SOFYA KOVALEVSKAYA: MATHEMATICS AS FANTASY

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What is entailed in doing mathematics and becoming a mathematician? Working from an autobiographical sketch and biographies of Sofya Kovalevskaya (1850-1891), the first woman generally thought to have gained a doctorate in mathematics, and using the Lacanian notion of desire, I examine the forces that shape and influence engagement with mathematics. This work has consequences for mathematics education in examining the construction of identity/subjectivity in teachers and students alike.

INTRODUCTION

Over the years, mathematics education research has renewed itself in its quest for understanding the nature of learning and teaching mathematics by studying mathematicians: from finding out what mathematicians know, to describing what they do (the practices of mathematicians, e.g. Burton, 2004), and then to exploring who mathematicians are. More recently, researchers, including Tony Brown (2008; 2011), Baldino and Cabral (2006), and Walshaw (2004), have focused on the subjective aspects of being a mathematician, using a postmodern and, more particularly, a psychoanalytic approach. After waves of study on beliefs, emotions, and psychodynamics, the present focus on subjectivity and identity is an inevitable consequence in the search for the factors relating to engagement with mathematics, apart from the usual considerations of students, teachers, classrooms, and tasks.

In this paper, I contend that any effort in understanding how and why students (and, in general, people) take up mathematics must begin with the mathematical subject, the individual in the encounter with the discipline, and that, contrary to expectations, the driving force in the endeavour is desire, on the part of both the subject and the discipline as a cultural phenomenon. I present, as an example of a trajectory in mathematics, the life of Sofya Kovalevskaya (1850-1891), the first woman in the world to have a professional university career in mathematics (Audin, 2013). Kovalevskaya did original work in three areas of mathematics, any of which would have been enough for a doctorate in mathematics. The first area of her work was in solving partial differential equations (one of her results, called the Cauchy-Kovalevsky theorem, is the basic theorem on partial differential equations over complex numbers). In the second, she extended some results of Euler, Lagrange and Poisson involving the reduction of Abelian integrals to elliptic integrals, and in the third, she made some additions to the work of Laplace on Saturn's rings.

Accounts by and about mathematicians regarding their journeys in mathematics have long been neglected as a source of knowledge about the discipline. These accounts

have generally been concerned with historiography, showing the unique lives and accomplishments of mathematicians. Using data from an autobiography and biographies, I argue that her journey in mathematics was shaped primarily by the face/t/s of desire. I then discuss the implications for school mathematics.

THEORETICAL INFLUENCES

In keeping with the psychoanalytic approach of the researchers above, I am guided by Lacan's theory of the subject and the construct of desire in the subject's psychic economy played out in three registers or orders which obtain at every stage of the subject's experience: the Imaginary, the Symbolic, and the Real. The Imaginary is the realm of "images, conscious or unconscious, perceived or imagined" (Lacan, 1973/1981, p. 279) of the people and objects in the world present to us. The Symbolic is derived from the "laws" of the wider world in its structure and organization, and shapes or interpellates (Latin: *inter*/between, within, *pellere*/push) the subject, becoming the Other for the subject. The Symbolic is enabled by language as it is language that gives us the structures for the signifiers for the "I" and the Other, and for articulating the lack and misidentification of the self with the specular image. The Real is the unmarked backdrop against which the Imaginary (image-based) and the Symbolic (word-based) come into play, the screen on which images and words unfold and move. In the confluence of these three registers, the subject comes into play or is played with the forces of separation and alienation that lead to desire. Thus, the Lacanian subject experiences desire as a manifestation of lack as the subject seeks to both identify and separate itself from the Other.

In applying these concepts to the interplay of the cultural phenomenon of mathematics and the subjects who encounter and engage with it, I tease out more carefully the notion of the Other, which, despite being a well-known concept in the social sciences, has a meaning in each of the three Lacanian registers. In the Symbolic, the Other is the code or discipline of mathematics, its knowledge and traditions with its concomitant demands and costs. In the Imaginary, the Other is the Imaginary others, the people who engage with mathematics in some form including the mathematicians who embody and make incarnate the code of mathematics. In the Real, the Other is the Lacanian *objet a*, which is the object-cause of desire, and which in some instances of desire will again turn out to be mathematics.

Mathematics as a cultural phenomenon is far-reaching in its forces and effects. With respect to the discourse of literary and cultural criticism, the noted Lacanian theorist, Mark Bracher, writes: "Insofar as a cultural phenomenon succeeds in interpellating subjects—that is, in summoning them to assume a certain subjective (dis)position—it does so by evoking some form of desire or by promising satisfaction of some desire" (1993, p. 19). I demonstrate in the life of Kovalevskaya the desire that mathematics evokes as it holds out the promise of satisfaction.

Bracher (1993, pp. 20-21) elaborates four forms of desire by exploring the ambiguities in Lacan's dictum that desire is desire of the Other. These four forms come from the

oppositions of two types of desire, the desire to be (narcissistic) and the desire to have (anaclitic), and the two roles, active and passive, that the subject and the Other take (when the one is active, the other is passive). I present these forms in the following table and give examples of each desire with respect to mathematics:

	Narcissistic (to *be*)	**Anaclitic** (to *have*)
Passive	I can desire to be the object of the Other's love (or the Other's admiration, idealization, or recognition). **"I want to be recognized by mathematics and its community as a mathematician."**	I can desire to be desired or possessed by the Other as the object of the Other's *jouissance*. **"I want to be desired by mathematics as, e.g., a means of adding to its glory."**
Active	I can desire to become the Other – a desire of which identification is one form and love or devotion is another. **"I want to be a mathematician."**	I can desire to possess the Other as a means of *jouissance*. **"I want to possess mathematics as, e.g., enjoyment, as a personal treasure."**

Table 1: Forms of desire (Bracher, 1993)

In describing desire, Lacan used the notion of the asymptote, always approaching but never attaining an object because there is no object of desire, only an object-cause of desire. The origin, nature, and path of desire are elaborated by Grosz (1990), in her feminist introduction to Lacan:

> Lurking beneath the demands for recognition uttered by the subject (to the other) is a disavowed, repressed or unspoken desire. Desire is a movement, a trajectory that asymptotically approaches its object but never attains it. Desire, as unconscious, belies and subverts the subject's conscious demands; it attests to the irruptive power of the 'other scene, the archaic unconscious discourse within all rational discourses. (p. 188)

Further, in order to stage its unconscious, unknown, and unacknowledged desire, the subject resorts to fantasy; "a fantasy constitutes our desire, provides its coordinates, that is, it literally 'teaches us how to desire'" (Žižek, 1997/2008, p. 7)

METHODOLOGY

The data for this study were accounts of Kovalevskaya' life published in English. I did not know of Kovalevskaya as a mathematician despite my many years of learning and teaching mathematics. I came upon her serendipitously from a collection of stories by Alice Munro (2009), *Too much happiness*. Munro had been looking for something else when she came upon Kovalevskaya, and was struck by the unusual combination of mathematician and novelist. I soon found that there was much more material on Kovalevskaya including a memoir, *A Russian childhood*; indeed, there is a small industry on her life and work among historians of mathematics and science, a few mathematicians, and a few who are interested in gender studies. So far these give different perspectives on her life and the myths that have been created around her; none of these takes a psychoanalytical approach. These studies also posed the challenge of translation into English and a related matter, citation. Much of the primary source material about Kovalevskaya is in other languages (Russian, French, and German) and

the English translations are not uniform (for example, the word, "imagination", in place of "fantasy").

Using biographies and Kovalevskaya's memoir as data, I searched for evidence of desire related to mathematics and being/becoming a mathematician. These included quotations (oral and written), events, and observations related to mathematics and mathematical activity. I then carried out a thematic analysis, informed by the lens of the above forms of desire.

ANALYSIS AND DISCUSSION

Of the four forms of desire, the one that stands out most clearly in Kovalevskaya's life is **active anaclitic desire**: mathematics was the Other that she wanted to possess. She writes of hiding an algebra textbook under her pillow and reading it through the night as well as of her protracted fascination with the notes of a calculus course that was used as wallpaper of her nursery. Mathematics became a part of her from the long hours spent staring at those hieroglyphics and symbols (in particular, the symbol for the limit) and sleeping with those algebraic equations and expressions. Indeed, when she is introduced to these symbols later, her professor remarks that she understands them as if she had known them in advance. She also writes of the trigonometry she devised in order to understand a physics textbook written by her neighbor. Also her desire for higher education in mathematics was inflamed by the political movement of the times (the serfs had been recently emancipated and there was much hope for reforms such as independence and higher education for women). As a woman, she was barred from classes in mathematics and science and was smuggled into these classes at the university by men sympathetic to the cause, but it was evident that true possibilities for higher education lay outside Russia, further afield in Europe.

Kovalevskaya continued her pursuit of mathematics by journeying though the major university cities in Europe seeking to be admitted or to attend classes (all barred to women). On the recommendation of her professor, Königsberger at Heidelberg, Kovalevskaya finally made her way to Weierstrass in Berlin in the desire and hope of being tutored by the best in the field of mathematics. Weierstrass (some thirty years older and a bachelor who lived with his spinster sisters) was so confused by her presence as a woman wanting to study mathematics that he gave her a list of problems to do in the hope that she would find them too hard and not return. She did return and amazed him with novel solutions that demonstrated unusually great depth of understanding. Her desire to possess higher mathematics led her to a relationship with Weierstrass as a colleague, no longer that of teacher and student.

Closely intertwined with active anaclitic desire is **active narcissistic desire** where the subject seeks to become the Other, to identify with or to be devoted to the Other. The Other of mathematics was embodied for Kovalevskaya in Weierstrass. He was her primary model of a mathematician as she strove to adopt his style: "These studies [with Weierstrass] had the deepest possible influence on my entire career in mathematics. They determined finally and irrevocably the direction I was to follow in my later

scientific work: all my work has been done precisely in the spirit of Weierstrass" (Kovalevskaya, 1889/1978, p. 218). This meticulous attention and devotion to the requirements of doing mathematics as exemplified by Weierstrass worked to her detriment in that some mathematicians, in particular Felix Klein, charged that it was Weierstrass, and not her, who did the work for which she was given credit. Klein wrote: "Her works are done in the style of Weierstrass and so one doesn't know how much of her own ideas are in them" (cited in Rappaport, 1981, p. 564), pointing to a loss of boundary in the fusion of her mathematical self in Weierstrass's style of doing mathematics. Weierstrass came to occupy a special place for her as a father-figure, his tone in his letters to her deepening from the formal to one of encouragement and support. In one letter, he refers to himself as her Spiritual father. This was in keeping with the substitutes in her life; she was parented by her nurse (her mother to her nurse when she was brought into company: take your savage away, she is not wanted here), she engaged in a platonic marriage, and she sought a substitute father in Weierstrass.

In seeking to identify with being a mathematician, Kovalevskaya carried out the work of a mathematician in writing and publishing. It was vital to her that her work was published in recognized arenas of mathematics at the time, namely *Crelle's Journal* and *Acta Mathematica*: "At this writing *Acta Mathematica* is regarded as one of the foremost mathematics journals in scholarly importance. Its contributors include the most distinguished scholars of all countries and deal with the most 'burning' questions – those which above all others attract the attention of contemporary mathematicians" (Kovalevskaya, 1889/1978, p. 221). In these way she worked towards belonging to the community of mathematicians (the Imaginary others of mathematics).

Beside the two active forms of desire, there are two passive forms of desire. I begin with **passive narcissistic desire**, the desire to be object of the Other's love, admiration, idealization, or recognition), which Lacan calls the strongest form of desire. Kovalevskaya desired strongly to be recognized as a mathematician; "At that time my name was fairly well-known in the mathematics world, through my work and also through my acquaintance with almost all the eminent mathematicians of Europe" (Kovalevskaya,1889/1978, p. 222). What is in a name and in wanting one's name to be known? For Kovalevskaya, it was her very subjectivity and her desire for posterity in the "mathematics world". Her desire was for a teaching position in a Russian or European university; the times dictated that her only opportunity would be at a school for girls. Despite an enthusiastic endorsement from Weierstrass, this desire went unfulfilled until with the help of Mittag-Leffler (also a former student of Weierstrass) she secured a position teaching mathematics at Stockholm University in Sweden.

Kovalevskaya sought to be desired by mathematics in assuming the position of the first female editor, and only the second editor, of a mathematical journal, *Acta Mathematica* (its first editor and founder was Mittag-Leffler); such a position being occupied by a woman was again unheard of at the time. A further example of seeking the favours of mathematics was in her competing for and winning the *Prix Bordin*, then of the level of

a Fields prize in mathematics, the high quality of her submission, *On the rotation of a solid body about a fixed point*, being noted and rewarded with greater prize money.

Her desire for recognition met with mixed results. As a woman studying mathematics, she was often considered a freak of nature which contributed to her gaining the status of a celebrity; people stopped in the street, pointing her out as the young woman who took her studies seriously. Though she could not be a woman lecturer in Russia nor a member of the Russian Academy of Sciences, the local newspaper carried this item: "Today we do not herald the arrival of some vulgar insignificant prince of noble blood. No, the Princess of Science, Madam Kovalevskaya, has honoured our city with her arrival. She is to be the first woman lecturer in all Sweden" (Flood and Wilson, 2011, p.167). But she met with opposition in some quarters, for example, from the playwright, August Strindberg, who abhorred the idea of a female academic.

The remaining form of passive desire is **passive anaclitic desire** or the desire to be desired or possessed by the Other as the object of the Other's enjoyment. In Kovalevskaya's life, the desire to be possessed by mathematics did not prove to be so strong as she had an equal passion for literature writing theatre reviews, poems (for herself), a novel, a memoir and play. For her, mathematics was to be revered: "a very lofty and mysterious science, which opened out to those who consecrated themselves to it a new and wonderful world not attained by simple mortals" (Kennedy, 1983, p. 17) but she continues:

> As far as I am concerned, during my life I could never decide whether I had a greater inclination toward mathematics or literature. Just as my mind would tire from purely abstract speculations, I would immediately be drawn to observations about life, about stories; at another time, contrarily when life would begin to seem uninteresting and insignificant then the incontrovertible laws of science would draw me to them. It may well be that in either of these spheres, I would have done much more, had I devoted myself to one exclusively, but I nevertheless could never give up either one completely. (p. 17)

Hence she did not devote herself entirely to mathematics, implying that mathematics was not "everything" for her, and perhaps that she could have been better had she been more faithful to it. Could she have served two masters or two gods? Does mathematics brook no other interests? She pushed away the one (mathematics) as she reached for the other (literature) but then later returned to her first love and passion. For Kovalevskaya, literature provided counterpoint to the "abstract speculations" of mathematics, both literature and mathematics being variations on the theme of the creative. It is interesting that she realizes that she could have accomplished more had she focused exclusively on one of the two but that she was willing to sacrifice that achievement in order to keep a foot in both worlds.

The leitmotif of her life: Asymptotic desire

The four forms above underpin the central theme of asymptotic desire in Kovalevskaya's life. For Lacan, every desire is born out of lack, out of alienation and separation. Kovalevskaya's desire arose out of various lacks: of not being allowed to

take her place as a mathematician, of not being complete as a mathematician, and of not meeting the requirement of being male (the identities demanded by the "masculinities" of mathematics are explored in Mendick (2006)). Desire, constant, repetitive, and forever circling, in the two spheres of literature and mathematics can be seen as an attempt to address and reconcile the various aspects of herself with respect to the registers of the Imaginary (she was interested in life, its characters, its appearances, and its illusions) and the Symbolic (the words of literature and the symbols of mathematics that she could marshal to give life to her thoughts and ideas). Her desire was fed by both avenues, the one coming to the fore as interest in the other faded or was blocked in some way.

CONCLUSION

The analysis above shows that the dimensions of subjectivity and desire in the mathematical endeavour are significant in probing human relationships with mathematics. Kovalevskaya's journey is an effect of desire orchestrated by the cultural phenomenon of mathematics and by her lack as a subject. Kovalevskaya was circumscribed by the signifiers of 'woman', 'Russian' and 'mathematician', none of which would have come up as an issue of struggle in a given society or community. Only when her desire was hemmed in by these did they become forces by which she was buffeted. Looking back on Kovalevskaya's life, it seems to me that the distance from the place of mathematics as fantasy that she accessed through her mathematical work to the reality of her life in the circles in which she moved was too great. The metric needed to conceptualize that distance would take a century and more of social upheaval. The costs were too inordinate to bear and the cold realization is that mathematics is indeed, even with the gifts of genius and charm, not for the faint of heart. In the end, she was unable to realize her dreams to the extent of her desire. She had started with quadratures and asymptotes. Her life was an ode to her attempts of squaring the circle amid her trajectory of asymptotic desire in search of her old friend and lost object, the limit.

The implications for the kind of knowledge that has been excavated above in mathematics and mathematics education are far-reaching. What is truly entailed in doing mathematics and being a mathematician? If what is true for Sofya Kovalevskaya is also true of others in becoming mathematicians, then desire is a paramount consideration. To this day, her life and work remains an inspiration for mathematicians and those who would be mathematicians. The most recent work on Kovalevskaya is a passionate subjective account by Michèle Audin (2008/2011), a renowned present-day mathematician who found Kovalevskaya from her own work on integrable systems.

Further, official documents that describe what is entailed in learning and/or doing mathematics (such The *Adding it up* document, Kilpatrick *et al*, 2001) as a means of helping children develop as mathematicians has five strands, none of which addresses the subjective aspect of the endeavour on both the parts of the student and the teacher. In the encounter between the rational discourse of mathematics and the bundles of

subjectivity that are students and teachers, how, as teachers of mathematics and researchers in mathematics education, how must we conduct ourselves? I contend that we consider that mathematics may not be for all, and that it is near transgressive that we do not address the personal costs and defences (Nimier, 1993). What is at stake is more than the curriculum, the delivery, and tasks; it is a recognition of the very nature of subjectivity, of who we are when we do mathematics, of the subject positions we are called to be in order to do mathematics. It is a matter of what drives the engagement with mathematics, namely, desire.

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