



Meta-analysis of gender and science research

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1. Introduction

In Austria, women's political movement as well as gender studies were implemented rather lately. It was only in the 1970s when the women's movement started to influence the political and social process. With the installation of the secretary for women's affairs in 1979 – it was transformed to a federal ministry for women's affairs in 1990 – programs promoting women and gender research became more support.

In the 1980s there were the first gender studies implemented at Austrian universities. This increased the studies on discrimination of women, gender stereotypes or gender equality. Influenced by the experiences of female scientists gender equality in science became a special topic in gender studies. It started with analysis of the most obvious lacks of women in male-dominated disciplines and with debates on discrimination of women. The department for research and statistics in the Ministry of Education and Science supported continuously gender studies and research since the late 1990s.

2. Analysis by topics

2.1. Horizontal and vertical segregation

Research questions

Segregation in science is discussed in many studies in Austria. Vertical and horizontal segregation were analyzed with different questions:

- Increasing the rate of high-skilled women in technical professions became a political goal in the 1980s and forced the interest in studies on horizontal segregation. The lack of women in different technical and natural sciences was considered, factors and causes for the absence of women like the lack of interest, their deficits in technical and natural knowledge or the scientific lifestyle were analyzed (Wächter 2003; Wagner 1987; Thaler 2006).
- Vertical segregation is included in many studies and is used to prove discrimination of women, patriarchal structures of science and universities and its historical tradition of a male-dominated field. The gender composition of the scientific staff of universities and non-university research institutions is described and used as an indicator for gender inequality (Gschwandtner et al 2002, Wroblewski et al. 2007).

The description of the under-representation of women in higher or management positions and certain scientific areas are mostly the starting point of discussions on causes and explanations for segregation. In both aspects of segregation push- and pull effects are discussed. This covers studies with a focus on the interests of women, their educational preconditions or socialization as well as studies on unequal treatments of women in science.

Research approaches

The following research approaches can be summarized for Austria:

- Empirical analysis of the share of women concerning students and graduates, staff of scientific institutions in different hierarchical positions and different scientific fields, historical developments of the share of women
- Description of career paths of female scientists and hindrances for scientific careers
- Analysis of causes and factors for the lack of women in male-dominated fields, including educational preconditions of women for technical and natural sciences
- Adaptation of general segregation mechanisms for the special field of science

Horizontal segregation is mostly focused on the lack of women in technical and natural sciences, whereas the female dominated fields are under-represented. Vertical segregation is more often covered indirectly in the analysis of gender inequality, except for the analysis of the leaky pipeline in science, the glass ceiling or career chances of women.

There are several studies using a compilation of statistics. The most of them are based on a state-of-the-art literature review or on qualitative techniques of empirical research. Statistical analysis on the presence of women are often used as a framework for the analysis of specific sorts of inequality.

Findings

The following results can be summarized for Austria:

- The concentration of women in business, economic and general educational secondary schools seems crucial for the choice of study courses: Female students predominate in the humanities, in social and economic sciences, and in veterinarian/human medicine. Science, mathematics and computing as well as engineering, manufacturing and construction are still male-dominated and women are a minority in all hierarchical levels.
- To increase the share of women in technical fields is a political goal in Austria for more than two decades. But the measures are hardly successful, too many social and economic factors work against it.
- There is hardly another sector where the gender ratio has changed as fundamentally as at the universities: Since the 1970s, the universities have slowly but steadily become 'feminised'. Women have indeed clearly caught up where access to the university system is concerned, yet they are confronted with a higher drop-out probability. Moreover, it is evident that women more seldom start and/or finish a doctoral thesis. Even lower is the probability for them to become university professors.
- Access to higher positions, however, is still denied to women in science. Even comprehensive supportive measures for increasing the equality between women and men could not avoid that the female share at the higher levels of the hierarchy remains low.
- One of the reasons for the inferior job and career opportunities of women is founded in the rigid scientific career scheme at the universities. Dissertation and habilitation form the prerequisites for an university career and; under the new University Act 2002, these prerequisites have to be fulfilled within 10 years. These circumstances may turn into barriers where private obligations must be combined with professional ones.
- The share of women increased especially in non-university research institutions. But university and non-university research are two relatively separate labour market sectors with very different working conditions for scientists and with hardly any institutionalized transfer possibilities from one sector to the other.

Gaps

There are some empirical studies describing horizontal and vertical segregation for science. But there are still gaps which are undocumented, like vertical segregation in the non-university sector or the relation of vertical and horizontal segregation in science.

Exclusion processes of women from top positions and also from male-dominated fields are mostly explained by family restrictions of women. Other factors for segregation are hardly discussed.

2.2. Pay and funding

Research questions

Pay and funding are rather new topics in Austrian gender and science research, when we are looking on studies that focus on these themes. Gender pay gaps are discussed as results of discrimination and exclusion of women from highly paid functions and sections. The few studies that discuss gender pay differences are concentrated on special fields like medical scientists (Mixa 2000) or graduates of the Vienna University of Economics and Business (Dawid 2002).

The gender pay gap was considered in the non-university sector (Papouschek 2004; Kreetz 2004) whereas there is no research on wage discrimination in the university sector.

Gender aspects of funding are mostly concentrated on the funding of gender research. The analysis of funding for gender research was discussed in national and international meetings. Gender bias in funding that is caused by the specific interpretation of scientific excellence has been recently analyzed (Schacherl et al. 2007).

Research approaches

As mentioned already, gender pay gaps have often been discussed indirectly, as a result of discrimination and exclusion of women of highly paid functions or disciplines. For example, in the series of gender lectures at the Vienna University of Economics and Business gender pay gaps in research are analyzed. For instance, they estimate gender pay differences as a result of gender differences concerning their functions. Funding is also seen as a result of functional differences or in terms of the funding of gender research connected with question of institutionalization of gender studies. There are hardly any empirical analyzes, except qualitative interviews on exclusion factors.

Findings

The findings concerning pay gaps are closely related to the (vertical) segregation in research. Especially in the non-university sector this might be seen as a backlash for women: female scientists are over-represented among careers starters where as controlling positions are mostly in the hand of men. The increasing integration of women in research goes along with flexibilization and growing gender pay gaps.

Concerning gender studies the advantages and disadvantages of its institutionalisation are discussed. The institutionalization of gender studies in Austrian universities means special quotas for courses and research. However, they are insufficient, as an analysis of Nöbauer et al. 2002 shows for the studies in physics and ethnology.

Although European and national research programs aim to increase the share of women in research projects, women are under-represented in funding. Schacherl et al. (2007) explain the under-representation of women in funding by the gender bias underlying instruments to assess scientific excellence. The understanding of scientific excellence implicates different chances for funding and academic careers.

Gaps

There are no empirical studies on wage discrimination and gender pay gap in academic research. With the autonomy of the universities wage, differences in equal functional positions will also become of higher interest. The discussion on gender bias in funding has barely begun and led to more questions than answers.

2.3. Stereotypes and identity

Research questions

Stereotypes and identity were discussed according to the following questions:

- Gender specific educational and vocational decisions
- Influences of gender stereotypes and identities on horizontal and vertical segregation

One of the first topics to discuss gender stereotypes and the importance of role models in research was the analysis of gender specific educational or vocational decisions. During the 1980s the goal to integrate more women in male-dominated fields of study or professions gained increasing importance. The development of measures to promote girls and women in

non-traditional professions led to the question of how and when girls and boys develop gender specific interests and competences. Hence, the role of schools was analyzed and how didactical concepts influence the development of gender specific interests and competences (e.g. Birmily et al 1991; Jungwirth 1991; Dorn 1996; Lassnigg, Paseka 1997; Tanzberger, Besenböck 2003).

Despite the school context, stereotypes and identities are one of the most important explanations of gender gaps, e.g. horizontal or vertical segregation. However, these topics are only seldom explicit topics of research. One exception might be the analysis of biographies of female pioneers at Universities. Here role stereotypes female pioneers have been confronted with are described and their effects on their career are discussed. Another exception might be the discussion of careers of female researchers and problems to reconcile work and private life, which also discuss role stereotypes, especially the norm of "true science" and the demands on scientists associated with that (e.g. Ingrisch, Lichtenberger-Fenz 2000; Buchinger et al. 2004)

Cognitive abilities are mainly discussed in the context of gender gaps in school achievement (e.g. mathematics, natural science). Such research was influenced highly by the availability of TIMSS data in Austria in 1995 (later also by PISA).

Research approaches

The research approach of the studies mentioned above focusing on social construction of identity include the whole range of qualitative and quantitative research approaches including secondary analysis of administrative data (school statistics, statistics on students at universities), standardised surveys among students, (biographical) interviews with scientists, observations (lessons in school), analysis of textbooks and interviews with parents or teachers.

Studies focusing on cognitive abilities are mainly based on secondary analysis of standardized tests like TIMSS or PISA.

Studies focusing on the social construction of science are also based on surveys or observations dealing with special aspects of scientific every day life, e.g. gender differences in working conditions at universities, understanding of "real" science or expectations on male and female scientists.

Findings

The following results can be summarized for Austria:

- Several studies and anthologies published by the Federal Ministry of Science and Research that deal with the situation of women in science and research show that stereotypes are one of the main reasons for the discrimination of women in academia (see section on 2.2. and 2.4).
- Studies showed the impact of how schooling is organized (e.g. co-education, didactics) on the interest of girls in science and engineering. One of the main factors is the self-confidence of girls in their abilities and their own perception of their achievements.
- Stereotypes are addressed in biographical research on female scientists – especially female pioneers at universities. In that context role stereotypes women have been confronted with by their male colleagues and superiors are analysed.

Gaps

The role of socialisation within the family (role of parents) is not analyzed explicitly. This factor is mainly used as an important explanatory factor. However, the relative importance compared to other factors (like schools) is not proven yet.

In other sections of this chapter it is also mentioned the scarcely presence of studies explicitly addressing stereotypes.

2.4. Science as a labour activity

Research questions

Gender-specific aspects of science as a labour activity refer to two questions:

- individual experiences of female scientists concerning working conditions, career opportunities and hindrances and
- structural conditions in science and academia.

Most of the literature belongs to the first category, where biographies of more or less famous women are described and analyzed (e.g. Keintzel, Korotin 2002; Buchholz 2004; Frakele et al. 1987). This includes female pioneers in academia, successful female scientists or female scientists of different fields. These biographical studies show interfaces between professional and private spheres and a continuity of the problems of female scientists of different generations.

Less attention attracts the research on structural aspects of working conditions in science. There are some rather new studies that focus on the organizational cultures of science (e.g. Gschwandtner et al. 2002 for universities; Papouschek, Pastner 2002 for the non-university sector; Sagebiel 2005 for Engineering or on work-life balance and science). Buchmayr and Neissl published 2006 an anthology that focus on work-life balance and science and goes back to a conference at the University of Linz on this topic.

Research approaches

The biographical analysis of female scientists is mostly based on biographical interviews and in-depth documental analysis. Especially the studies on the female pioneers in science offer historical perspectives on influences and hindrances of scientific careers. The interplay between political, economical and legal conditions on scientific careers indicates some freedom for measures to improve the chances of women in science.

There are some studies that collect facts on the distribution of women and men in different scientific hierarchies and relate this data to experiences and attitudes to work of individual scientists. They are also based on qualitative interviews, biographical analysis or case studies. But there are hardly any facts on the working time or the working conditions in science.

Some of the studies are based on general contributions on patriarchal structures in the labour market, gender division of labour or organizational cultures and make their conclusions for science.

Findings

The findings for gender and science as a labour activity mostly relate to the reconciliation of work and family. Depending on the approach and on the analyzed time or generation of scientists different working conditions are indicated that cause differences of male or female scientific careers.

- Science as labour activity that requires all the time and all the energy of a person makes it hardly impossible to reconcile it with family or other activities outside the scientific field. Whether this is just a myth and science can be organized like other regulated jobs or becomes the main hindrance for women and men is assessed differently.
- Hindrances for women for scientific careers have been and still are problems with the reconciliation of work and family. This reconciliation problem concerns nowadays also men. But there seems to be a big difference between the arguments of men and the reality.
- There are hardly any facts on concrete working conditions and working time. But the differences of female and male career chances indicate intense time demands that can hardly be fulfilled by women with children. This is mainly result of informal demands for networking and engagement in the scientific community.

- There are considerable differences between scientific fields and institutional frameworks. There seem to be more difficulties for women in the male-dominated fields. In the non-university sector, the tension between economic demands and scientific approaches exacerbates scientific careers.

Gaps

There are hardly any facts on working time and working conditions. The discussion on structural conditions has just begun and shows a lack of reliable studies and data. Work-life balance is mostly reduced on questions of the reconciliation on work and family, but overlooks other aspects like health risks of overwork.

2.5. Scientific excellence

Research questions

There is only one research report that focuses on gender and excellence (Schacherl et al. 2007). The other related to that key word does not focus explicitly on gender and scientific excellence but on the following topics:

- Bibliography of female scientists to make research of women or on women's topics visible (e.g. Klösch-Melliwa et al. 1992; Maurer 1993)
- Biographic research on female pioneers in different time periods or fields of research (e.g. Maurer 1983; Ingrisich 1993; Ingrisich, Lichtenberger-Fenz 2000).
- Discussion of subtle mechanisms of discrimination of women in professional career (e.g. Holzleithner 2002, 2004, see also chapter 2.7).
- Development and institutionalization of Women's Studies or Gender Studies at Universities (e.g. Buber-Schwab 1990; University of Vienna, Moser 2001; Kock, Moser 2005).
- Analysis of gender bias in excellence-measurement and performance rating at universities and concerning applications to research funds (Schacherl et al. 2007).

The mentioned biographical studies on female pioneers discuss not only their careers but also difficulties to get accepted with innovative (not male stream) research topics. This is also an underlying question of recent studies discussing subtle mechanisms of discrimination of women. The aim of the study of Schacherl et al. (2007) is to analyze established procedures to measure and assess scientific excellence focusing on subtle mechanisms that discriminate women.

Research approaches

Schacherl et al. (2007) explore the main implications of the research funding systems in Austria and the characteristics of the conception of scientific excellence of the Austrian Science Fund. This analysis is mainly based on analysis of documents. Furthermore, the participation of women in existing funding instruments is analyzed based on secondary analysis of administrative data and a survey of female beneficiaries of the Austrian Science Fund conducted in 2004.

Biographic research on female pioneers is mainly based on oral history, interviews, and analysis of documents. Rentetzi (2001) analyzes the publication output of female and male researchers at the Institute for Radium Research in Vienna during the 1920s and 1930s.

The description of development and institutionalization of Women's Studies or Gender Studies at Universities is mainly based on expert opinions, analysis of research topics and literature.

Findings

The following results can be summarized for Austria:

- Schacherl et al. (2007) show that women are under-represented in funding by the Austrian Science Fund although female professors in Austria submit more applications to the Austrian Science Fund per year (0.8 applications on average per

year, male colleagues only about 0.4). Women submit more often projects that are considered as too broad and too explorative and therefore refused. Finally, they show that differences in publishing between men and women are explained by discipline.

Gaps

One restriction of existing bibliographies is that they mainly focus on a specific field of research or on a specific time period. The gap is that there is no continuity of such analysis and therefore no analysis of change over time. Maurer (1993) focuses on women's studies in science, engineering and medicine in the 1970s and 1980s. Klösch-Melliwa et al. (1992) focused on research conducted at the University of Graz since 1985.

The following gaps for scientific excellence can be considered:

- There is no in-depth debate about the definition of scientific excellence
- There isn't research about scientific productivity of Austrian scientists by sex
- There aren't studies about bias/or not bias in the scientific evaluation procedures.
- There are no studies about scientific excellence in the field of non-university research.

2.6 Gender in research contents

Research questions

The main research questions for gender in research contents are:

- Neglected gender aspects in male-stream research
- Status quo of gender research in several disciplines
- New and innovative concepts of research considering the relevance of gender
- Gender aspects in teaching at universities and in school

During the 1990s the perception of a gender-blind research was criticised. Female researchers – in most cases arguing from a feminist perspective – discuss relevant gender aspects in their field of research that are neglected in male-stream research. Such discussions are to be found in:

- science and engineering (women in IT, natural science, mathematics etc., e.g. Wagner 1987; Maurer 1993; Stadler 2005)
- political science and law (in the context of labour, reproduction, welfare state etc., e.g. Pircher 1984; Hidden-Sommer 1994; Flossmann 1997; Mairhuber 1999; Sauer 2006)
- and from 2000 on in the context of life sciences and biotechnology (reproduction technologies, prenatal diagnostics etc., e.g. Abels et al. 2003)

In 1999 the Federal Ministry of Science and Research launched two anthologies, one released by the Coordination centre for women's studies and gender research at the University of Vienna, the other one released by the similar institution at the University of Graz (cf. Birkhan et al. 1999; Hey 1999). The aim is to describe the status quo of gender research in the 1990s in several disciplines.

In general research, questions focus on the specific interests of women in the respective field of study and the differences between men and women. The aim is to develop new and innovative concepts of research that take relevance of gender into account. Furthermore, the consideration of gender aspects in teaching at universities and in school is discussed (e.g. Jungwirth 1991; Lassnigg, Paseka 1997).

Research approaches

In most cases the analysis of status quo is based on a review of literature and research. The results are discussed from a gender or feminist perspective, showing that specific gender relevant aspects are not considered in research. The implementation of centres for women's

studies and gender research at universities led to a publication that documented the status quo of gender research at the institution.

Findings

The following results can be summarized for Austria:

- In most disciplines the discussion of ways to introduce a gender perspective in research has already started. In some disciplines this discussion has meanwhile a tradition of more than a decade. This process was initiated by the implementation of centres for women's studies and gender research at universities.
- The development of new gender-sensitive concepts and the implementation of such concepts in empirical research started during the 1980s in social sciences and law. In that context the implementation of the law on equal treatment had a great influence on the perception of gender relevant topics. Another focus lied on gender differences in use of information and communication technologies and electronic/technical equipment.
- In life sciences the discussion was highly influenced by the development of biotechnology, prenatal diagnostics and genetic research. These discussions are also very often part of interdisciplinary research, e.g. natural or medical scientists together with social scientists, philosophers or lawyers.

Gaps

There are several attempts to document the status quo of gender research at specific institutions (universities) or in specific disciplines. However, such attempts might be characterised as purely descriptive or as theoretical discussions about how to implement a gender perspective in research. There is hardly any research on factors supporting or hindering the institutionalization of gender research or research that doesn't follow the mainstream argumentation.

2.7 Policies towards gender equality in science

Research questions

First research on policies towards gender equality emerged in the beginning of the 1990s when the topic became more prominent in public discussions and first positive measures of the Federal Ministry of Science have been launched. In the beginning the focus lied on positive measures to tackle the under-representation of women in engineering and science and on the implementation of legal measures at universities to fight discrimination (Working Committee on Equal Treatment at Universities). By the end of the 1990s several anthologies were published which discussed the actual situation of women or gender gaps at different Universities or in different subjects (cf. Bundesministerium für Wissenschaft und Verkehr 1997; Schaller-Steidl, Neuwirth 2003). In recent years the evaluation of positive measures as well as the implementation of gender mainstreaming at universities became a central topic (Nöbauer et al. 2005; Wroblewski et al. 2007). In recent years the situation of girls in schools – especially in mathematics and science – was intensively discussed in the context of gender mainstreaming in schools (Seiter 2007, Falkinger 2006).

Therefore the research questions for policies towards gender equality in science can be summarized with the following points:

- legal measures at universities against discrimination
- positive measures for the promotion of women at universities
- gender mainstreaming at universities and in schools

Research approaches

In most cases the analysis is focused on the state of the art and conceptual contributions, i.e. discussing the actual situation of women at universities, in research or schools and the need for positive measures. In most cases the articles contain a description of relevant positive

measures or good practice examples. In the early 1990s, the analysis of gender gaps by using administrative data was the starting point of discussions about the necessity of positive measures. First research on the implementation of such measures focused on the acceptance and the underlying program theory. These articles mainly refer to experiences of experts involved in the implementation of such measures (e.g. Holzleithner 2002, 2004; Ulrich 2003; Schaller-Steidl, Neuwirth 2003).

Evaluation of single positive or gender mainstreaming measures use qualitative methods (interviews, focus group discussions, observations etc.) to analyze the implementation and acceptance of the intervention (see Nöbauer et al. 2005 who evaluated the implementation of mentoring at the University of Vienna). A comprehensive evaluation conducted in 2004 used a mix of quantitative and qualitative methods to analyze a policy mix (Wroblewski et al. 2007).

Findings

The results for Austria can be summarized with the following points:

- In 2003 the Austrian Federal Ministry for Education, Science and Culture commissioned an evaluation of several measures to promote women in universities and science (cf. Wroblewski et al. 2007). These measures have been implemented since 1990 and form the basis of public promotion of women in science in Austria. The study aims at collecting and assessing the achieved effects and results in a systematic way in order to identify possible 'blind' spots and to derive possibilities for the future development.
- Object of evaluation is a set of measures, containing, for example, cholarships for women, financial support for publications, child care facilities at universities, coordination offices for Women and Gender Studies, legal measures like the Working Committee on Equal Treatment at the Universities or the Decree for Affirmative Action Plan in the Sphere of the Federal Ministry, and programmatic measures like the White Paper for Affirmative Action in Science. Those single measures have been introduced at several points in time (during the 1990s) and are extremely heterogeneous in terms of contents, goals, target groups, intensity, and governance.
- The results clearly indicate that selective single measures achieve their principle targets to a lesser extent than measures, which combine different approaches. But using synergies from different interventional procedures requires a coordinated set of measures with clear definition of goals. During the last years the measures set to promote women in science and research in Austria have this strong focus on detecting and using synergies, which is demonstrated best by the fFORTE-initiative (for women in research and technology) that combines different types of measures as well as target-groups and contents.

Gaps

There is hardly any research on gender gaps and measures to promote women in science and research outside universities. There are no specific measures focusing on women working in non-university research institutions.

3. Conclusions

Considering the Austrian publications according to their time of publication shows a peak at the end of the 1990s. The number of publications increased since the 1980s but decreased in the last years.

These developments seem to correspond with the gender equality policy in the ministry of science. The department for research and statistics with its head Eva Knollmayer was a very important promoter of gender and science research. She did not only promote gender studies at universities and the networking of feminist scientists but also financed gender research. Research questions were pushed to analyse disadvantages and exclusion processes of women in science in a systematic way. These studies were published by the Ministry in the series "Materialien zur Förderung von Frauen in der Wissenschaft".

The support of gender research by the ministry of science has also contributed to the fact that a significant part of the research of gender and science was done by non-university scientists. With the financing of special research questions of the ministry researchers of the non-university sector could be attracted for doing gender and science research. In many ways these research questions were formulated in order to promote the development of specific promotion measures. For instance, the promotion of women in technical and natural science was accompanied by analysis of the hindrances of women for these fields and by evaluation studies of such measures.

Another Austrian specific aspect influencing the research on gender and science was the implementation of the gender equality act in public employment in 1993 that also covers the staff of the universities. That means, that women and men have to be treated equally, otherwise the institutions for equality like the Working Committee on Equal Treatment at the Universities can prevent decisions discriminating women. The gender equality act covers discrimination concerning equal pay, staffing, sexual harassment etc. in the public service and should prevent discrimination of women on universities. This betterment of women in the public service, including women at universities, might have contributed to the fact, that disadvantages at universities are less prominent than in other countries.

Other gaps in gender and science research in Austria can be summarized in the following fields:

- comprehensive empirical analysis of vertical segregation
- wage discrimination on universities
- gender bias in funding
- analysis on the working time and working conditions in research
- extending analysis on scientific excellence
- hindrances and risks of the institutionalization of gender research
- gender inequalities in non-university research institutions

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