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Behind the "Success Story": Exploring the Experiences of a Woman Mathematics Major

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Abstract In Canada, women are a minority in university mathematics programmes, and this situation has not improved in the past several years. To examine this situation, research was conducted to investigate the experiences of women who might be considered "success stories" in mathematics—those who persevered beyond their initial years of university study—to understand the supports and challenges that they faced. Elise, a master's student in mathematics, participated in this study. Although by external standards Elise was a very successful student and perhaps even a "model" of a successful woman in this field, her interview provided evidence that she was very anxious and nervous, and felt extreme pressure to succeed and be "perfect". By examining Elise's experiences, a better understanding of the tension between Elise's outward success and internal anxieties can be garnered. Additionally, a re-examination of traditional definitions of women's success in fields dominated by men is provided. We also discuss considerations that should be taken into account when interacting with high-achieving students.

Résumé Au Canada, les femmes sont en minorité dans les programmes de mathématiques à l'université, et la situation ne s'est guère améliorée dans les dernières années. Pour analyser cette situation, une recherche a été menée afin d'examiner l'expérience de femmes qu'on peut considérer comme des exemples de réussite en mathématiques – celles qui ont persévéré au-delà des premières années d'études universitaires – dans le but de mieux comprendre le soutien qu'elles ont reçu et les défis qu'elles ont relevés. Elise, étudiante à la maîtrise en mathématiques, a participé à cette étude. Même si, selon les critères standards, Elise était une excellente étudiante, voire un modèle de femme ayant réussi dans cette discipline, l'entrevue réalisée avec elle indique qu'elle était très anxieuse et nerveuse, et qu'elle sentait une forte pression l'obligeant à réussir et à être « parfaite ». En analysant l'expérience d'Elise, nous sommes en mesure de mieux comprendre la tension qui existe entre les signes extérieurs de la réussite et l'anxiété profonde. En outre, nous proposons une remise en question des définitions traditionnelles lorsqu'il s'agit de la réussite des femmes dans des disciplines dominées par les hommes. Nous nous penchons également sur certains facteurs dont il faudrait tenir compte lorsqu'on interagit avec des étudiants très performants.

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Introduction

Mathematics is a highly gendered field that is often perceived to be "difficult, cold, abstract, theoretical, ultra-rational, but important and largely masculine" (Ernest 1998, p. 45; see also Burton 1995; de Freitas 2008; Jungwirth 2003). In part due to this enduring societal perception, mathematics has a long history of gender inequities in achievement, attitudes, and participation (Boaler and Sengupta-Irving 2006; Hanna 2003; Leder 1992). As such, much mathematics education research has been devoted to investigating gender issues (Damarin 2008; Fennema and Hart 1994; Leder 1992). In recent decades, mentorship programmes, intervention programmes, and other strategies have been introduced to address gender inequities in mathematics. Whilst improvements have been made, particularly at the elementary and secondary levels, gender gaps in participation persist at the post-secondary level, in several countries and at all levels of study (e.g. Hall 2012; Becker and Jacobs 2001; Sumpter 2015).

In Canada, women have always constituted a minority in university degree programmes in mathematical fields.[1] Problematically, the proportion of women in these fields has stagnated since the late 1990s, with women comprising approximately 27–28% of enrolling students and 30–32% of graduating students in Canadian university degree programmes in mathematical fields (Statistics Canada 2017a, 2017b). These statistics are even more problematic when considering that approximately 56–57% of enrolling students and 58–59% of graduating students are women, proportions that have remained consistent since the late 1990s (Statistics Canada 2017a, 2017b). This situation results in very few women working in mathematics-intensive fields, leading to few women role models. Prior researchers (e.g. Gill 2000; Zeldin and Pajares 2000) have suggested that women role models support girls and women in selecting and persevering in mathematics and related fields.

Whilst these statistics highlight some troubling trends, "Statistics do not talk; however, they only point us to whom we need to talk" (Stepp 2007, p. 8). Furthermore, "Quantitative *counts* exclude qualitative *accounts*" (Wilson 2009, p. 25, emphasis in original). Thus, we sought to learn about the "stories behind the statistics" and provide an in-depth examination of one of these stories.

The Larger Research Study

The research study was framed by a perspective on gender as relating to socially constructed roles or identities (Pryzgoda and Chrisler 2000). We conceptualise gender as "the culturally determined behaviors and attributes that are associated with, but not determined by, biological sex" (Hollander et al. 2011, p. 13). We view gender as a performative social construction that occurs on a spectrum, rather than in a binary[2] (Butler 1990, 1999). Given this stance on gender, we have been attentive to our language choices, electing to use gender-based (e.g. "field dominated by men") rather than sex-based (e.g. "male-dominated field") language to highlight that differences in people's mathematical experiences are related to sociocultural, rather than biological, factors.

Considerations of gender are particularly relevant to mathematics, a field that has been historically considered to be the domain of men. Women were initially seen as being biologically incompatible: "First it was argued that their brains were too small, later that it would compromise their reproductive capacities, still

[1] In the Statistics Canada database, mathematics, computer science, and information science are aggregated.

[2] Whilst we view gender as a spectrum, some of the authors and sources that we cite, particularly regarding statistics and large-scale datasets, treat gender as a binary, so we report their findings as such.

later that their hormones were not compatible with mathematical development" (Henrion 1997, p. xxiv). Whilst these biological arguments have long been debunked, mathematics has continued to be positioned as being incompatible with femininity (Hanna 2003; Leder 1992). Whilst part of this perception arises from the gendered composition of those involved in mathematical fields (i.e. predominately men), it also relates to how mathematics itself is viewed. Due to the continued perception of mathematics as a "masculine" discipline, scholars (e.g. Mendick 2005, 2006) have suggested that doing mathematics is one way of performing gender. Discourses about masculinity and mathematics "inscribe mathematics as masculine, and so it is more difficult for girls and women to feel talented at and comfortable with mathematics and so to choose it and to do well at it" (Mendick 2005, p. 217).

Framed by this lens on gender, in this study, we explored how various sociocultural factors affect women's experiences with mathematics at the high school and university level. The study was guided by the following research question: In what ways do women who were educated in Canada and who are nearing completion of undergraduate mathematics degrees feel they have been supported and challenged in their high school and university mathematics experiences? To address this question, semi-structured individual interviews were conducted, focusing on the supports and challenges that women mathematics majors faced with regard to four key dimensions that have been shown to be linked to women's choice of and perseverance in university-level mathematics (and related fields): (1) family (e.g. Kleanthous and Williams 2013; Leder 2011; Mujtaba and Reiss 2016), (2) peers (e.g. Herzig 2010; Piatek-Jimenez 2015), (3) personal characteristics (e.g. Alcock et al. 2014; Rodd and Bartholomew 2006), and (4) the formal education system (e.g. Gill 2000; Herzig 2004, 2010; Rodd et al. 2014).

The desired participants were women who had solely been educated in Canada and who were in their final years of an undergraduate degree in mathematics at a Canadian university, in order to learn more about the "success stories". Specifically, we wanted to investigate how these women became interested in university studies in mathematics and persisted with their programmes past the point when many other students, particularly women, leave the field. Six women were recruited to participate.

The interviews had a mean duration of approximately 80 minutes. Audio recordings of the interviews were transcribed verbatim, and the participants could review a full transcript or a summary to ensure accuracy. Analysis occurred via thematic coding (Bogdan and Biklen 2007; Creswell 2014) of the transcript data, both with regard to the four pre-established dimensions and with regard to emergent sub-categories.

Whilst five participants met all of the participation requirements, the sixth participant, Elise, did not meet the "year of study" requirement, as she was a second-year master's student. Elise had received a mass email about the study from the mathematics department, and she emailed to express her interest in participating. We accepted her into the study as she fulfilled all the other requirements and, more importantly, she was still immersed in university culture and could discuss her experiences as an undergraduate student, which was the study's focus. Elise's interview was the longest by a significant margin (1:59:33), and she had an interesting story to tell, which brought forth many issues and wonderings.

In particular, the apparent disconnect between the "facts" about her academic success and her own perceptions of her success was striking. Although Elise was a highly successful student, completing her undergraduate mathematics degree by the age of 20 with A+ grades in all her mathematics courses and earning a large national scholarship for her master's degree, she did not seem confident about her capabilities in mathematics. She described how she was highly anxious and perfectionistic, and worried that she would be the "dumbest one" in each class. Elise reported being afraid to ask questions, both in class and of her supervisor: "Sometimes I will not ask questions because I'm afraid I'll look dumb or stupid." As a result, she would struggle on her own beyond a reasonable period of time. When she did not understand something immediately, she jumped to the conclusion that she probably did not belong in mathematics. Elise reported that she feared that people would find out that she was not as intelligent as they believed her to be.

Elise's interview raised questions about what it meant to be a "success story". The study had been framed with the notion of a "success story" being a woman who had persevered in mathematics, a field dominated by men, beyond the initial years of undergraduate study. The rationale was that if the number of "success

stories" increased, then mathematics would come closer to having equitable representation by and input from people of all genders. However, as we delved further into this perceived "success story", we saw the tension between external measures of success and the participant's self-image of being successful. This raised many questions, such as: If a woman completes a mathematics degree with high marks but leaves with feelings of inadequacy that may have been instigated by her experiences in the degree programme, is that a success?

Academic literature is rife with examples of girls and women underestimating their mathematical abilities, as well as boys and men overestimating their mathematical abilities, and these gender differences appear from a young age (e.g. Ellis et al. 2016; Herbert and Stipek 2005; Pajares 2005; Sheldrake et al. 2015). For instance, in an analysis of large-scale assessment data from students in Grades 3, 6, and 9 in Ontario, Canada, Hall (2012) found that boys and girls performed very similarly, but a larger proportion of boys, compared to girls, reported being "good at mathematics". This pattern occurred at all grade levels, with gender gaps ranging from 11 to 18%, in boys' favour. Similarly, in a meta-analysis of large-scale assessment data from New Zealand and Australia, Vale (2008) found that boys consistently reported higher levels of confidence in their abilities than did girls, a finding that held true over time and across grade levels. In an example from the post-secondary level, researchers in the southern US (Bench et al. 2015) found that men tended to overestimate how well they performed on mathematics tests. The researchers suggested that this overconfidence was linked to men's intent to study STEM-related fields at university, a finding that is supported by other researchers (e.g. Ellis et al. 2016).

By exploring Elise's story, we have an in-depth look at the tensions between mathematics achievement and self-perceptions of mathematics ability experienced by a woman who would be seen as successful in mathematics. In the following sections, we provide a brief introduction to Elise and then discuss our conception of Elise as a case study. Elise's story is then explored in depth by considering her early university attendance, family situation, and experiences at university. We further unpack these experiences and Elise's feelings by considering three related topics: stereotypes, role models, and women in graduate-level mathematics. We conclude by questioning what it means to be "successful" in post-secondary mathematics and pondering how we, as professors, can support all students, particularly those who are high-achieving and those from minority groups.

Introducing Elise

Elise grew up in the Canadian province of Quebec. Elise stated that during elementary school, she struggled with mathematics. In high school, she began to understand and enjoy mathematics, even having "math parties" to study with friends. Near the end of high school, Elise's family moved from Quebec, a primarily French-speaking province, to Ontario, a primarily English-speaking province with a different educational system. Consequently, Elise began university in Ontario at the age of 16, two years younger than students from the Ontario high school system, in a French-language programme that resulted in a mathematics degree. She did extremely well in her mathematics courses, receiving an A+ final mark in each. Elise's academic success was noticed by her professors, who suggested that she do her master's degree in mathematics. At the time of the interview, Elise was finishing the second year of her master's degree and planned to begin working in a statistical field upon completion of her degree.

Elise as a Case Study

Although the larger research project was not conceived of as case study research, in this article, we consider Elise as a case study by re-examining her interview data to better understand her experiences. Case studies are particularly appropriate in educational contexts, as educators are concerned with the unique needs of individual students (Donmoyer 1990). Creswell (2007) suggests that individuals selected for case studies

can be best described as fitting into one or more of the following three categories: (a) a "marginal person", someone who is outside the main culture; (b) a "great person", someone who impacted history/society at large; or (c) an "ordinary person", someone who is representative of a group. Elise is a woman who is a graduate student in mathematics, and she estimates that the ratio of men to women in her programme is 4:1. In some of her graduate-level mathematics classes, Elise was the only woman student. Thus, as a woman, Elise can be viewed as a marginal person, as she is at the periphery of the mathematics programme, which is dominated by men. Alternatively, as will be discussed later, Elise described herself as similar to the other women who are mathematics graduate students at her university. In this sense, she could also be conceived of as an "ordinary person" with regard to this particular population. Interestingly, Elise's role of being a woman who is a graduate student in mathematics makes her both a "marginal person" and an "ordinary person" in Creswell's categorisation.

Stake (1995) categorises case studies differently: as intrinsic cases or instrumental cases. An intrinsic case is studied to learn more about the specifics of that case, rather than to "learn about other cases or about some general problem" (p. 3). Conversely, an instrumental case is studied to learn more about a larger issue, rather than the unique case. Although Elise could be considered an intrinsic case, her story is also an instrumental case with respect to two issues. Specifically, through Elise's case, we will focus on the issues of (a) being a university student in a gender-atypical field and (b) being a "successful" student in the field of mathematics.

Elise's Story

As mentioned, Elise is high-achieving but expressed a lack of confidence in her abilities and reported feeling anxious about constantly having to perform at an extremely high level. Although she was a strong student in high school, Elise did not discuss feeling anxious or lacking confidence then. Elise reported that her feelings of anxiety and low confidence arose when she began university and became more substantial as she proceeded through her undergraduate degree.

During her interview, Elise frequently mentioned feeling anxious and not believing that she was as smart as everyone thought she was. For instance, in her first year of university, she applied for a scholarship that required a reference letter from a professor. He was so impressed by her transcript that he began talking to his colleagues about her, as well as encouraging her to do her master's degree in mathematics. When Elise learned that other professors were talking about her, she was quite surprised:

> I thought I was a normal student. I thought it was normal to get A+ all the time… and that's the first time I realised that maybe I'm different. Maybe I'm… good at what I'm doing. […] I guess those teachers [professors] who told me "You're doing fine" made me feel better. […] I would start a class assuming I was the worst one, and always be surprised when I learned that I was one of the top students.

Although Elise stated that the external praise from the professors made her "feel better", her interview suggested otherwise. As she proceeded in her degree and more professors learned about her mathematical prowess, Elise said that she felt intense pressure to be perfect and "perform all the time". Consequently, in her master's degree, she reported that she sometimes would struggle with a problem on her own for days rather than ask her supervisor for help. Elise noted that she always wanted to figure things out by herself and that she was afraid of what people might think if she asked for help.

> I'm scared of asking for help because sometimes people look at you and they're like, "What? You don't know that? You should know that!" Or, I'm just afraid of that. […] I always want to understand everything right away. And when I don't, I start to feel like, "Oh my God! Maybe I shouldn't be in math. Maybe I shouldn't be here. I don't understand this and everybody seems to understand."

As shown, Elise's feelings of inadequacy are sufficiently strong that when she does not immediately understand something, she jumps to the conclusion that she does not belong in mathematics. In the following sections, we present highlights of Elise's experiences that were significant to her development as a mathematics student: (1) early university entry, (2) family situation, and (3) university experiences.

Early University Entry

When Elise was 16, her family moved from Quebec to Ontario. This changed her educational trajectory, as moving to Ontario meant that she had two fewer years of public schooling before university. Elise began university at the age of 16, a point in her life when she did not feel ready for such a significant step. Elise expressed her feelings about this as follows:

> I was really pissed off when they forced me to do that. […] And it was a huge deal, and now she's [her mother is] always saying how she was right to do that and I do so well… and she was right! But I still think I should have had the choice, but it did work out pretty well. I guess I was so nervous that I – I just thought I couldn't do it because I was so young.

In her interview, nearly six years after this event, Elise was still visibly upset. She described how she felt that she did not fit in with the other first-year students, who were generally two years her senior. In her first-year classes, Elise reported that there was often "high school review" material that she had never learned. As a result, she worked particularly hard, spending several hours each day studying. Although the literature is somewhat mixed regarding students who enter university early (Gross and van Vliet 2005), there is evidence that these students may struggle and/or be delayed socially (Cornell et al. 1991a, 1991b; Janos et al. 1988) and may feel academically unprepared, regardless of meeting official entrance criteria (Muratori et al. 2003).

In the summer before she began university, Elise had to take two mathematics classes to ensure that she was caught up with her peers. However, one class was only offered in English, so Elise, who only spoke French at the time, taught herself English from her mathematics textbooks, without any formal outside assistance. Elise stated that she decided to learn the material on her own from the English-language textbook, rather than attend the class, as she was "so scared about the English part, that I wouldn't be able to follow." Elise reported that the experience was very stressful.

Furthermore, Elise shared that she had a difficult time making friends with the other students since "in Ontario, they all went from high school to university together, so most of them knew each other. Everybody was friends and I was alone because I was the only one from my school." She noted that she would often spend her breaks between her first-year classes by herself: "First year was hard. […] I knew nobody. I would go read alone. It was really depressing." In second year, Elise became comfortable with the social situation and academic material, the latter of which was due to her long hours spent studying alone. Elise continued with these study habits and experienced success in academics. However, she reported that the better that she did in her classes, the more pressure that was placed on her to succeed.

Family Situation

Elise said that she was designated as the "academic" in her family and was expected to "naturally" be successful in university. She was the first person in her family, including her extended family, to ever attend university. Elise noted that her family members did not seem to have any idea about what she does at university. For instance, in describing her mother's understanding of Elise's degree, Elise noted:

> It could have been physics. It could have been math. She doesn't even know the difference. […] To this day, she doesn't know what I do. […] And she doesn't really want to know. [Laughter] She's just very proud of me.

A lack of parental understanding of and experience with the university system may lead to a lack of specific, contributing support, even though the parents may be generally supportive of higher education (Weiner 2008). Elise reported that, for all her family members, "It's all new and they are proud, but they don't understand. They're just proud."

Considered the "academic" of her family, Elise admitted that she did not really think about why she was doing her master's degree; she just did it because she felt like it was expected. It was only partway through her degree that she began to question her "decision" and change her educational plans. When Elise decided not to undertake her Ph.D., even though she would have received funding from a large national scholarship, her parents were quite surprised. As Elise explained:

> They were like […] "Why are you not doing it? You have the scholarships." For them, it was not logical. […] They just weren't sure why I wasn't happy doing the master's and the Ph.D. They had always seen me as going to do that. So, that was a shock.

Elise's parents eventually accepted the idea of her working in a statistical field at a government agency once they saw that she was serious about it, but it took them some time to deal with the change in the future that they had envisioned for Elise.

University Experiences

As Elise proceeded through her undergraduate degree and became more at ease with the university setting, professors took note of her excellent grades in mathematics, which Elise stated put additional pressure on her to be "perfect" academically. She shared an incident that occurred in fourth year that she found disturbing. When Elise went to pick up an exam, she learned that she had not done as well as she usually did, and the professor did not hesitate to point that out:

> He [the professor] was like, "You do know that you didn't get the best mark of the class" and he told me who got the best mark. I was like, "Okay"; I didn't need to get the best mark. And… he said, "Well, I'm very disappointed in you because everybody told me so many good things about you, and I find it disappointing, looking at your final – you could have done so much better. People actually beat you, so anyway… This is a low A+."

Elise noted that she felt that his comments were inappropriate and added to her pressure as she felt that "everyone" in the mathematics department expected her to do exceptionally well. Elise described how previously she did not worry about exams and would not study during the day of an exam. However, things changed as individuals in the department became aware of her success:

> It started getting serious and people wanted me to do even better and better, and I started to have anxiety. […] It started in third year where I wanted to perform all the time. […] It's because of teachers [professors] like him that you realise there's pressure.

Elise said that several professors encouraged her to go to graduate school in mathematics, saying things like, "You need to go to grad school. It would be a complete waste if you didn't. You have such good marks." Elise was aware that word about her achievement had spread around the department. For instance, she once took a summer course taught by a Ph.D. student who told her, "I've heard lots of good things about you and apparently I need to give you a really good course to prepare you for the rest because you're

obviously going to keep going." Elise said that she felt that the senior members of the mathematics department thought that it was inevitable that she would complete her master's degree. Elise admitted that she did not really think about this decision and did not even consider applying to other universities: "I never really questioned… I just – yeah, I'm going to do my Ph.D. and I'm going to be a teacher [professor]. […] To me, it was all – that's what I had to do."

Elise stated that it was only once she began her graduate work that she started to question her decisions and educational path. Part of this was because she observed the difficulties that friends with graduate degrees in mathematics had, as they were only able to find jobs teaching at high schools or community colleges, which was not what Elise wanted to do. Also, she commented on her supervisor's demanding lifestyle—only having the time each evening to eat dinner with his family and then going to work on his own research at night, often not getting to bed until 3:00 a.m. Elise stated that she wanted to have a 9:00 to 5:00, Monday to Friday job that was separate from the rest of her life, and she felt that being a professor did not align with her ideals because "you're always thinking about it [your research]." Elise also admitted that when she was envisioning becoming a professor, she only thought about research, but "there's teaching every day – and I hate that!" Finally, and perhaps most fundamental to her decision, Elise realised that she was not passionate about mathematics, even though she was very talented in it: "I don't love it. Like, I do it. I'm good at it. I get it fast. But it doesn't mean I like doing it." When she considered all of these aspects, she concluded "I just realised it wasn't for me. And it was the first time I really thought about what I want to do." It seemed like up until that point she had done what she was expected because she was viewed as talented at mathematics.

Additional Considerations

There are several ideas and other studies that connect with Elise's experiences and feelings. In the following sections, we explore stereotypes about mathematics, mathematicians, and those who are "good at math" and the possible influence of such stereotypes. We also consider role models for women studying mathematics and discuss Elise's perceptions of the other women in the master's degree programme in mathematics.

Stereotypes

Views of mathematics and mathematicians often serve to create pressure and praise for those proficient in mathematics. Mathematicians are typically viewed as socially awkward, unstylish, and unattractive, but also very intelligent (Mendick et al. 2008; Picker and Berry 2000, 2001). Similarly, mathematics is often portrayed as being a difficult subject that can only be understood by a select few (Applebaum 1995; Mendick et al. 2007). Researchers (e.g. Piatek-Jimenez 2008) have found that even women mathematics majors ascribe to such stereotyped views, although they distance themselves from them.

These stereotypes arose in the interview with Elise. Paradoxically, whilst she discounted her friends' praise for being "so smart" for studying mathematics ("I don't deserve to be admired because it's easy for me"), Elise also accepted the common belief that mathematics is equated with intelligence. Indeed, Mendick (2006) argues that mathematics is seen as "the ultimate form of rational thought and so a proof of intelligence" (p. 18). When Elise was considering what to study at university, she was torn between psychology and mathematics, and admitted that her own biases and external perceptions played a role in her decision:

> I always thought, "Well, psychology – anybody can do psychology." […] I didn't want to do something easy. It happens that I love psychology, but it's easy, so… it's not as rewarding. […] And I was good in math and people are not usually good in math. […] And whenever I say I'm doing my master's, they're like, "Oh my God! How do you do it? Math! I can't do math!" […] That is a part

> of it. It's not – I don't care about what people think that much, but it is a good feeling to know that you're one of the few who can do it.

Here, Elise reiterates the stereotype that mathematics is the domain of a select few individuals. Likewise, in her discussions, she showed that she felt special for being good at mathematics, which contributed to her continuing in the field without question. Similar beliefs about feeling "special" have also been found in research involving women mathematics majors (Piatek-Jimenez 2015; Rodd and Bartholomew 2006). Whilst Elise and her friends espouse the stereotypes about mathematics and intelligence, there is even more pressure to do well, as she has identified herself as being even more special due to the "difficult" field that she studies.

Role Models

During the interview, Elise reflected on gender inequity in post-secondary mathematics. She was very interested in gender issues in mathematics and had spent time considering why she and so many other women did not continue with mathematics to the doctoral level. Elise noted that part of her drive to follow her original educational plan (to become a professor) was that she wanted to be an example for other women in mathematics. Elise reflected:

> Maybe you'd be more interested and keep going, but there's nobody [no women role models]. It's all men! So, maybe somehow, like, without us even noticing it, we just feel like it's not our place… at some level, and just find a reason to change what we're doing.

Elise's ideas have also been echoed in studies (e.g. Herzig 2002, 2004, 2010; Stage and Maple 1996) conducted with women graduate students in mathematics—both those who were in the field and those who had left the field at the time of the studies. These researchers have found that there is a great deal of attrition from such programmes as women feel that they do not belong in an "old boys' club" environment. Without women role models or even, in some cases, other women students, a mathematics department tends to become an uninviting place for women. Women students may not become integrated into the mathematics culture, thus missing out on important connections for their future educational and career prospects.

Women in Graduate-Level Mathematics: Multiple "Otherings"

Society views mathematicians as somewhat different and special. Because women in graduate-level mathematics are a minority, woman mathematicians could be viewed as special within a class of special people. This can create pressure and praise, as well as insecurity and confidence. Although we are focusing on Elise's experiences, insight about the other women in the graduate mathematics programme was gleaned from Elise's interview. She described the pressure on women as follows:

> We always need to perform. We need to have the best mark and we get anxious – We get nervous, so nervous. Like, we always think we're failing, but we're getting A+. […] If you were to look at our résumés, you'd be like, "Oh my God! I want this person!" but she's probably looking at it and saying, "Oh! Don't look at it!"

Elise also noted that the women in her programme were generally shy and unsure of themselves, which she contrasted with the men in her programme, whom she found to be much more outgoing and confident. Elise provided the example of giving in-class presentations to highlight this difference:

> They're [The men are] going to do their presentations, and if you're not happy, too bad. Pfft! But for me, if I do a presentation, I need to understand everything and be prepared for any question, while a

> guy, I think, from what I know, will be more relaxed and be like, "Well, if I don't know the answer, I'll just say I don't know". But for me, that's not an answer. That's not a possibility. I will not allow that. So, we're [the women are] more nervous, more stressed out.

On the surface, Elise and the other women who are graduate students in mathematics may appear to be ideal students, excelling academically and persevering at the graduate level in mathematics, a field dominated by men. Interestingly, although the other women in her programme presumably did not have the same, unique educational background as Elise (i.e. early university entry, first in her family to attend university), the manner in which Elise described these women's feelings and behaviours is remarkably similar to her own feelings and behaviours.

Concluding Remarks

Using Elise as an example of a high-achieving university student in a gender-atypical field furthers our understanding of the unseen struggles that some of our top students may be facing. Since educational systems are concerned with individual students and educators, each of whom is unique, Donmoyer (1990) argues that educational research can never be truly generalisable, nor should that be a goal of such research. He posits that case study research "might be used to expand and enrich the repertoire of social constructions available to practitioners and others; it may help, in other words, in the forming of questions rather than in the finding of answers" (p. 182). It is in this sense that we believe that the case of Elise has much to teach us, as it has raised questions regarding what success and equity mean in the context of fields that are gender-imbalanced. Delving deeply into Elise's story challenges what "success" might mean for women in the field of mathematics, as well as how we can make the situation equitable. Although success on an individual level may be represented by perseverance by women in a field dominated by men and statistical equivalence in participation may indicate that the field is equitable, a deeper understanding of women's experiences in mathematics probes whether they personally feel successful and confident and whether they feel as though mathematics is a field for them.

More broadly, we need to consider if mathematics departments are places where individuals from many backgrounds—in particular, women—feel as though they belong. If the environment feels safe and comfortable for students, then they will not be afraid to ask questions and make mistakes. Since mathematics continues to be perceived by many as being a discipline that is very "black or white", with only one right answer to a question, students may feel less comfortable taking risks, simply due to this perception of mathematics itself (Nickson 1992). Additionally, we need to consider why women's participation rates in mathematical fields of study at university seem resistant to change, as shown by the statistics (Statistics Canada 2017a, 2017b) presented earlier. Mendick (2006) suggests that various interventions and strategies, such as mathematics classes for girls, may have been unsuccessful because "they have attempted to change the girls and women to fit into maths while being happy to leave maths fixed as it is" (p. 141).

It may also be meaningful to consider how we, as professors, interact with our top students. There is a fine line between encouraging/supporting these students and placing undue stress upon them to succeed academically, the latter of which may instigate feelings of stress and anxiety. Although students may achieve high grades and complete degrees, it is their own perceptions of their experiences as "successes" that are of the greatest importance, and we can only learn about these experiences and feelings by talking to students themselves. This is particularly necessary for groups of students who are minorities in their field, such as women in mathematics. These students may have unique needs that are not being met by their faculties, which tend to be tailored toward the majority group of students—men, in the case of mathematics (e.g. Herzig 2004, 2010). By learning about minority

students' experiences in their university fields of study, we may be able to take steps to improve future students' experiences.

Compliance with Ethical Standards

Conflict of Interest The authors declare that there is no conflict of interest.

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