well as workshops and certification. There has also been little transfer of ‘high-end’ technology skills like programming; as a result the dominance of male programmers or hyper-masculine ‘bro-grammers’ persists. I found both challenges and opportunities, which are listed in Table 1.

Table 1: Challenges and opportunities faced by bloggers

Challenges	Opportunities
Lack of infrastructure and low internet penetration rates linked to slow ICT systems	Creating space for critical discussions where mainstream media do not
Inadequate access to evolving technology	Turning intangible assets (talent, skills, time and products) into bankable assets
Isolation – lack of role models in technological spaces, consumption rather than production of goods and STEM courses are also targeted at male counterparts	Teaching and reaching by organisations and companies such as BlackGirlsCode provide useful models
Lack of early exposure to computers (average age of tech exposure is 15)	Increased ease of use and recognition of blogs by industry
Normative stereotypes and the rise of the male programmer (bro-grammer)	Absorption into economy through entrepreneurship and innovation

12 Lessons to learn for women in sciences

There is a widespread perception that women are consumers and not producers of technology; this myth can be dispelled by using ICT to its full potential. With increasing ease of use of technological devices there is the potential to increase the benefits of research conducted or innovations created.

Many women in the sciences are technologically adept and confident in their specific fields. There is, however, an opportunity to learn more from women in different countries and different disciplines about chosen subjects through social networking platforms such as blogs. ICTs when used to full effect can play a major role in facilitating these discussions. There is a need to adopt interdisciplinary approaches to tackle the problems of unequal access to technology and socio-economic inequality in general. This can boost the role of women in setting the ICT policy agenda and ensure their needs are considered by ICT manufacturers, service providers and researchers.

All girls are from the future; we can master technology and add to its wonders only if given the chance.

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Family Policy in a Global Perspective: Integrating Care Responsibilities with a Career in Science

Dorian R. Woods[1]

1 Introduction

Women are underrepresented in scientific fields, whether it is in the social sciences (Abels/Woods 2013; Ostendorf 2009) or in the natural sciences (Kahlert 2012; Dautzenberg et al. 2011), and one factor in women's slower ability to enter and advance their careers has been the responsibilities of care work at home. Family obligations affect women differently to men, as women spend on average more time caring for children and the elderly. Indeed, across almost all countries women tend to spend at least twice as much time on care work as a primary activity than men, and in some countries it can be up to six times as much (OECD 2011: 3). In this sense, as more women have been pursuing careers, reconciling work and family life has become a bigger (political) issue: bolstering care commitments has been recognised as improving women's opportunities in employment and as a way to support women in scientific careers. Workforce regulations are increasingly allowing both men and women to take off time to care, and governments often have extended programmes and services which help with care, such as child care and flexible time measures in order to reconcile care duties with employment.

This article examines the development of family policy in the last 20 years on an international scale and what implications this change has had for women's integration of family life and their work in science. Family leave policies for the care of children and the care of the frail elderly have been undergoing a global transformation, especially for parents. While work regulations for parental family leave have grown at an incredible pace across nations, some inequality in access can be observed. Also, although parental policies are flourishing, paid leave for elderly care is still in its early stages. This progress in leave regulations

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has several implications for women in science. With advancements in parental leave policies, parents and their employers are more able to predict time away from work, and because of the increase in paternity leave, parents are able to share care for children more readily. These policies reduce some of the precariousness of employment for parents in the beginning years of children's care. However, because (paid) elderly care leave and care supports for the frail elderly are still scant, the careers of women can be in jeopardy if they are faced with elder care responsibilities. These care responsibilities might especially affect women at the later stages of their scientific careers.

This article first explains family policy functions and instruments, and the ways in which family leave programmes are globally comparable. In the next section, I trace the global trends in paid maternity, paternity and parental leave. After examining forms of family leave for the care of children, I analyse family leave for the care of the frail elderly and their consequences for women in science. Country examples of family leave in Germany, South Africa and the US illustrate in more detail the ways in which leave affects women and their career ambitions. Finally, in the last section, I discuss developments in leave for child and elderly care with respect to women in science and their future perspectives in reconciling work and family life.

2 What is family policy?

Generally, family policy is defined as policy which affects families and helps to alleviate their problems. This definition could theoretically encompass all policy because of the wide scope of policy that affects families, although family policy usually describes programmes and services which have direct transformative power to organise a better life for women, men and children (see Woods 2012). Such broad policy entails cultural variety across countries according to the starting points where families find themselves as well as the goals they hold for the future. For example, South Africa focuses its family policy on issues such as poverty, inequality, unemployment, housing, HIV and AIDS, absentee fathers, crime, substance abuse, gender-based violence, teenage pregnancy and 'moral degeneration' (DSDRSA 2012: 22). Goals for family policy for the present German government are somewhat different; the family minister states that policy is meant to support men and women in the fulfilment of their familial responsibilities by giving them the freedom to do this in the best way families see fit. The government presumes that this requires that men and women have equal opportunities to balance family and their careers, and have the possibility to decide how they wish to divide employment and care responsibilities (BMFSFJ 2012: 3).

With this article I narrow the definition of family policy to encompass programmes that help combat overarching problems for families that result from what some scholars have called 'new social risks'[2] (see, for example, Taylor-Gooby 2004). In particular, risks associated with caring activities have been a major issue for family policy. Family policy is especially challenged to help families adapt to the shifting social organisation of care and employment because of these new social risks. Care issues become a challenge in the both the growing necessity of women's employment and women's desire for fulfilment outside the home. Additionally, governments' legitimisation of much of the innovation in family policy rests on helping integrate care with employment. In the narrower sense I thus define family policy as 'a group of social policies that directly or indirectly affect families with respect to their responsibilities due to the care of small children and the frail elderly'. I focus on the challenge of work-life balance measures in family policy because families increasingly face new social risks globally.

Family policy has several instruments, according to Gabel and Kamerman (2006), which can be used to lessen family problems and to help families balance their care and employment obligations:

1. Family allowances
2. Family leave or flex-time measures
3. Benefits-in-kind
4. Other family in-kind services

The first instrument of family allowances usually entails pure money transfers in the form of cash or tax benefits. These are relatively easy to administer and can be either means-tested, universal, or based on specific criteria (such as single parenthood or low-income employment). The second type of family policy in-

2 Social risks describe risks which come from demographic change, such as an aging population, lower fertility rates, changing family forms such an increase of single parent-headed households. Social risks are also said to come from employment change – increased irregular forms of employment, insufficient social insurance because of gaps of unemployment, pressure for a mobile workforce, large-scale unemployment, decline in traditional blue collar labour and union membership, increasing importance of education for employment.

struments are employment leave and flex-time measures which contain regulations set by the government for the workforce. Such rules can address certain kinds of employment and employees or they can apply universally. Leave can also be paid or unpaid, based on work history or types of employment. The third type of instrument is benefits-in-kind services, such as early childcare education, child and elderly care, and home-help services. These are harder to administer than family allowances or work regulations because such services not only need to be funded, but the government is required to set a framework and regulate duration and quality. Other family in-kind services refer to specific supports that might not provide direct caring services, but provide individual supports for specific clientele, such as counselling or information services (for more, see Gabel/Kamerman 2006).

Of these instruments, the second policy mechanism, family leave, can provide comparable data and its expansion can be measured over time more easily than the other instruments listed above. This is because the amounts of payment and the weeks involved are applicable to comparison, even when examining requirements. Comparing leave is easier than comparing family allowances because allowances are distributed for different groups with different goals – so much so, that these policies are prone to have ‘functional equivalents’, that is, policy instruments that are different but are attaining similar results. Leave is also easier to compare than services. Services are largely the hardest to compare globally because of the many variables which make up these policies, such as the professional requirements for those offering the services, the range of hours available, the facilities and regulations for these services, the eligibility for those receiving services, and the actual numbers of these recipients. Measuring services and change in services of one country is dependent on many factors so that a global comparison is difficult. On the other hand, data on family leave has remained stable over time, and will be used as a comparable source for this article. By tracing global developments and explaining differences through case studies, the article considers eligibility, issues of equality, and the implications for women in science at various levels of their career. The country examples of Germany, South Africa and the US present an additional overview of expansions and illustrate differences in inequality.

3 Family leave for parents

Family leave allows an employee a set amount of time away from their employment and guarantees that an employee can come back to his or her job (or its equivalent) after an allotted time. Such policy can be paid or unpaid but most countries have adopted some sort of paid arrangement for various circumstances where a parent might need to take time off from employment to care for a child. These job protections are widespread for parents and maternal leave is the most traditional and readily available type of parental leave. Maternity leave usually contains guaranteed leave for a mother at the birth (or adoption) of her child and subsequent weeks or months of care for the beginning of the child's life. Paternity leave, designated for fathers at the early stages of a child's life, was developed on a global scale later than maternity leave and is often shorter in length. Parental leave as a general term is applied to both mothers and fathers, and it can encompass shared leave at the beginning of a child's life or designate policy in the later stages of a child's life, such as guaranteed time off from work for parents who need to care for a sick (older) child.

3.1 Maternity leave

Maternity leave protects mothers from dismissal from employment after birth and the first few weeks or months of a child's life. As one can see from Figure 1, almost all countries provide some kind of paid maternity leave. There is a range of time allowed off from work: from fewer than 14 weeks to more than 52 weeks. The only countries that do not provide paid maternity leave are the US, Liberia, Guinea, Swaziland and Papua New Guinea, although some unpaid leave is available. Russia and many European countries provide the most extensive paid leave weeks for mothers with up to a year or more.

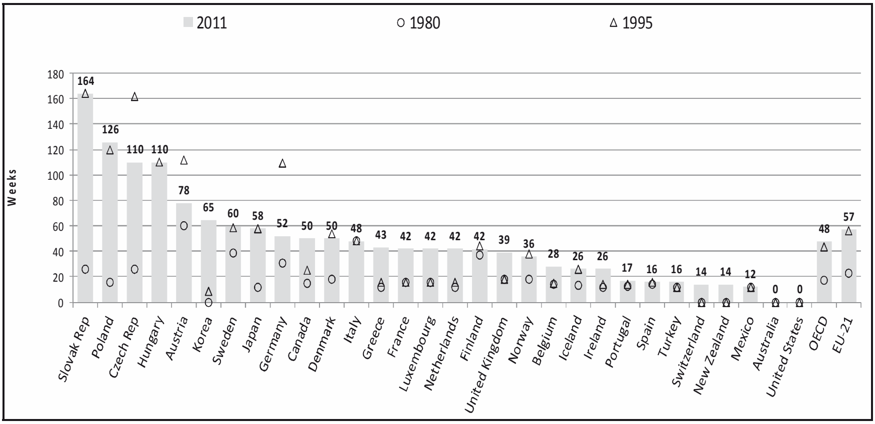
While maternity leave is extensive across countries and most leave is paid, the adequacy of payments and the universality of eligibility impact on women in science differently. Data on wage replacements show that leave might be less of an option if its rates are low. Low rates do not ameliorate job security for low-paid women in science and so risks associated with care responsibilities hit them harder. Indeed, where maternity leave is unpaid, as it is in the United States, women might either choose to stay in employment in suboptimal conditions or they might take more radical steps to leave their careers completely. Eligibility for paid leave for these mothers is also important to note. Unpaid leave in the US covers only 66% of the workforce – wage replacements are available only in a few individual states. South Africa's employment insurance is also not universal and covers from 31 to 59% of wages.

Figure 1: Is paid leave available for mothers of infants?

While maternity leave is universally available in Germany, wage replacements of 67% often cannot cover living expenses of low-income earners. Poor and non-working mothers and students receive a flat rate of 300 euros per month.

Paid leave for mothers has greatly improved in the last 30 years, as an overview for OECD countries shows in figure 2.

The continual expansion in paid leave (and lengths of time) has been extensive. Almost all countries have experienced some kind of increase in leave duration since the 1980s. For the noted few countries that have undergone a drop in lengths of leave (sometimes from the 1990s), these countries have done so in conjunction with their re-evaluation of the reimbursement and employment goals for the leave policy. For example, Germany reduced the duration of its parental leave in 2007 with a trade-off to include higher amounts of paid leave for some employed parents. This was in the hope that women would return to well-paid jobs faster, and better-paid men might consider taking more time off to care for their children.



Notes: Weeks of maternity and parental leave that women can take after maternity leave are included. Weeks of childcare or homecare leave have also been added where relevant. When there are several payment options, the shortest period with highest payment is taken into account. Source: OECD Family database.

Figure 2: Total weeks of paid leave granted to mothers in 1980, 1995 and 2011. Countries ranked by number of paid weeks available in 2011.
Source: Thévenon/Solaz (2013: 16).

On the other hand, adequately paid extended periods of maternity leave are not always helpful in promoting equality between men and women or for women's careers, especially when there are no paternity leave alternatives. Lengthy periods of leave time reflect expectations that mothers will take the full extent of this leave. The longer women are away from the labour market, the more difficult it is for women to re-enter it. This is especially the case if mothers have additional children where they might extend this leave period even further. In order to consider this issue further, it is necessary for maternity leave to be examined together with the other leave available in a country, that is, paternity leave and general parental leave for both parents in order to obtain an overall picture of support for women to combine employment and care. Below I will discuss these other leave forms for parents.

3.2 Paternity and other parental leave

Paternity leave, specifically for fathers or a second caring adult in the family, has developed more recently. Such leave is not as extensive as maternity leave and is often used in conjunction with other leave forms for children. Of the 182 countries viewed by the World Policy Analysis Center, just 74 countries granted paternal leave (WPAC 2013). The Russian Federation, the Nordic countries and some continental European countries offered the most extensive paternity leave with 52 weeks or more, usually in exchange for maternity leave. Australia, Canada, Japan and most of the other continental European countries had a paid leave policy for fathers from 14 to 51 weeks. Roughly a third of the rest of the countries offering paternity leave provided less than two weeks of paid leave.

In terms of wage replacements, however, often the countries providing less paid leave were also able to reimburse the parent with a higher rate. For example, the African and Latin American countries were in the highest brackets of reimbursement rates, even if they could only offer up to two weeks. High rates of wage replacement (75–100%) were also covered by the Nordic countries, Britain, France, Spain, Iceland, Poland, Romania and the Baltic countries, to name a few. Wage replacement rates from 50 to 74% were offered by Canada, Germany and Cuba. The Russian Federation, Italy and Japan had a rate below 50% and some countries, like Australia and some Central European countries, had a flat rate (WPAC 2013).

In comparison to maternity leave, paternity leave is generally less extensive and its wage replacement rates are lower. In light of these policy options, couples who must make a choice for one parent to stay at home are more likely to opt for a woman to stay at home to care for children. Nevertheless, with the establishment of paternity leave at least in some countries, we see goals for gender equality with respect to sharing care and employment among men and women. Reforms in family leave that have targeted fathers specifically have been shown to encourage them to care for children, although the take up of such mandated leave usually falls below the maximum allowed time – usually 20 to 30% less than their entitlements (Thevenon/Solaz 2013: 15).

Other parental leave covers both maternity and paternity leave not only for early childhood care but also for the care of an older sick child. Relatively few countries have paid parental leave of this kind, nor is it usually extensive. The US, Latin and South American countries generally have no federally mandated paid parental leave. Similarly, the African countries, Middle East and South Asia countries (outside of Japan and Korea) have no paid forms of leave. On the other hand, some Western European countries, especially the Nordic countries, as well as the Russian Federation, have generous lengths of paid parental leave with 52 weeks or more. A handful of countries with paid leave have an annual wage replacement of between 75 and 100%, which was provided again by the Nordic countries, some Baltic countries, and also Spain, Portugal, Iceland, Romania and New Zealand (WPAC 2013). In general, parental leave is important not only for new parents (in the form of maternity and paternity leave) but for parents at later stages of a child's development should they need to take time off from work in emergencies when their children need extra care.

4 Family leave for frail elderly care

Family leave for adult care or for the frail elderly has been expanding but has advanced not nearly as fast as the leave policies for the care of children. The right to leave employment in order to care for an adult family member, other than a child (in the most cases, frail elderly spouses or parents), is underdeveloped to say the least. Far fewer countries have leave legislation for the care of adult family members. If countries offer caregivers short-duration leave from employment to deal with emergencies or unexpected care needs, more often than not this leave is unpaid. The majority of longer leave is restrictive in eligibility requirements and is usually conditional on approval of the employer, especially in the private sector. In addition to leave schemes, some countries, but only a few, offer caregivers the option of reducing working time while needs persist, or guarantee the right to switch to flexible working time, but this flexible time is also recent.

In the Americas there are just three countries which have paid leave: Nicaragua, El Salvador and Canada. Namibia, Burkina Faso and Angola are a further three countries in Africa which have paid leave for the care of adults. Many European countries provide either paid or unpaid leave, except for Greece, Latvia, Switzerland, Slovenia and Romania, which have no such leave.[3] Further east, countries such as the Ukraine, Uzbekistan, Turkmenistan, Tajikistan, Kyrgyzstan, the Russian Federation, Japan and New Zealand also offer paid leave for adult care.

3 Paid leave is available in Spain, Ireland, Italy, Poland, Norway, Sweden, Denmark, Slovakia, Estonia, Albania, Serbia, Bulgaria and Australia.

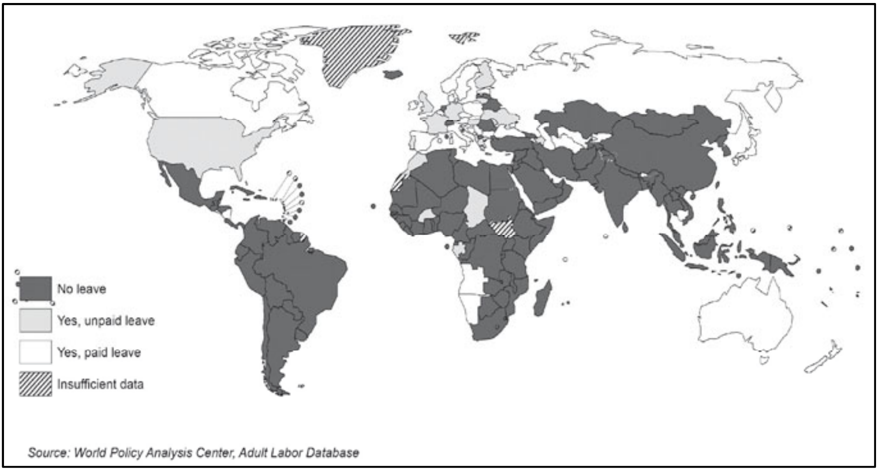


Figure 3: Leave to care for adult family members

Because of the demographics of an aging population and because of the influx of women in employment, the issues around time off from employment to care for adults has become pressing. For the most part, the care of the frail elderly is still performed overwhelmingly on an informal basis by family members. An OECD report on long-term care finds that family and friends remain the most important group of providers and the majority of these carers are women, although rates of male carers have been increasing (OECD 2011b: 93). In Germany, for example, two-thirds of the frail elderly who receive benefits from care insurance rely on care from friends and family members (Destatis 2013). Unfortunately, the take-up rates of available leave from employment for the care of the frail elderly are not known, nor are the gender differences between the take-up rates. According to the study, however, women tend to leave employment instead of enter into part-time work or flexible working times (OECD 2011b: 96).

Policy changes reflect caring issues for the elderly, but legislation has focused more on those in need of care rather than the carers. European countries, for example, have reformed cash transfers for the elderly in order to help finance their care. From 2008 to 2010 thirty-three countries passed reforms in cash payments that aimed to increase the affordability of care (EU 2010: 164-169). With these cash payments many seniors then in turn pay for care informally, as the cash amounts cannot completely cover formal arrangements. Family members often benefit but, as the elderly stay longer outside of formal care structures, these family members might end up caring for longer periods of time or supporting more serious care needs. Employment leave and available flexible working schedules for carers, however, tend to be scarce and non-binding.

5 Country examples of family leave

Forms of family leave have become for the most part more explicit in Germany, South Africa and the US, and these policies were expanded during the 1990s and early 2000s. A comparison of these outlines possible policy effects for women in science and illustrates problems in universal eligibility, pay equality, lengths of time, and the feasibility of their take-up.

Of the forms of family leave available in Germany, maternity leave is obligatory, with six weeks before and eight weeks after the birth, paid in full from health insurance funds. After this, Germany provides a parental leave option at 67% of wage replacement for up to a year with an additional two months if the father also takes paternity leave or a parent is raising children alone. The lowest leave pay available for non-employed mothers/fathers and students is a flat rate of 300 euros. Family leave for the care of adults and the frail elderly is less well developed. There is no paid elderly care leave in Germany. The family long-term care law (Familienpflegezeitgesetz) in Germany creates incentives for employers to allow employees to reduce up to 15 working hours within 24 months if employees need to care for adult family members. The government supplies an advancement of wages for an employee for the missed work time, so that pay will not be otherwise drastically reduced. After 24 months, employees must agree to work full-time to make up for the advanced income. These employees will be paid at a reduced rate until the advancements in wages in the initial 24 months are paid in full. Research is unclear as to the take-up rates.

In South Africa parental leave includes four months of paid maternal leave through the federal Basic Conditions of Employment Act 1997 and the Employment Act 2002. A mother can leave up to four weeks before the due date of her child and may not work for six weeks after the birth. The federal law does not stipulate payment, but the Unemployment Insurance Fund and Unemployment Insurance Contributions Act regulate guaranteed payment for some employees with a previous work history of four months, with a minimum of 24 hours a month. Students, public servants, foreigners working on contract or employees who get monthly state pensions or only earn commission are not included. The scale of payment ranges from 31 to 59% of earnings depending on the level of earning (Moss 2011: 205). Extended unpaid leave is possible for public servants, and some Bargaining Council Agreements have sought additional leave rights as well. Family responsibility leave allows for three annual paid days. Fathers are not entitled to paternity leave but can use these three annual paid days. Public service employees can also use three days for taking care of adult family members, and in the event of a death in the family, employees are entitled to five days a year and this is usually paid. Some special conditions apply to companies with fewer than 10 employees. There is no statutory entitlement to flexible work time or longer leave periods to care for adults.

Wage replacement for family leave is only available in the US in the states of California and New Jersey. Federal parental leave includes a general non-paid childbirth and sickness leave for an annual 12 weeks. Fathers and mothers can take this unpaid leave interchangeably, as well as spouses or children who need to take care of elderly relatives. Flexibility of the leave, however, is limited because it must be applied for in advance – so it usually covers larger periods of care. The law covers only mid-sized to large employers with 50 or more employees (within 75 miles). Some individual states have extended eligibility of unpaid leave by including smaller companies, but generally only about 66% of the workforce is covered under the law (IWPR 2013: 8). Larger sized companies also might have benefit plans that cover absences due to care or provide payment which would supplement the federal law, but only 35% of employees work for an employer that provides paid maternity leave and 20% of employees work for an employer that offers paid paternity leave (IWPR 2013:1). There is no statutory entitlement to flexible work time.

Leave coverage is varied in the US, Germany and South Africa. Of the three countries, Germany has the most generous leave policies for parents, both in lengths of time and in the rates of wage replacements for those who are employed in well-paying jobs. But leave for low wage workers or for students, for example, is not well paid. Leave for elderly care is not guaranteed and payments for family members to leave employment are only partially covered in Germany. Similarly, South Africa has a maternal leave policy which covers women unevenly. Here payments are not universal, nor is there paternity leave for fathers. Those persons needing to care for the frail elderly are covered for just three days annually. The US has neither parental nor elderly care paid leave. Flexible working schedules are underdeveloped in all three countries.

6 Lessons to learn for women in sciences

Family leave is one instrument of family policy among many of the growing government programmes to help women (and men) better balance the responsibilities of care and employment. This article summarised leave for the care of children and for the elderly, and traced this policy's development globally. The article also presented three country case study examples in more detail. The article found that paid forms of family leave for the care of children have grown immensely since the 1980s and almost all countries have some sort of paid parental leave. However, not all policy is universally available or generous in wage reimbursement. In addition, family leave for the care of (elderly) adult family members is less readily available and is in need of improvement – in the expansion of the leave forms, in their flexibility, and in wage replacements.

This survey of global family policy presents many lessons for women in the sciences. First, family policy creates structures which promote a work-life balance. Equal opportunities are provided for men and women to enter into and advance in the scientific fields, if risks are also covered for caring responsibilities in the family. These policies have a particular impact on gender equality. For example, in terms of gender, when maternity leave is more readily available than paternity leave or women's wage replacement covers more than men's, internal family pressures will push women out of their careers to care and cause men to remain employed. With less work experience, and more hurdles to re-enter the workforce, women will not be able to advance as quickly as men in their careers. Interestingly, leave policies that support longer spells away from work might in fact also reinforce gender differences because the longer a woman is away from the science field, the more she has to 'catch up' when re-entering the field.

Certain leave characteristics also reinforce other problems. For example, leave is hardly an option for many women in science if they have low incomes. If paid policies are based on the percentage of wages earned, low earners or those receiving unpaid leave will find their position even more insecure if they are constrained by caring responsibilities. Policies might easily exacerbate the precarious situation of these women in entering or establishing themselves in their field. Another hurdle is the unavailability of elderly care leave. This affects women later in life, and might pose a threat to women's careers if their lifework has already been delayed through the care of children. On the one hand, women could be more established in their field in this phase of their life, and thus be cushioned by this security. On the other hand, care of elderly parents or spouses is more unpredictable than the care of children in terms of intensity and time. It also requires more flexibility in employment. At critical juncture points in their careers, either in the establishment stage of their careers or later in the advancement stages of their careers, women in science will be affected by government policies to balance family and employment.

Family policy has been changing on a global scale and there has been an integration of care and employment issues across countries. Family policy has become more explicit and such measures have grown, especially around a work-life balance for families with children. However, family policies have been developing unevenly, and more disadvantaged families as well as those who have care responsibilities for adult family members are especially at high risk in the labour market. Policies that serve to equalise opportunities and life chances across society need to address inequality among family types, family members and life phases of individuals. There is hope for women's advancement in scientific careers if governments can promote and expand policies around care responsibilities and attempt to reach as many families as possible to alleviate the social risks of care work.

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Infrastructure, Confidence and Network: Motherhood as a Scientist in Germany

Karin Bodewits and Philipp Gramlich[1]

1 Introduction

Female scientists are facing specific and significant problems in Germany – paradoxically because of their high level of education. The aim of this chapter is to explain this situation using a case study and observations from statistical analyses and reviews. Two general approaches to tackling this problem are described and contrasted with respect to their effects. General observations about these issues from scientific and journalistic publications are interspersed with the authors' first-hand experience and their conclusions on these.

2 Case study

The case study used in this article is the author herself, who moved to Germany as a freshly graduated natural scientist, taking up a two-year contract at the university. As a biologist with a master's degree from her home country, the Netherlands, and a PhD in chemistry from Scotland, her outlook on motherhood and career was distinctly different from that of most German-born scientists. In a Nordic country like the Netherlands, the usual approach to integrating motherhood into one´s life is by sharing family obligations with one's partner, in contrast to the male breadwinner model in Germany. In the Nordic countries, it is more common for men to take parental leave and, most importantly, affordable childcare is widely available and can be booked in a flexible way. Women are welcome in the labour market with job sharing, home office and part-time options being commonplace. The situation which was encountered by the author in Germany, however, was a different one.

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The first experiences as a pregnant woman in Germany were indeed very positive. The pre-natal healthcare was perceived as very good, modern and caring. Also, the German government provides further help in the form of widely available and generous subsidy handouts.

However, these positive aspects do not in general help one to keep in touch with professional life during the phase of early motherhood or to resume a career afterwards. Employers very often require physical presence in the office for the entire working day. If the travel time is added to this, long hours of childcare every week are required. In Munich, childcare was only available from expensive private providers while the affordable city-run institutions, if available, could only be booked for five full days and not part-time. In addition to these practical issues, strong societal pressures on mothers to stay at home with their child for a long time after birth strengthen the feeling of coercion into a generally accepted lifestyle. Arranging a family life in a way that both partners share family and professional obligations evenly was found to be an option that the generous but inflexible German social system clearly does not cater for.

In the author´s specific case, fulfilling the two-year contract at the university did not seem to be an option. However, even if she had tried to stick with the job, the contract would have ended before a place in a publicly run nursery had become available. Finding another job would have been very difficult, with the implicit question ‘when will she have the second child?’ dominating every job interview. At that stage, her professional experience would have been viewed as too little to have a running start in a new job. So the path to start her own business seemed like the most rewarding and feasible option, as will be described in some more detail in section 3.2.

This case study describes an all too familiar situation for female scientists in Germany, a setting in which much money and help is available but just does not seem to solve the most pressing problems. This article should give insights into characteristic situations, for which typical and atypical solutions exist. The typical solution encompasses choosing between the two extremes of an (almost) completely home-based life or a careerist one with little family contact. We would like to add some insights into atypical solutions as well, in which it is attempted to square the circle and find a way between these extremes in Germany in order to really combine family and professional life. These atypical solutions comprise activities for individuals as well as initiatives that help this process.

3 General situation for women in science in Germany

3.1 Practical and employment considerations for women in science

Taking on a science study takes commitment: a heavy workload with theory and laboratory classes from the first semester onwards, as well as the prospect that one will only be deemed ready for the job market on completion of a PhD or even a postdoc. This investment only pays back if a high-level position can be held for many years afterwards. The long training period of, typically, almost ten years until the PhD degree is attained (GDCh 2012) leads to the fact that many female scientists are not yet fully established professionally by the time they have their first child. The labour market in the scientific fields in Germany is a rather traditional one, with full-time employment in permanent positions being the norm. Flexible hours or home office work is not yet well established, with long hours of physical presence still being considered the crucial measure for productivity and loyalty, regardless of the actual output. This 'jacket on the back of the chair' mentality makes it particularly challenging for mothers to maintain jobs that are adequate to their training level during life periods in which a full-time position cannot be held. Highly educated women in Germany struggle to find part-time positions that are satisfying and challenging. When taken up, these positions can often lead to the downgrading of a career (Steinmetz 2012: 203; Paoli/Merrlié 2001; Birkelund/Rosenfeld 1995: 111-134). Countries like the Netherlands, which is often referred to as 'the first part-time economy of the world', integrate part-time jobs as a normal area of the primary labour market (Freeman 1998: 1-24).

In addition to these observations, one should take a look at the typical structures within workplaces. Women and mothers in particular have lower chances to participate in informal meetings and after-work activities, be it due to the engrained male structure in the higher ranks or family obligations (Rutherford 2001: 371-382). These gatherings are of the utmost importance for building a professional network, which in turn constitutes an indispensable stepping stone on the career path.

Moreover, occupational health and safety laws, meant to protect workers and mothers in particular, include a particularly strict ban on pregnant women in laboratories.

Taken together, these findings place a tremendous hurdle between women and top positions in the labour market. The further up the career ladder, the lower the proportion of women. At universities, women have overtaken men even in terms of the number of PhD graduates in most broad fields of study. In the group ‘science, mathematics and computing’ the figure for Germany is 38% and in ‘life sciences’ 57%. However, when looking at the researcher population in Germany, less than 15% is female (European Commission 2013) and in executive committees this figure drops to 3% (Devillard et al. 2012). The societal and political reasons for this and the effects of these will be discussed in the following sections.

The scientific job market is thus a relatively difficult one for women and mothers in particular to access. However, the main obstacles that women face in such situations lie deeply embedded within society, as described in the next section.

3.2 Politics

It is without doubt one of the major challenges of politics in the next few years to tackle the challenges of our current demographic developments. With a birth rate of just 1.35 children per woman and the second oldest population on earth, Germany is facing a severe shortage of skilled labour, which is set to grow to 6.5 million by 2025 (*The Economist* 2013a). In the last few years, the main source of growth in this market has come from females (León 2005: 204-218). As nearly all childless women aged 30 and over are already participating in the labour market, any further increase in female participation has to come from mothers (Chevalier/Viitanen 2002: 915-918). Several studies have also shown a clear link between female participation in high-level positions and corporate performance (Devillard et al. 2012). Contrary to popular belief, birth rates also increase with female participation: ‘High birth rates and female employment rates tend to move together’ (Bennhold 2010). In this context, it seems paradoxical that highly qualified female scientists who are willing to work face such severe problems in the labour market. The huge investment in time, energy and money from both the females and society as a whole is often wasted, with natural science studies being particularly costly and time-intense. In the population as a whole, only 13% of mothers take up full-time employment again after their first child and this figure drops further to 6% after the second child (Bennhold 2011). Both figures are extremely low compared to our European neighbours. Another finding is particularly telling for the situation of female scientists: The trend in the EU-27 is that scientists are more likely to have children compared to the rest of the working population (European Commission 2013). In Germany, this trend is reversed. This can be seen as a clear indicator that it is harder to combine family and research in Germany than is the case in most other European countries.

These trends are also reflected in the financial side of the labour market, because, for example, the gender wage gap in Germany is one of the highest in Europe (Steinmetz 2012: 104). This adds to the risk of poverty for single or divorced mothers, particularly at retirement age (Fagan/Urwin/Melling 2006).

German politicians have invented a total of 156 subsidies in the area of family politics, costing a total of more than 170 billion Euros per year (*Die Zeit* 2013). These measures preferably place money directly in the hands of families instead of funding infrastructure. Marriage as such is subsidised by splitting taxation, which is particularly rewarding for couples with a high income inequality, thereby discouraging female labour (Steinmetz 2012: 110). On top of that, staying home with your children brings in several additional handouts.

Germany has very generous parental leave schemes. These are useful when providing an alternative to losing a job position altogether, but are shown to be detrimental to female labour market attachment when not in connection with a high coverage of childcare places (Steinmetz 2012: 113). In the latter case, employers are also discouraged from hiring women in the first place. The German government has set itself the bold aim of providing every child from the age of one year on with a nursery place by 1 August 2013; this target will fall short by about 200 000 places (ZDF 2013). In addition, the Barcelona targets for reaching 33% coverage of nursery places for children under three years by 2010 have been missed (European Commission 2001: 15). Even at kindergarten and school age, the provision of full-day services is underdeveloped in large areas of Germany (*The Economist* 2013a; Bennhold 2010). Having children thus means having to overcome severe practical problems for many years when both partners are trying to keep in touch with their qualifications and usually means a ‘double burden’ for at least one of them (León 2005: 204-218).

In summary it can be said that certain family models are very well accommodated within the structure of social politics in Germany, while others are not. This inflexibility in politics forces mothers into the decision of whether to focus on family or career with little room in between for alternative arrangements between these extremes.

3.3 *Society – views on motherhood*

German society is a relatively modern and open one in many respects: technology, travel and language skills, to name just a few. The views on what family life should look like, however, are deeply traditional and conservative (Steinmetz 2012: 140). The alliteration 'Kinder-Kirche-Küche' (Children-Church-Kitchen) is a recurring theme describing the conservative view on the role of women. Citing these three Ks is typically used in reference to the 'old days'; however, the influence on German society up to today can hardly be overstated. Mothers who do not personally look after their children for several years after birth are often called 'Rabenmutter' (raven mother), a term which, tellingly, does not exist in other languages. The enormous peer pressure which is inherent in society makes it very uncomfortable to arrange one's personal work-life balance outside of these generally accepted norms (Bennhold 2011) and influences individual professional choices and views about one's possibilities (Charles/Grusky 2004: 302). This traditional mindset thus increases both the horizontal and vertical dimensions of sex segregation (Correll 2004: 93-113). In the words of Thomas Sattelberger, head of human resources at Deutsche Telekom: 'Germany is good at structural reforms, but not at cultural reforms' (Bennhold 2011).

3.4 *Female behaviour on the labour market – internal barriers*

In sections 2.1 to 2.3 we focused mainly on external barriers, which are forced onto mothers by society, rather than as a result of individual decision-making processes. The fact that women, both mothers and future mothers, are often hindered by internal barriers embedded in their own personality is rarely discussed, although it is arguably a very important factor influencing their success in the labour market. Many of these internal barriers are described in detail in the recently published book *Lean In* by Sheryl Sandberg (2013). For the purpose of this chapter we discuss four areas relevant to female scientists: career steps before motherhood, presenting and networking, partner choice and seeing motherhood as a time of economic and personal investment rather than harvesting.

Career steps before motherhood

Outsourcing the care of one's children at any age in order to stay in touch with or return to the workforce and advance in a career is a very difficult decision for most mothers. Leaving one's child in a nursery or with the grandparents for the first time is emotionally stressful for parents. This decision will, however, be easier to make if there is a challenging and rewarding job waiting (Bennhold 2010). Therefore, it is important that women make the right decisions in the early stages of their careers. One typical form of behaviour displayed by many women is to create space for children and family life far before they actually become mothers, thereby missing out on promotions and challenging job offers because they cannot see these positions being compatible with their future family. This internal barrier clearly results in a career that is already, even before having any children or a stable relationship, downgraded without any real need. A step back can always be taken, but a missed chance might never come back (Sandberg 2013).

Visibility, networking and career planning

Female natural scientists often think that it is only hard work, a publication record and technical skills that define the success of a career in research. As a result, the importance of being visible (e.g. presenting work at conferences, actively participating in discussion sessions), building up and maintaining a professional network as well as strategic career planning are often neglected. Having well-developed 'soft-skills', being an active participant at meetings and conferences, constantly looking out for new opportunities and a willingness to take risks, will help women to get to the top. Several initiatives have been launched in Germany to increase the visibility of good female researchers. For example, the internet platform AcademiaNet of the Robert Bosch Stiftung, a databank with about 1200 profiles of outstanding researchers, and a number of prizes like the L'Oréal-UNESCO-Preis directed at female scientists in particular (L'Oréal), work in this direction. Harder to find are initiatives that help female natural scientists during the crucial early stages of their career (snf 2013).

Partner choice

Very important for a successful female career is the woman's choice of partner. The active participation of women and mothers in particular in the labour market is most likely only feasible and enjoyable when both partners are contributing substantially to family life. As a mother, having a challenging and demanding job is largely incompatible with traditional gender roles at home. Therefore, picking the 'right' partner, who is also willing to challenge traditional roles, is essential in order to be successful as a female researcher.

Motherhood as a time of investment rather than harvesting

From the authors' personal experiences and impressions, German mothers in particular often say things like: 'It does not pay financially to work when the kids are still young and need childcare.' For natural scientists in particular this might be true in the early stages of their careers. Salaries just after the PhD for part-time work will, most likely, barely cover the costs a working mother has to bear (e.g. nursery, babysitter, housekeeper). However, highly educated natural scientists should see early motherhood as a time of sowing rather than as a time of harvesting. Staying in touch with a job, at least to some extent, during early motherhood will bring large benefits in terms of salaries and professional opportunities later on in the career. Figures from America show that the penalty for leaving the workforce for just one year after childbirth will result in a 20% decrease in salary for the rest of women's lives. Furthermore, the assumption of many highly educated women that their degrees and skills earned before motherhood are sufficient insurance for a return to the labour market after a long break often turns out to be wrong. In a competitive job market, relevant real-life experience is indispensable (*The Economist* 2013b).

4 Approaches to solve these problems

Following this analysis of the current state, we would like to investigate two general approaches to tackling the problems we have outlined: quotas on the one hand and initiatives to increase workplace flexibility on the other. These two have been chosen as examples as they both have the intention to increase female participation in higher positions but lead to these goals in very different ways.

4.1 Quotas

Quotas are the most direct way of translating political targets into reality within organisations and companies. If the implementation of such quotas is enacted with heavy enough fines and sanctions, it leaves no choice but to comply. The target could thus be met almost regardless of the practical issues and attempts to evade them. Despite these compellingly clear-cut rules there are some critical points to be considered before implementing quotas.

Most existing and proposed quotas are focused on the top executive level with a typical rule being: ‘A minimum of 30% women on the executive level by 20XX.’ Quite recently, for example, the European Parliament passed a resolution calling for at least 40% of the seats on the supervisory boards of listed companies to be reserved for women (*The Economist* 2011). However, what should be considered is the fact that just below the executive level, the senior management level, the proportion of females is only 13% in Germany and 24% in Europe as a whole (Grant Thornton 2012). If 30% or even 40% of female executives are to be chosen from this small pool of only 13% of senior managers, it is clear that the quota strongly distorts the staffing decision away from purely quality considerations, thus curtailing the entrepreneurial decision-making process (*The Economist* 2011). This is particularly problematic in fields with a generally low rate of females like IT and engineering.

Although women appreciate seeing their chances in the labour market increasing; they do not particularly like the way in which these opportunities are being created. This holds true particularly for the natural sciences, in which a strongly meritocratic mentality prevails. Weighing even heavier than their personal restraints are prejudices from colleagues (Bennhold 2011). Seeing someone being promoted over oneself on the basis of their mere gender, as happens to many male colleagues with regard to such ‘statutory women’, seems highly unfair to these men. The women in leadership positions will consequently have grave problems adding natural authority to their hierarchical position. A quote from the *Women matter 2012* report by McKinsey & Company is evidence of this (Devillard et al. 2012): ‘Women-specific programs stigmatize women. We prefer to focus on excellent talent management – for both men and women.’ Opponents of quotas like to mention excessive outgrowths of equality measures like the highly unpopular and complex point systems at US universities (Washington Post 2013), which lead to the paradoxical situation where Asian students face penalties based on their race. That means it is not their foreign origin which is ‘priced in’ to give them a bonus, but the stringent work mentality of many Asian cultures, which brings them this penalty. A discouraging example of a large company setting its own female quota is Deutsche Telekom, which reported the failure to increase the female participation rate in middle and upper management (*The Economist* 2011).

The underlying thought behind setting quotas specifically for the top positions is that this newly installed leadership generation will positively influence the gender culture in the entire company or organisation. This top-down approach should consequently make positions more accessible for women on the lower tiers of the hierarchy. Two questions should be asked in this context: Why not turn around the approach and start setting quotas bottom-up? With a new generation of leaders moving up the ranks, the question of whether there will be enough talented women with relevant experience in the pipeline will not even come up. The second question is whether the quota is not merely a measure to patch up a situation which has deteriorated somewhere completely different already. Is it not merely a forceful approach to make up for the fact that precious talent has been lost along the way to top positions? And is that in turn not a clear sign that society is extremely wasteful with regard to the resource of female intellectual capacity (Steinmetz 2012: 19)?

Proponents of quota rules bring up a knockout argument: Despite the imperfections of quotas, is there a better way? Is there another way to produce actual results, to actually force participants to deliver, and not just give benevolent applause – an outcome that ‘softer’ measures often do? The next section will shed light on such approaches.

4.2 Initiatives for workplace flexibility

Being ambitious, well educated and willing to stay in touch with the working environment is not enough for many female scientists in order to reach high positions. What is it that is missing in a society with a good education system, far-reaching equality legislation and a whole bundle of supporting measures? One reason contributing to the problems described here is the lack of workplace flexibility, which is crucial for women´s access to employment (Leon 2005: 204-218). German labour law is generous towards employees wanting to reduce their working hours in addition to the aforementioned generous parental leave schemes. However, alternative arrangements like job sharing, flexible hours or home office arrangements are less developed in Germany (Plantenga/Remery 2009), so that the rights given to employees by law are not necessarily mirrored in a cultural acceptance of workspace flexibility. Such measures are, however, of immense importance to women when they are trying to arrange family and professional obligations.

Organisations and companies, particularly large ones, can make a positive impact by welcoming female talent and offering them some of the possibilities mentioned here. In the light of the current demographic changes, it also seems highly likely that an economic profit would be gained from attracting talented females. This would lead to a gradual change in mentality, which should in turn have an impact on the gender composition in leadership positions over time. Apart from these changes within large entities themselves, can there be initiatives from smaller groups that might influence our society?

Some start-up companies like Flexperten, MaBiz and ScienceMums specialise in flexible work such as home office, part-time or project work. In certain fields of employment like IT and engineering, a vast array of flexible work arrangements is already on offer, so that it seems likely that some of this flexibility could be transferred to other job fields like the natural sciences as well. The start-ups mentioned here are exploring various ways to generate added value for both their members and clients.

- The bundling together of experts on the one hand and relevant work on the other is a valuable tool for both employers and employees.
- Networking sites allow for the establishment of a wider community as well as increasing the visibility of the initiative itself.
- The fact that these initiatives touch a range of relevant current topics makes it attractive for companies to act as partners and therefore be seen as trailblazers for modern forms of work and gender equality.
- The success of such initiatives may eventually spark the founding of similar start-ups and influence established companies to open up to a wider range of work arrangements.

ScienceMums is described in more detail as an example of an approach which combines several of these benefits. A database of experts has been formed from the vast and previously undervalued pool of female scientists. This focus on women and mothers in particular does not exclude others, as for example foreigners and seniors face similar challenges in the German labour market and can therefore also profit from the membership in such a database. ScienceMums is attracting flexible project work, which is a valuable but underdeveloped part of the labour market in science, and then subcontracts this to the experts in the database. The natural science background of the founders allows for a high degree of quality control of these work packages and an evaluation of the experts based on their scientific skills. This forms a unique selling point when comparing ScienceMums to, for example, conventional recruiters or staffing agencies, which typically have a human resource background. The very high qualification level of the database members that have been attracted so far, as well as the openness of many newspapers and magazines to report about the company, can be seen as positive signs.

The potentially weak spot of these approaches is their lack of coercion. There might be a natural tendency for companies to officially welcome such initiatives for PR reasons but retain their old ways and structures. However, the underlying rationale of such initiatives is that factors such as demographic developments do eventually leave no choice but to rearrange the work life in a way that will be more open to women in leading positions, as well as new forms of work at the same time. Additionally, technological advances are helping to develop and spread ever new forms of work arrangements.

5 Conclusion

A set of initiatives and rules from Norway is given here as an example of a country which combines quotas with a high level of workplace flexibility. It has to be noted that it would be an unwarranted simplification to ascribe all the statistical effects mentioned here to either the quota rules or the general workplace structure.

In 2003, a law was passed which set a target of 40% women at the executive level for all publicly listed companies by 2008. Figures from 2010 have shown that the proportion of female board members was three times higher than their proportion on the more powerful executive committees, which can be seen as an indicator that a good deal of 'window-dressing' was used in the process, on top of genuine efforts (*The Economist* 2011). Still, even at the level of executive committees, Norway shows higher numbers of females than nearly all its European neighbours.

Norway scores equally well in workplace flexibility: universal childcare is offered to children of all ages, men often take parental leave as well and companies often have a tradition of finishing all meetings by 3 pm so as to allow full participation of all part-time staff when required. Surprisingly enough, Norway and the other Nordic countries exhibit high levels of occupational sex segregation, meaning that different occupational fields are strongly dominated by one or the other gender (Steinmetz 2012: 24). Apart from this finding, the aforementioned combination of quota rules, together with widely available childcare facilities and workplace flexibility, leads to excellent values in all other measures of female labour integration in Norway.

After several decades of women's rights struggles in labour issues, full equality has been established when considering the number of graduates up to PhD level and entry positions in nearly all western countries. However, the dramatic decrease in female participation on the higher levels of hierarchy can be attributed to a predominantly conservative political environment, a traditional labour market and deeply ingrained societal norms. All this applies to the entire female working population as well as to female scientists in particular, who are struggling with lengthy training periods. A host of different measures are being attempted simultaneously in order to tackle this issue. Some of these measures include using fixed numbers as targets as is the case for quota rules, as well as trying to effect wider societal change, such as initiatives to increase workplace flexibility. When looking at past efforts in Germany as well as at experiences from other countries, it can be hoped that decision makers within politics will draw sensible conclusions from the facts elaborated in this chapter.

6 Lessons to learn for women in science

If the work location can be freely chosen, pick an open-minded one, ideally with a good infrastructure. Female expertise should be desired, not just tolerated or even constricted.

If possible, get some professional experience. In case of doubt, this will count more than yet another or a higher academic degree in a job market where these are abundant.

If influence can be exerted on politics and society, creative new options between the extremes/classical fronts seem to offer exciting new possibilities.

A long-term vision is required for career planning from early on, as well as flexibility and inventiveness as soon as children come into one´s life.

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Epilogue

Silvester Popescu-Willigmann and Britta Thege[1]

The research presented in this volume dealt with issues such as how cultures in science and research (re)produce gender (in)equality, how traditional role images and working cultures impact on women's career development in academia, and how and why female and male scientific careers differ. The studies from South Africa, Germany and Austria provided fresh insights into several scientific fields of study, mainly from SET disciplines. Throughout the world fewer women than men study science, engineering and technology. However, mere access to education and study is not the solution to increasing women's proportions in SET. Furthermore, far fewer women than men climb to the top of the scientific career ladder, a phenomenon described with the term 'leaky pipeline'. Particularly at postgraduate level or in the transition phase from postdoc level to the higher academic echelons women tend to 'disappear'.

In consideration of the two very different historical backgrounds of Germany and South Africa and different national (future) challenges, the research presented here brought a range of similarities in relation to the above problems to the fore. Although legislation and initiatives for gender equality are in place and are operating in both the German and South African research systems, progress in this regard has remained rather slow so far. As the research here showed 'one-size-fits-all' programmes are not the best solution. National policies and strategies have to integrate women more effectively into the national science systems in order to tackle the 'hidden agenda', such as the organisational constraints of academic institutions, gender bias in terms of different performance and qualification criteria being applied to female and male scientists and, in consequence, women's underrepresentation in higher academic positions.

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In this context the role that the gatekeepers of academic careers and their individual mind-sets play in academic careers are key to women's career advancement, especially at the transition to postdoc level or job entry. To achieve structural change in universities and research institutions efforts must be widened in terms of gender awareness programmes, mentoring programmes, and parent support programmes. A major issue which arose in almost all the studies presented in this book and which impacts negatively on women's scientific careers is women's factual or alleged family commitment and – more generally – care responsibilities (including the care of elderly/adult family members). Hence, an important measure for reconciling an academic career and family responsibilities remains the offer of adequate childcare facilities as well as measures such as return to work grants following breaks for having a family.

South Africa in its still ongoing transition to democracy faces a number of challenges in the development of its human capital that differ from the German situation. Poverty reduction and closing the gender and race gap are issues of high priority in South African policies. In order to increase the number of girls in schools who study the STEM subjects, further efforts need to be made. In the rural areas in particular, the lack of basic infrastructure and the lack of adequate teaching and learning environments is a major developmental challenge. Furthermore, despite the strong legislative framework on gender equality and strong national gender machinery, a set of sociocultural constraints for women and girls continues to militate against women's equal participation in tertiary education. However, according to the 2002 Research and Development Strategy, South Africa strives to increase the number of women and people from previously disadvantaged communities entering the sciences and remaining there. It is the responsibility of the Department of Science and Technology (DST) to implement and monitor initiatives that increase women's participation in the higher education and research system and to particularly support black women in achieving higher academic degrees through, for instance, bursaries and scholarships. Based on legislation, the National Advisory Council on Innovation (NACI)[2] and its subcommittee SET4W[3] are important advisors to the ministry and stakeholders promoting gender-related issues in science, technology and innovation.

2 Available at http://www.naci.org.za/

3 Science, Engineering and Technology for Women.

In *Germany* the improvement of equal opportunities at institutions of higher education and research institutions is supported by legal provisions in the Framework Act for Higher Education, as well as in the corresponding higher education laws of the federal states; secondly, specific measures for women and, in particular, a range of large-scale political programmes, such as long-term special funding programmes for higher education and research. Since 2007, the German Federal Ministry of Education and Research (BMBF) has been running the Programme for Women Professors and has implemented instruments of equal opportunities quality control within the higher education system.[4] Overall, in Germany the number of women holding a professorship has increased in the last twenty years from under 10 to almost 20%, with a significant difference in terms of disciplines, for instance in engineering only 9% of chairs are held by women. Although the progress is encouraging women are still in the minority, which has to be further challenged. Even more efforts are necessary when it comes to female leadership at research institutes outside the higher education system. Here the number of women did not increase in the same way as it did at universities: only 13% of leadership positions are currently held by women.[5] At present German universities and research institutions are asked to set their own goals according to the so-called cascade model, that is, the share of graduates defines the goal for the share of female doctoral students, while the share of female professors should not be lower than the share of female students doing their PhD.[6]

The studies in this book have shown that it is not the individual woman scientist who can bring about structural change, but the political and institutional systems with their particular impact on gender equality that create the frameworks which allow the promotion of women in science and leadership. Such frameworks include work-life balance, incentives for equality measures, or funding provision for equal opportunity initiatives. The active participation of universities and their members in this process of structural change and system transformation is underway.

The authors of this book also derived lessons to learn from their research findings, recommending a variety of individual strategies for promoting the careers of young women scientists. Despite all the structural barriers, young scientists have to make their own informed decisions on where to take their careers in

4 cf. http://www.bmbf.de/en/494.php
5 cf. http://www.bmbf.de/en/494.php
6 cf. http://www.dfg.de/en/service/press/press_releases/2008/pressemitteilung_nr_35/index.html

terms of the options available. The rules that are shaping the field of academia have to be understood before they can be changed.

Women and men can participate actively in this process of structural change and system transformation as change agents and advocates for equity. Only if we open up to diverse perspectives in the scientific community will genuine sustainable knowledge building be attainable.

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