

## How Informal Processes and Relationships Shape Gendered Careers in STEM

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**Abstract:** The number of women in the STEM sciences decreases the higher you look up the career ladder. Although the number of female university entrants reached 22% fifteen years ago, the percentage of female professors at universities and universities of applied sciences in this subject group in Germany is currently around 12%.

Universities and other science and research organizations react to this problem by introducing new policies, which aim to 'fixing the women' by conveying relevant career skills to them. Such measures are based on the assumption that a successful career depends first and foremost on the decisions and properties of the individual.

In this article, we address the problem of this actor-oriented perspective, which disregards the fact that gender-specific barriers in the field of STEM sciences do not only result from supposedly different behaviour of women that could be 'retrained' or simply adapted. Rather, we focus on hurdles, which arise from the influence of informal relationship networks, which are embedded in the structural and cultural context of the scientific field.

We refer to contributions from research literature on gender, work, and organisation as well as social network analysis in order to problematize and expand the actor-oriented perspective. Using the network practice of 'creating visibility', which is described in two case studies in the field of STEM sciences as career-relevant, it is shown how specific cultural and structural framework conditions influence informal networks. The success of network practices depends, among other things, on the perception and recognition of peers, which is influenced by gender- and field-specific stereotypes.

In order to propose a more differentiated analysis of gender-specific barriers in STEM careers in higher education, we draw our attention to the multi-layered conditions of informal network and relationship constellations.

**Keywords:** informal networks, women in STEM, scientific careers, gender equality policies, gendered careers, organisational studies

### 1. Introduction

The promotion of equal opportunities in STEM has meanwhile become a widely discussed topic with continued high relevance. In recent years, the proportion of women there has risen. German data show that the percentage of women among first-year engineering students rose from 17% to 25% between 1993 and 2017 (Federal Statistical Office of Germany 2001; Federal Statistical Office of Germany 2018). However, if one observes the proportions over the stages of a scientific career path, the proportion of women decreases from 22% of first-year female students in 2003 to 12.21% of female engineering professors at German universities today. It turns out that the higher the career level, the lower the proportion of women – this is illustrated by the imagination of a "leaky pipeline" (Berryman 1983).

Policies react to the under-representation of women in high professional positions with targeted coaching and support offers. These measures aim to impart career skills and bring women closer to strategies that promote success (Bamberg et al. 2009). These sets of measures, which are to be classified under the term 'fixing the women' (Schiebinger 2008; Chant/Sweetman 2012), are based on a disproportionate orientation towards actors and the assumption that the career path can be formed to a high degree on one's own initiative. In a way, they provide support for adaptation, implying that women would have the same opportunities for career advancement as men if they only applied the strategies in question. However, such measures, which propose a reorientation of women's micro-political actions, are not enough. They disregard that the hurdles for women are rooted in the structural and cultural framework of the scientific field (Lind 2007).

The complex relationship between organisational, cultural and individual factors must be taken into account if new evidence is to be found of causes for the under-representation of women in executive positions. Gender policies and their measures aimed at promoting equal opportunities for women must not overlook this complexity. Previous sociological studies on scientific careers – which deal in particular with organisational and structural barriers as well as implicit selective mechanisms (e.g. Beaufaÿs 2003; Leemann 2002; Maurer 2010) – have been insufficiently connected with the practice of networking. It is therefore our attempt to conceptually link cultural and structural conditions, informal relationships and network practices. In order to clarify the area between theory and practice, specific practices, in our case informal networking practices, that enact gender-specific career obstacles at the upper hierarchical levels of universities, need to be identified and fathomed (Beaufaÿs 2012).

Starting with a literature analysis, the relevance of networks for careers in general and for scientific careers, in particular, is explained (2). Then the disproportionate orientation towards the actors' capacity to form their career and the associated problems are outlined (3). In order to identify barriers that become effective within informal relationships, we will open the analytical perspective to the conditions in which network practices are embedded and to the specific 'logic of the social field' (following Bourdieu 2006) by which actors are influenced. Subsequently, our article is based on a content analysis of two problem-oriented, narrative interviews with postdoctoral researchers from STEM sciences. These selected contrastive interviews are part of the ongoing research project GenderNetz on the relevance of networking on scientific careers in STEM. Discussing one networking practice, selected from these two case studies, which we call 'creating visibility', it will be shown how framework conditions affect specific possibilities for action and to what extent a field's ideals and perceptions influence informal relationships and the perception of the counterpart (4).

This article thus critically examines previous approaches to investigate informal networks and their practices and opens up a more differentiated horizon for research on networking practices.

## **2. The relevance of networks for careers**

In order to gain an impression of the effects of networks on careers, we present a brief outline of the essential contexts that affect networking in the field in which our project is concerned. The labour market is a matching market. The search for a new employee or a new job is burdened with considerable information deficits for respective seekers. Market participants are therefore interested in minimising their information deficits. Certified performance records and complex application procedures have only limited success in reducing this deficit. Therefore, social networks are activated to a considerable extent during the search in order to get more informations about the market and potential contract participants (Voss 2007). The mediation via networks is supposed to save searching costs and increase the quality of the selection through a better fit. Although Voss notes that the advantages of activating social networks on the labour market are not demonstrably present from an economic perspective, he notes the enormous quantitative importance of social contacts for getting a job or employee (*ibid.*).

Social network analysis confirms this relevance. Granovetter's (1973) study on the strength of weak ties, concluded that access to new jobs for workers often stems from weak ties. Unlike strong ties, they offer a chance for new information. Even though subsequent studies discuss the exact network structure relevant to the labour market and their function as social capital, the great importance of networks remains undisputed (Burt 1992; Coleman 1994).

Weak ties are likely to be informal. The vague characterization of informal relationships as not formal indicates the broad focus that this term places on a wide range of phenomena. Informal networks serve to provide advice, support, information, friendship, influence, all of which have the potential to be used as resources to improve career opportunities (Burke et al. 1995; McGuire 2002). In a more indirect sense (informal) relationships help to understand implicit knowledge (Durbin 2011), such as specific logic and ideals of a social field.

Within the field of science, it can generally be assumed that a meritocratic principle prevails, which alone justifies scientific achievements as the basis for a successful career. However, as Kahlert shows, even in structured doctoral programmes and comparable doctoral settings, the qualification of young researchers is highly influenced by personal relationships, individualised funding practices and selective cooptation processes (Kahlert 2015). Here especially mentor relationships play an import role. They can take place exclusively within the formal framework or develop into an intensive promotional relationship. Cooperation in science is also of great importance beyond the relationship of supervision. It serves to open up new research fields, help to increase the publication rate, facilitate scientific exchange, help to acquire partners or third-party funding and are thus an important career capital (Gruhlich 2016; Hendrix et al. 2016).

In the specific case of engineering sciences on the career path to a professorship at a university or college, there is often a requirement to have gained knowledge from entrepreneurial practice before being appointed. These scientists' networks are of great value to their universities. So at one point engineering scientists have to leave the scientific field (Leemann 2013). Networks and relationships can help to provide information on and gain insights into a previously unknown field.

### **3. The actor-oriented perspective on networks and networking**

From a socio-theoretical point of view, the use of the network concept itself is an expression of a changed legitimacy structure of entrepreneurial action (Boltanski/Chiapello 2007). Up until the 1960s, the term network had a negative connotation. Networks were associated with secret societies and hidden negotiations about offices and positions. It was not until the 1980s that the term gained positive connotation since it could represent the mobility and dynamics of the liberal globalized society (ibid.). This conceptual shift is associated with an increasing demand for flexibility, in which responsibility for one's own career has been delegated from organizations to individual actors (Wingender/Wolff 2017). Nevertheless, networks were associated with a liberating significance, as actors could set themselves apart from their class affiliation through the targeted design of their relationship environment. From this insight that the relationship environment has a vital influence on the individual's potential for action, the idea grew that it is possible to influence one's own fate through the targeted design of the relationship network.

It is a paradox that this actor-oriented perspective on networks is based on the results of social network analysis, which follows the methodological and theoretical tradition of structural analysis (Diaz-Bone 2007). Although this tradition is subject to a powerful critique by Emirbayer and Goodwin (1994), who attribute a structural determinism to traditional social network analysis and argue for the implementation of the analysis of cultural formations and the agency of actors in networks (Diaz-Bone 2007), it is not a well suited framework for an individualistic theory of action. Transferring the findings of this structural approach into instructions for action ("networking") remains problematic, particularly with regard to the complex relationship between structure, culture, and action.

But the instrumental availability of relationships is emphasized, especially in studies with a theoretical foundation in micropolitics according to Crozier and Friedberg (1980). Networking is understood as an instrumental political action aimed at asserting one's own interests against resistance (Wingender/Wolff 2017). Actors in organisations struggle for power and resources, which they want to increase by forming their network of relationships. Micro-political approaches in the field of gender equality policies, therefore, draw on the necessity for women to learn the competencies of successful networking.

If the promotion of careers and especially the under-representation of women in executive positions is addressed with specific policies, it is often the micro-political promotion of networking skills. The under-representation is partly attributed to a deficit practice of women, which has resulted in coaching and mentoring programmes that specifically target women (Rastetter/Cornils 2012; Muser et al. 2015; de Janasz/Forret 2008). These approaches promote 'fixing the women' strategies starting from the idea that women must be 'coached' in order to learn the promising ways of acting or networking in the field in order to fit into the male-dominated system. They place women in a position of justification and delegate to them the responsibility of 'improving' their professional networks in a targeted manner.

The emphasis on individual opportunities for action is particularly problematic if, due to different (pre-)conditions, be they structural, cultural or individual, the same recommendations for action cannot be effective for everyone. The micropolitical concept does not take into account the specific needs and conditions to which women are exposed in the field of engineering sciences we are investigating.

### **4. Framework conditions of networking: Insights from case studies**

GenderNetz investigates the importance of contacts for the scientific career path and focuses on gender-specific aspects. Therefore 68 narrative interviews shall be conducted with post-docs and gatekeepers in engineering sciences and information technology. As a preliminary study, we analysed two interviews with post-docs we selected because we observed a very similar practice in them, which we will discuss further in the following section.

This analysis serves to examine the structural and cultural conditions of network relationships and their influence on career paths. In the following, we present selected results of these case studies and associate them with theoretical approaches.

#### **4.1 Creating Visibility**

In both selected post-doc interviews one career-relevant network practice becomes in particular apparent, that seems to play a crucial role in everyday working life. This practice may serve as an example to point out the limitations of micro-political networking support programmes. It outlines the conditions in which network practices are generally embedded and which determinants are relevant to identify possible gender-specific barriers. We call this networking practice 'creating visibility', which appears in various facets in the narratives. Creating visibility means that career-relevant contacts are made aware of one's character, activities or performance. It is about strategically generating visibility in order to benefit from it in further stages of a career in form of being considered in important projects, receiving support or being consulted for cooperation.

#### **4.2 Determining framework conditions for 'creating visibility'**

With regard to the conditions that promote successful networking, time, in particular, must be considered as a necessary resource and condition to establish and ensure visibility. The male interviewee states that he invests a lot of time figuring out how his work is perceived and judged in his scientific field and which topics are more popular in order to be able to promote his work in a targeted manner: *"And that's why I just spend a lot of time on networking. To somehow experience this community sensing with 'what does my peer group think' – so the people who rate our papers – 'what do they think is cool. Where does it go'. Um, but of course also the opposite somehow to strengthen our position with 'we think that's cool, we're working on that right now. Please don't forget us'"* (P2, 674-680). Therefore, it requires the availability and investment of time, in order to create visibility for oneself or one's achievements in coffee breaks, corridor discussions and conferences for instance. Time and presence are two essential aspects that are mandatory in order to conform to the academic ideal, as Paulitz, Goisauf and Zapusek (2015) mention in their study on work-life balance in scientific life. This applies particularly to 'creating visibility' as a networking strategy.

But, the resource time and therefore also presence is not evenly distributed among scientists. This imbalance is illustrated by the female interviewee describing the limitations of part-time work as follows: *"I think the difference between a part-time job and a full-time job is that in a full-time job you have a great amount of time to stand somewhere in a coffee break and say 'I already did that'. To pat oneself on the back (...) to show up everywhere and say 'boa, what have I done great again today'. (...), everyone does that. (...) But you don't have time for that in a part-time position anymore."* (P1, 752-767). Part-time work increases the work density and reduces presence thus the time for casual conversations is limited.

The descriptions of the compensatory mechanisms the female interviewee used during parental leave indicates negative effects on visibility which occurs due to a longer period of absence. The interviewee actively and strategically establishes her visibility during parental leave, otherwise fearing to be forgotten and not considered for further employment: *"I've been to the institute regularly. And I always asked what's up. I simply believe that by the time you are no longer there, when you are no longer present at the institute daily and, uhm, can't draw attention to yourself or can say 'it looks like this and that', you are going out of focus a bit"* (P1, 267-273).

Given the fact that in most cases women go to parental leave, the resulting gender inequality of opportunity is obvious (Winker, 2010). Although the number of men taking parental leave has increased in Germany since the introduction of the Federal Parental Allowance and the Parental Leave Act in 2007, traditional gender relations continue to have an effect, with women being seen as key persons for child care (Becker-Schmidt 1987; Peukert 2015).

#### **4.3 Conditional factors for attributing competence**

As Engler (2001) shows, scientific careers are not simply about achieving excellent results. The key to a successful career are recognition and attribution processes which determine opportunities to a large extent. *"In science (...) you can do your job as good as you want, (...), but progress depends on external colleagues. And of course, it makes it somehow more difficult, because it's simply unpredictable (...) a lot of it depends on external persons. If I apply for third-party funding, if I submit project proposals, how many of these are approved depends on external reviewers"* (P2, 898-923). This interview quote indicates that 'being perceived' as competent by the counterpart becomes relevant but in a process that is described as 'uncontrollable' and 'incalculable' (P2, 940, 946). Even if it is assumed that the strategies are well mastered, it does not mean that they are actually successful.

In order to understand how competence is attributed, it is important to consider the ideal image of competence in scientific contexts. On the one hand, the attribution of competence is required in the scientific field to take up leading positions (Beaufaÿs 2012). On the other hand, the ideal of a scientist is closely linked to the expectation that science always has to be the highest priority in all life's areas. Following Bourdieu's field concept Paulitz, Goisauf and Zapusek (2015) analyse the field-specific characteristics of engineering science.

They come to the conclusion, among other aspects, that complete devotion and a holistic commitment form the ideal of the scientist. The ideals take part in the constitution of patterns of perception and evaluation of those belonging to the field.

Following McGuire (2002) and the "Status Characteristics Theory" (Berger et al. 1977), it can be understood how ideals, conceptions and stereotypes determine the perception and attribution of competence. The male post-doc describes his impression of the situation of women in information technology in the following way: "*I think it is rather that she is very advantaged. I don't mean that negatively, but um, I mean it's a male domain. If there is a woman every male fellow student is somehow/ ((laughs)) has a great interest in helping her to explain certain things*" (P2, 759-764). Although he considers being a woman in the field of information technology as an advantage, in his statement the attribution of women as being in need of help and support predominates. McGuire examines how gender inequalities manifest in informal networks. She states that even if women have a strong position in their network, manage relevant resources and have connections to powerful employees, they receive less career-relevant assistance and support from their network members than men do (McGuire 2002). She shows that the evaluation of the counterpart depends on the resources which are attributed via his or her gender. Network members consider women to be less resourceful and competent.

In line with the Status Characteristic Theory, we find that the attributions that determine support in our study stem from a male-technically oriented field. It is not only the ideal image of absolute devotion to science that forms the conception, but also specific stereotypes that link gender with an affinity for technology (Buchholz et al. 2018). Faulkner traces in her study of software developers the bipolar construction of the mindscapes that are effective in the field in the form of "masculine instrumentalism and feminine expressivity" (Faulkner 2000). The historical development of the close connection between masculinity and affinity for technology leads to a devaluation of women. Technology is conceived and constructed as a male domain (Paulitz 2015). Women are also devalued by the fact that they are always assigned to the social sphere (Faulkner 2000). This can be seen clearly when their role in the team is mentioned in the context of the working atmosphere: "*Well I mean in the end I believe - as I said, we once had female employees - I believe that also for the total atmosphere it is quite good, if this is not a pure male workplace*" (P2, 838-841). The female interviewee says she needs to point out that she's actually not in the role of a mother: "*I already had to put my foot down once or twice and say 'I'm not reduced to the role of a mom here'. So someone says 'yes, you're our mum here'. #mhm# and I said 'to make one thing clear: 'I'm a post-doc here'*" (P1, 747-750). Women are subtly reminded that they are still foreign in the production sphere. They are regarded as potential mothers who may be absent from the organisation for a period of time due to pregnancy/parental leave (Paulitz/Goisauf/Zapusek 2015). The connection of the mother role and the family sphere with being a woman influences the perception and is contrary to the ideal of a scientist.

## 5. Conclusion

After analysing the two interviews, we are able to identify different levels of 'creating visibility'. Visibility is created for example by presenting research results, meeting for dinner with relevant people but also in casual everyday situations. Both interviewees clearly show that they want to advance their careers strategically by presenting their achievements.

Furthermore, the micro-political and actor-oriented perspective only aims in one direction and neglects the second or third person within the relationship and disregards their influence on the relationship. Thereby gender-specific barriers in networking are thus overlooked. Our analysis has shown that perception and attribution processes, which arise from field-specific mindsets, are decisive for attributing competence to a person and thus for successful networking. These processes are influenced by the ideal of a scientist who completely surrenders to science. In addition, the historical and bipolar connection between masculinity and technical affinity and between femininity and technical incompetence plays an important role for attributing competence along field specific stereotypes. Furthermore, our empirical material showed that mothers on part-time or parental leave have fewer time resources, which are necessary to successfully establish visibility, and we outlined in that way the influence of structural conditions.

In STEM sciences there is still an under-representation of women. Therefore, we have linked in our paper structural and cultural conditions and informal relationships to networking practices that are career relevant for scientists in STEM. Our results indicate that policies which only encourage women to learn successful networking disregard relevant aspects leading to gender inequality. These policies take too little account of the given environment's complexity.

Future gender equality policies will have to take into consideration the entanglement of multi-layered factors and develop measures that take into account gender-specific barriers which arise out of the influence of

informal networks and relationships. A relevant starting point may be the softening of the concept of the 'ideal scientists' who dedicates their resources unreservedly to science. Alternative concepts of a scientific lifestyle should be equally enabled and institutionalized.

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