

# WHY ANNA LEFT ACADEMIA

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*This paper aims to explain why Swedish female mathematicians decide not to work in academia. The stories of five women were merged into one narrative. Anna describes a struggle with her own self-identity in a gendered structure that most often involved implicit power. One of the main reasons for not working in a mathematics department after finishing their PhD was the difficulty in getting a job without support.*

## INTRODUCTION

In Sweden, more women attend undergraduate higher education and more women than men receive degrees from such studies in most subjects. For graduate studies, the Swedish government has set an official gender policy of 60/40 meaning that no sex constitutes more than 60% of the total numbers of individuals. Nevertheless, there are still some unbalanced areas, and mathematics is one of the most extreme examples (Lindberg, Riis & Silander, 2011). This is despite a 50-50 division at the most mathematical intense upper secondary school programme. Women seem to disappear starting at undergraduate level: one third of all students in mathematics or other mathematics intensive courses including engineer and teacher education are female (Brandell, 2008). This is a similar situation to the USA (Herzig, 2004) and most of the European countries e.g. UK (Burton, 2004). For female post-doctoral fellows, senior lecturers and professors the number decreases even more. In 2007 the number of female post-docs in mathematics in Sweden were 6 %, senior lecturers 21%, and professors 7% (Lindberg, Riis & Silander, 2011). This decreasing pattern is in many ways an international phenomenon with different aspects connected to it (see e.g. Forgasz, Becker, Lee and Steinhorsdottir, 2010). In USA the number of women doing a postdoc is far less the number of graduate students, and considering that a postdoc is a strong factor for the possibility to get a tenure track it affects the number of professors (Nerad & Cerny, 1999). In the UK, in 2002 only 2 % of the professors in mathematics were women (Burton, 2004). Comparing with Sweden and 7% women professors, most of them are in subjects such as mathematical statistics and mathematics education (Wedeg, 2011). This means that some areas are (even) more male than others, and this in a society where “gender equity is highly valued at societal and political levels” (Brandell, 2008, p. 659). The main problem seems to be number of women disappearing after undergraduate/graduate level, and the Glass Ceiling Effect in mathematics is in Sweden high (European commission, 2009). If all women doing a PhD in mathematical sciences (one third) stayed on, we would most likely have more female lectures and professors even in the areas ‘less female’. So, where do all the women go and why do they leave?

Earlier research suggests different potential answers that might explain why this is happening. By interviewing mathematicians, Burton (2004) found that one of the themes that indicated a gender structure was the discourse of power. Women seem to be facing the use of power in many different ways e.g. being disadvantaged as a job applicant only because of being a woman. This use of power can be explicit but also implicit and hidden, so called ‘non-events’ (Husu, 2013). Non-events can be anything from being ignored at meetings or in the coffee room to not being invited to conferences or selected as keynote speakers. The lack of support and discrimination (both explicit or hidden) are two main factors behind women struggle to advance in their careers both general (Husu, 2005) and in mathematics (Henrion, 1997) or other STEM subjects (Heilbronner, 2013). Women develop several coping mechanism in order to ‘survive’ (Husu, 2005), especially in areas where a female identity is attached with negative symbols (Volman & Ten Dam, 1998). Solomon (2012) women undergraduate students in mathematics are forced to work with their identity, their self-concept as ‘a woman in mathematics’, including how they talk about themselves and their situation. Other factors are built in the structure itself, such as norm-controlled self-selections and internal and external factors such as how research grants and other funding are distributed (Lindberg, Riis & Silander, 2011). Solomon (2007) concluded that even when they are successful, women position themselves as not belonging in mathematics. The aim for this paper is to explore women’s own stories. The research question posed is: What reasons do female mathematicians give for leaving mathematics as an academic profession?

## **BACKGROUND**

The two main concepts for this paper are gender and self-concept or self-identity. I will here discuss these shortly.

Gender is understood as a social construction more than a consequence of a biological sex (West & Zimmerman, 1987; Damarin and Erchick, 2010). It refers to what is thought of as “feminine and masculine, characteristics and culture dependent traits attributed by society to men and women” (Wedeg, 2011, p. 6). The concept gender can be divided into four different aspects (Bjerrum Nielsen, 2003): structural, symbolic, personal, and interactional gender. The structural aspect refers to gender as part of a social structure alongside other factors e.g. ethnicity and class. The number of female PhD students in mathematics in Sweden in relation to male students is an example of structural gender. The second aspect, symbolic gender, stems from these structures. Symbols and discourses are attributed to a specific gender creating norms and trajectories that tell us what is normal and what is deviant. The third aspect is personal gender. It focuses on for instance how the individual perceive the structure with its symbols, e.g. female professional mathematicians description what it is like to work in a mathematics department (Burton, 2004). Sometimes there can be discrepancies between the personal gender and the symbolic gender, e.g. girls are considered insecure in mathematics but don’t feel insecure themselves (Sumpter, 2012). The last aspect is interactional gender. Compared to personal gender, which

describes gender as something we “are”, interactional gender is something we “do” (Wedegé, 2011). These four aspects on gender is an analytical tool used to highlight different sides of the same phenomena more than something that occurs in different situations.

Self-identity (or self-concept) is how you view yourself including dimensions, such as capacity or role in different situations (Devos & Banaji, 2003). A broad definition is a person’s perceptions of him- or herself (Marsh & Shavelson, 1985). This doesn’t need to be conscious knowledge that is explicitly indicated but could also be measured “via unconscious expressions of thought and feeling” (Devos & Banaji, 2003, p. 154). The notion of self-concept should be viewed as a dynamic concept that is developed and changed through interactions and experiences.

## METHOD

A written questionnaire was sent out to nine female mathematicians that finished their PhD in a Swedish university in mathematics during the years 2002-2012. Mathematics should here be interpreted as mathematical sciences such as pure and applied mathematics, mathematical statistics, computational mathematics and optimization but not including mathematics history or mathematics education. The author knows four of the women and the other five were found through a mutual contact or the Swedish network ‘Women and mathematics’, a sub-organisation of IOWME. Since the answers to the questionnaire were kept anonymous, and the respondents were aware of this, the assumption is that the difference connections didn’t affect the objectivity or the quality of the replies. The respondents were instructed that they could write as much or as little as they wanted. The main questions posed were: (1) Why did you become a mathematician/ Why mathematics?; (2) How come you did a PhD in mathematics?; (3) How was it to be a (female) PhD student in mathematics?; and, (4) You have a career outside the university. How come? To each question, several optional sub-questions were posed to decompose the main questions. They were also asked to write something about their background. The respondents were requested to send back their answers within two weeks. A first analysis of the data showed that five of them had similar answers with a slightly more negative tone in their responses whereas the remaining four described a slightly more positive view. In this paper, because of the limited space, I will focus on the first five. They constitute the base of for the story here presented as Anna’s. This method, to create a collective narrative from several respondents, is a method used by several researchers e.g. Mendick (2002). It is a tool to emphasize meaning of responses, patterns, in a collective context rather than to show individual’s replies (Mendick, 2002). In this way, the collective narrative analysis here shares a similar approach to the data as content analysis (Smith, 2000): the aim is to identify characteristics of the material. Here the characteristics are told by a fictive voice. The story presents the most common replies to the questions, where the respondents’ written answers have been interweaved into one. This is helpful when you want to increase to possibility of keeping the respondents anonymous especially in a small community. As common in narrative analysis, my own voice is part of the story

(Smith, 2000) although I've tried to minimize it as much as possible by using the respondents' own formulations. Sometimes the formulations have been joined together to one sentence and in some cases I've changed the context (e.g. lessons have become seminars) to make sure that the specific person/ situation can't be identified. The meaning of the replies remains the same in both these cases. This study falls under the personal aspect of gender focusing on women's own explicit self-concept in the role of 'female non-academic mathematician'.

## **RESULTS**

Anna was born and grew up in a middle size town in Sweden. She studied the most mathematical intensive program at upper secondary school (age 16-19), the natural Science Programme. Her parents, although not in mathematics themselves, have always supported Anna in her studies. Anna started her PhD almost right after her undergraduate studies (which was in mathematics/applied mathematics combined with engineering/ physics/ statistics/ computer science; 4-5 years). She was then 25-30 years old. During her PhD, she had children and was on parental leave. Anna finished her PhD when she was around the age of 35. This is now 1-10 years ago. She had both female and male supervisors (where the most common situation was only male supervisors). Anna is now working as a mathematician/ researcher in a private corporation or at a council/governmental institute.

So why did Anna choose mathematics in the first place? Her answer is based in school mathematics and mathematics education:

I have always found mathematics easy during school. Maybe it wasn't fun to do all the routine stuff, but I really liked problem solving. Math is fascinating!

She studied as much mathematics you can do at upper secondary school. When it was time to enter university, the choice of programme included mathematics. But it wasn't obvious that she would do a Ph.D. in mathematics. Some people encouraged her to become a part of the department, but there were also people who discouraged her:

During my undergraduate studies I was encouraged to take an amanuensis position. I doubted if I was clever enough to do a Ph.D. in mathematics, and one time during an oral examination, the teacher asked what my plans were. I said I was thinking about Ph.D. but that I wasn't sure that I was clever enough. He said 'yes, I can agree with that.' But in the end, I felt that this was something I really wanted to do. I wanted to do a PhD, I wanted to learn more.

Anna got a PhD position at the same department where she had done her undergraduate studies and worked as an amanuensis. How was it then to be a (female) PhD student in a mathematics department? Anna explains:

Often you are the only woman (or one of few) when you study mathematics, so I was used to this from my undergraduate studies. Most people were positive and friendly, but it was like an underlying structure that now and again reminded me that I should not think that I was as good or clever as the male students. For instance, one time I took a course and the professor ignored me – he wouldn't answer my questions! In seminars, when I raised

topics that could be seen as critique, I was told not to be so troublesome. Male students, they were instead praised for their ability to scrutinize and flexible thinking. But this didn't discourage me. I would say I got more determined to show them wrong.

Anna thinks that this might be a reason why female mathematics professor now and again are described as cold and sharp. She says:

Sometimes you hear that female professor's got sharp elbows because they have to fight their way up, and I assume it is because of the feeling of working in constant headwind.

However, the symbols attributed and used in comments can be tiresome:

I've heard everything that aims to diminish what I'm doing, such as that it is no point with female PhD students since they are going to end up next to the stove anyway to that the only reason why I got funding is because I'm a woman. Once I was told that you should have higher demands on female PhD students since they need to prove themselves.

The department seemed to be aware of this structure and now and again made some effort to change the work climate. But this was not an easy task:

When the department tried to implement things to make working life easier for women it was worked against [by some people]. It was like there was a systematic way of opposition against women, but it was made in a very subtle way so no one could really object.

This hidden conscious or not conscious structure got more explicit at some occasions, for instance when scheduling seminars. During her PhD, Anna got pregnant and had children. She was on parental leave and then came back to work, trying to combine parenthood with work:

The first years being a parent they scheduled seminars late in the afternoon, which meant that I couldn't go since I had to pick up children from nursery. In the beginning there was no understanding about this.

But overall, having children during the PhD was not a problem. The issues were more based on the restricted time of a PhD (related to funding) and the change of view of when to do work.

Overall, I have never felt I was treated differently or badly for having children. The difference is how you as a parent want to spend your time changes. The working hours are for work, but when the day is over I want to go home to my family. It was though being pregnant, but that was more due to the pregnancy itself. But it was hard to focus when you are tired and math is a subject where you need to be focused the whole time. It was also tough coming back from parental leave because work felt so distance. It was hard to remember and to get going. It took some time and energy before I was back on track so to speak, and now I realise that this cost me a few months.

The choice to leave was easy.

I started by applying for lot of different positions. I didn't get them. One time, they gave a position to a man who wasn't as qualified as me with the explanation that his work was much more 'developed'. How can you argue against that? I didn't have the network to work for me, to argue for my case. I was alone, and you can't get a position when you don't have support. My supervisor(s) didn't help me at all. So the choice was in some sense easy.



In my current workplace, I've been extremely well taken care of and they appreciate the work I'm doing. There is a clear plan of how I shall develop and the work I should do. We work in teams and we have the same goals. The sum is greater than the parts. At the department, we sat in our offices with closed doors and that didn't suit me so well. And we are not pushed to work overtime – they respect our working hours. It is very interesting. You get a lot of feedback and you push each other forward. And our product is useful for the society.

But Anna would have stayed if the situation had been different.

You know, I really wanted to stay in academia. The only thing that was needed was a position that wasn't a short-term temporary one. I both miss the type of research you do at a university – that you can completely focus on one single detail of a problem - and the teaching. I miss going to seminars even in subjects that wasn't your own one. But I do not miss the working climate and I definitely don't miss the stress of applying for grants that you are most likely not to get. I didn't like that everyone should be 'best', the competition and the lack of common goals to strive for.

Anna gives two main reasons for why she is working outside academia. The first reason is the lack of full-time, long-term jobs in academia, or more specifically, how hard it is to get such a job without the right network. The other reason is the atmosphere especially when compared to other workplaces.

## **DISCUSSION**

The purpose of this paper is to try to understand the decreasing numbers of female in positions in higher education in mathematics in Sweden. Anna is one (fictional) voice aiming to give such explanations. Her voice relates to a structure recognised in previous research (e.g. Forgasz, et al, 2010). She describes the subtleness in how women are worked against and the struggle of keeping your self-concept in an environment where you are under pressure just for having the 'wrong' sex. Seminar scheduling and who to praise in a seminar are examples of explicit and implicit power, the latter one including what Husu (2013) refers to as 'non-events'. Anna uses the term 'constant headwind' as an illustration of this struggle.

Anna describes several instances when she is talking about herself in relation to the context and the changes in her self-identity, for instance the change of view of work when having children. The negotiation of the self-identity seems to be an ongoing work (Solomon, 2012). If the efforts to change made by the department were successful depended on the people, not a lack of regulations or policy documents. One of the main reasons why Anna is working out-side academia is the struggle to find a job without support. This has been highlighted in previous studies both in mathematics (Henrion, 1997) and general (Husu, 2005). Anna mentions also the stress of getting grants, which seems to be a filter for further careers (Lindberg, Riis & Silander, 2011). She also compares work environments and stresses how nice it was to find another place where the (collective) effort was appreciated. As Solomon (2007) concluded, there exists a language of a 'not belonging' even when a women is successful. Anna

expressed that she belongs to mathematics and mathematics belongs to her. What we need to further understand is why working in a mathematics department is not an option and how we can change this situation.

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