Queer(y)ing Mathematical Knowledge and Practices

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K. G. Valente

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Abstract

What does mathematics, broadly viewed, have to do with queer concerns or theory? In contributing to a collection of pieces that engage with new influences on the discipline – particularly in the ways that knowledge is produced, understood, and shared – this chapter considers some aspects of queer visibility that have affected and continue to shape professional and pedagogical sensibilities. Adopting an analytic approach found within queer theory that serves to expose often overlooked concerns, it centers small and sometimes tenuous acts as meaningful interventions. It also calls attention to the transformative potential associated with the adoption of recuperative practices as well as the liminal and generative spaces that exist for reorienting perspectives.

K. G. Valente (✉)
Colgate University, Hamilton, NY, USA
e-mail: kvalente@colgate.edu

A contextualizing section outlines both the historical appropriations of the term "queer" and the rhetorical intentions served by adopting it as a signifier throughout this chapter. Also included in it are brief overviews of queer theory as well as some of the theoretical frameworks adopted by its foundational contributors. Attending to relevant vocabulary and motives provides a backdrop for considering the scope of professional visibility, support, and resources related to queer practitioners in mathematics and other science-related subjects. Subsequent sections survey efforts at queering mathematics curricula and educational practices. While the first of these addresses possibilities most closely related to K-12 education, particular attention is paid to exploring ways that mathematical courses and content aimed at undergraduate students and majors can be queered.

Introduction

Within a universe consisting of knowledge production, how might one envision the Venn diagram representing mathematics and queer theory? It would be essential for the exercise to begin by stipulating that inclusive interpretations of words such as "knowledge" and "practices" are to be encouraged. Such readings allow knowledge production to speak to more than the artifacts produced, by encompassing activities such as doing and teaching mathematics, as well as other dynamics associated with disseminating its ideas. Even granted such latitude, many mathematicians might be reluctant to contemplate the question owing to an understandable unfamiliarity with the tenets of queer theory. Others with some appreciation of the latter and its purview might render an image of two nonintersecting areas of inquiry. After all, mathematical truths are not commonly considered to be influenced by the personally descriptive categories embraced by those who contribute to their articulation, let alone the sexual orientation or gender identity of these individuals. Additionally, and setting aside either the circumstances attributed to or identities claimed by its practitioners, some would likely argue that the development of mathematical knowledge relies on the consistent adherence to rules and logic, while queer theory embraces the contingent and commits itself to the intentionally disruptive interrogation of conventions and strictures. How could anyone possibly find nonempty areas of intersection between them?

This chapter undertakes the task of exposing common ground between mathematics and queer theory with both generosity and integrity. It does so by recognizing that mathematical knowledge is simultaneously multifaceted and multi-facing, a perspective that purposefully attends to visibility in both professional and pedagogical contexts. In particular, this admission allows for the consideration of strategies that have been – and might be – employed to help some individuals more fully

appreciate the power of its history, ideas, and methods, as well as to encourage others who aspire to become accomplished, confident, and welcomed contributors to the field. Committed to raising awareness and highlighting productive potential rather than providing prescriptions, the chapter ultimately finds both imaginative impetus and inspiration in Wittgenstein's observation about the nature of mathematical knowledge: "Surely there is something queer about this" (Wittgenstein et al. 1976, p. 96).

Appreciating Queer in Context

Alongside the commonly held sense of the unusual that Wittgenstein was clearly evoking, the term "queer" has long been used to refer to people who defy conventions associated with gender expression or sexual orientation. While not exclusively the case, many will admit it has served as a derogatory and othering epithet. Its controversial reclamation as a term of empowerment is largely the result of radical activism that followed on from the now legendary Stonewall uprising of 1969 and found renewed urgency during the AIDS crisis, which first commanded worldwide attention in the 1980s. Emergent groups like the AIDS Coalition to Unleash Power (ACT UP) and Queer Nation embraced the term as one of many defiant responses to and confrontations with forms of power that operate to silence and deny. Among these responsive reactions is the anonymously written leaflet that served as a call to action: "Queers read this" (Anonymous 1990). Consequently, "queer" bears various relationships – though typically fluid, disruptive, and contentious ones – to subjects and subjectivities, originally understood in terms of identifiable types of individuals.

Courses, curricula, and programs dedicated to what is now generally, though not consistently, described as lesbian, gay, bisexual, transgender, and queer studies (variously abbreviated as LGBTQ, LGBTQ+, and LGBT+ Studies) have existed in recognizable forms since the 1990s and were developed, in part, as a way of legitimizing methodologies for examining the lives and experiences of individuals who identified as homosexual. Their earliest academic manifestations, along with their attendant concerns, were essentially circumscribed by gay and lesbian subjectivities, as documented by Minton (1993) for a special issue of the *Journal of Homosexuality*. The provocations that "queer" signified in terms of late twentieth-century identity politics soon found critical and scholarly purchase in queer theory. Early articulations have evolved and expanded over time in ways that continue to reshape curricula (Valente et al. 2018), even as they reconstitute and imbue the term "queer" with a productive, if willfully defiant, intellectual agency. One consequence of this development is that "queer" can simultaneously connote both subjects – including, but not limited to, lives and experiences – and analyses committed to exposing the dynamics that produce the subjects under consideration.

Writing at the time of its earliest incarnations, Britzman (1995, p. 153) observed that queer theory instigates "terms of engagement that work both to recuperate and to exceed stereotypes . . . ." At the same time, it seeks to interrogate "the precari-

ousness of the signified [subject]: the limits within its convention and rules, and the ways in which these various conventions and rules incite subversive performances, citations, and inconveniences." Emerging as it did, the stereotypes and subjects of primary concern to queer theory related to individuals. However, in examining the subjects signified, early deployments also focused critical attention on the multiplicity of ways by which systems of power and authority are simultaneously exercised and sustained (Barker and Sheele 2016). As a consequence of encouraging such perspectives, queer theory can be extended to a variety of subjects as well as bodies of knowledge, with the term "queering" signaling this strategic analytic move.

Some particular aspects of power and authority examined by pioneering scholars of queer theory feature in later sections of this survey. Among these, Michel Foucault's influential work on the *History of Sexuality* (1990) scrutinizes the dynamics by which systems of power and authority are made both manifest and salient. The term "discourses" features prominently in his analysis and connotes the thematic consolidation of linguistic and other social practices that imbue power relationships. It is important to note, however, that discourses associated with power flow in multiple ways, as evidenced by the attention Foucault paid to "reverse" discourses. These represent opportunities, found in the interstices within the deployments and structures of power, to talk back to or to resist the very power that gives rise to them. Among a myriad of possible examples, the defiant reclamation of "queer" in the 1980s can be considered an aspect of reverse discourse.

Performance and performativity bear close relationships to power, especially to the extent that they relate to shaping expectations for and responses to lived experiences. Judith Butler's *Gender Trouble* (1990) and Eve Kosofsky Sedgwick's *Epistemology of the Closet* (1990) are especially notable for their foundational emphasis on the significance of performance. Butler's text explores gender roles, particularly those associated with women, in the context of which troubles arise when actors find themselves at odds with the social scripts they are compelled to enact. Sedgwick's analysis focuses on the constraining limitations that result from an insistence that sexuality be described in terms of a heterosexual/homosexual binary, with the metaphorical "closet" representing a regulating space that some will eventually reject in the process of "coming out." While these focus on distinct, yet interrelated, themes of gender and sexuality, both works are considered canonical texts in queer theory.

Among many critical contributions, Jack Halberstam has queerly reappraised the powerful compulsions for success, convention, and compliance by embracing failure as deserving of consideration. As the title of his treatment suggests, *The Queer Art of Failure* (2011) liberates waywardness, whether cultivated or capricious, by exploring and advocating for its productive potential. Among other things, the argument developed reflects on the ways by which imagery evoking the "monstrous" – the un- or subhuman – is effectively harnessed by those who seek to illuminate or subvert a prioritization of success over alternatives typically assumed to be less than ideal. In Halberstam's analysis failure ultimately comes out of the closet (so to speak) as an impulse worthy of reassessment on its own terms, unruly though those terms may be.

A final aspect of queer perspectives warrants note insofar as this chapter references sources that, while perhaps unusual for a survey of this type, reflect an ambition to promote accessibility both in terms of distribution and content. For example, the work of Barker and Sheele (2016), identified above, playfully disrupts many of the conventions of academic writing and publishing by providing a very readable and rich overview of the complicated development of queer theory in the form of a graphic history. The choice of particular references herein reflects the spirit of democratizing knowledge that runs through many projects aligned with queer theory. This is not to deny the significance of scholarly treatments of the queer past or present; rather, it is an attempt to honor foundational – and often ephemeral – documents on which queer history rests and to provide the curious with points of entry to more detailed work.

Queering Visibility, Support, and Resources in Mathematics and STEM

Queer visibility in professional contexts – including all areas related to science, technology, engineering, and mathematics (STEM) – has increased significantly in recent years. Mathematicians can find opportunities for networking and support in fledgling organizations such as Spectra, the Association for LGBT Mathematicians (n.d.). At the time of writing, at least three other groups are primarily dedicated to supporting LGBTQ individuals who are committed to or working within science-related fields more broadly: LGBT STEM (n.d.), the National Organization of Gay and Lesbian Scientists and Technical Professionals (2019), and Out in Science, Technology, Engineering, and Mathematics (2019). While some of these, as well as others mentioned later in this section, maintain the kind of grassroots structures that mirror characteristics of the LGBTQ rights movement during the late twentieth century, all of these organizations are – by their very presence – playing important roles in terms of creating spaces for fostering awareness and community. As evidenced by the work of Bryson (2005), Jones (2013), and Fish et al. (2018), it would be antithetical to the tenets of queer theory to either diminish or dismiss the agency of quotidian activism – which intentionally highlights commonplace and everyday acts of existence – in appreciating the power of authentically living and being in the world, whether personally or professionally.

Signaling various aspects of one's identity represents an important element of queer quotidian activism, particularly when considering young people who might be seeking reflections of themselves or role models among members of the mathematics community. That identity signaling of this kind can carry with it considerable influence is underscored by research undertaken by Hughes (2018), whose longitudinal study shows that students identifying along the LGBTQ spectrum are less likely to persist in STEM subjects when compared to their heterosexual peers. In this regard, it is significant that the American Mathematical Society (AMS) now maintains a searchable blog site dedicated to "inclusion/exclusion" that seeks to promote discussion of "issues pertaining to marginalized and underrepresented

groups in mathematics" (2019). Here one can find, among other things, the personal reflections of LGBTQ-identified mathematicians in posts such as "Love ≅ love: A celebration of LGBT+ mathematicians" (Salerno 2017) and "On performing queerness and mathematics" (Riehl 2017). Reflections such as "What's it like to be queer in STEM?" (Leman 2018), which appears as part of online content curated by *Scientific American*, extend the disciplinary scope of the conversation, as well as its potential audience. The website bearing the banner "500 queer scientists" (2018) is as welcome for unabashedly proclaiming its mission as it is for archiving the invited biographical sketches it proudly displays in order to "ensure the next STEM generation has LGBTQ+ role models; [to] help the current generation recognize they're not alone; [and to] create opportunities for community connections and greater visibility within STEM."

It is important to acknowledge that individually curated websites, particular online content, and social media networks can evolve quickly and follow unpredictable trajectories. Mindful of this, as well as the ephemeral nature of much of the evidence that queer history and reflection draws upon, the intention that motivates this short section is not to provide an exhaustive or stable list of available resources. Rather, its broader purpose is to mark the recent past as a period of increased visibility, during which it has become easier for LGBTQ-identified individuals to find professional support and networks that speak to the various ways in which queer identities intersect with mathematics and other STEM disciplines.

Queering Curricula

Curricular interventions aimed at enhancing diversity and inclusion have undoubtedly occurred at different times, in different ways, and with various degrees of institutional or professional support. Still, the motivation for many of those undertaken is to help students to see themselves represented in the material being taught. Kellermeier (1995) documented an early effort by recounting the decision to portray LGBTQ lives, concerns, and scholarship in word problems he developed for an introductory course on statistics. While other educators were certainly thinking and working along similar lines, as is evidenced by Britzman (1995), the significance of Kellermeier's essay to this survey lies in the rich curricular resource it then provided others and the historical evidence it now represents for intentionally marking queer considerations when teaching mathematics. With history in mind, Meseck (2017, p. 10) observes that Kellermeier served as the faculty advisor for the student-organized Lesbian Gay Bisexual Alliance at the State University of New York in Plattsburgh, which was established in 1990. His curricular intervention, thus might be safely read as an extension of his commitments to institutional activism at the time.

Pedagogies dedicated to social justice have propelled recent efforts to queer curricula in mathematics and mathematics education. Sheldon and Rands (2013) reflect such motives in announcing the creation of ambitious plans for a working group dedicated to this objective. Main headings they employed signal the scope of their

concerns, ranging from "research"; to "curriculum, resources, representations"; to "pedagogy and teacher education"; to "mathematical concepts and content areas" (pp. 1369–1370). Though not exclusively the case, K-12 numeracy and mathematics education have received the greatest amount of attention; indeed Pennell (2019), Sheldon (2019), and Woolley and Airton (2019) all evidence the growing body of literature that critically addresses queering mathematics education and teaching practices. Their work signals the richness of possibilities that exist beyond what Rands (2016) has referred to as an "Add-Queers-and-Stir" approach, which primarily works to decenter heteronormativity by prioritizing the recognition of LGBTQ individuals as subjects under the widely adopted "queer" umbrella (p. 184).

As Sheldon and Rands (2013) outlined in largely encouraging and aspirational terms, and Sheldon (2019) later elaborated on by recounting a specific experience, there are approaches to queering mathematics that are more appropriate for the kind of disciplinary engagements that take place in higher education. Interventions that might interrogate rhetorical or editorial strategies and forms of argumentation, which will be considered further in the next section, may present significant challenges when being incorporated into a standard undergraduate mathematics curriculum, in which the acquisition and development of skills is a primary instructional consideration and expectation. Still, others may be well-suited to courses that examine mathematics as an area of inquiry, offerings that attract large and diverse audiences by contributing to general education requirements at colleges and universities.

Introductory courses in statistics, as Kellermeier (1995) reminds us, may be an exemplary arena in which to queer course content and delivery. This is particularly true when considering the types of exercises, supplementary materials, projects, and discussions that can be incorporated into statistics syllabi. Perhaps the most salient development along these lines is the accessibility of databases that reflect the demographics and attitudes of LGBTQ-identified individuals. Instructors and students can find and retrieve information from, among others, sites such as LGBTData.com (n.d.), a resource curated by Randell Sell at Drexel University; LGBTStats (n.d.) maintained by UCLA's Williams Institute; the Pew Resource Center Survey of LGBT Americans (2013); and the Population Research in Sexual Minority (PRISM) Health Data Archive (2019). While important and statistically relevant questions might usefully compare data reflecting LGBTQ populations with information obtained from straight-identifying cohorts, having access to sources of data exclusively associated with queer subjects opens the door to intersectional interrogations that take seriously the ways that race, class, gender, and a multiplicity of other identities combine to influence lives and experiences. Indeed, attention to intersectionality effectively serves to disrupt a commonly held notion of a monolithic "queer community." It is also worth noting that queer perspectives understand intersectional characteristics to be inextricably intertwined with experiences and meaning-making, whereas statistical analyses can render them confounding variables that require specific testing or control.

The task of identifying individuals for the purposes of surveying attitudes and behaviors raises other questions that can be productively discussed in introductory-

level statistics classes. How does one best reach LGBTQ populations? What informs our understanding of individuals who might be counted among them? How can researchers be confident that subjects will identify with fixed or available identity categories, when they may consider their sexuality or gender expression to be more fluid or contingent? To highlight the salience of the last of these questions, one need only consider the history of lesbian feminism, as reflected in the Radicalesbians' (1970) "Woman-Identified Woman" manifesto, or, as discussed by Sandfort and Dodge (2008) in the context of HIV/AIDS education and prevention, those men who have sex with men on the "down low" – to take but one example – while resisting any identification as "gay."

Intrepid statistics instructors can take these exercises to another level – perhaps as a way of imagining a thoroughly queer approach to course content and development – by asking students to reflect on the extent to which our culture fetishizes quantification. Greteman and Thorpe (2018) take the seductive and neoliberal allure of numbers as the impetus for posing a meta-question of particular relevance to statistics: "[H]ave numbers become the object of the lessons we want to teach regarding [otherwise displaced] issues of gay, lesbian, bisexual, and transgender subjectivity . . . " (p. 107)? Put another way, and echoing previous comments related to intersectionality, to what extent do statistical analyses elide realities and concerns that might be better examined using more nuanced approaches. Realizing the queer potential represented by such inquiry would undoubtedly require leveraging considerable degrees of confidence and trust on the part of both instructors and students, but the transformative rewards could be equally significant.

While many have found – and will continue to develop – ways to connect mathematical education and course content to queer concerns, the next section elaborates on three particular possibilities best directed at undergraduates for exploring the extent to which mathematics and its disciplinary practices can be examined using perspectives informed by queer theory.

Queer(y)ing Perspectives on Disciplinary Knowledge and Practices

Alan Turing

The life and legacy of Alan Turing (1912–1954) provide several opportunities for queer interrogations and reflections that intersect with mathematical content and teaching. Many are now familiar with his significant role in the history of mathematics as well as British code-breaking activities during World War II, with efforts in the 1980s to reclaim his place in history relying significantly on the declassification of documents that shed light on the latter. This access to previously classified materials coincided with a sense of urgency aroused, then, by gay and lesbian liberation movements and AIDs activism, both of which encouraged the identification and celebration of queer heroes. Since then, Turing's stature as a historical figure – and, some might say, an icon – has continued to grow in response

to increased awareness of his mathematical and wartime accomplishments, as well as to efforts associated with cultural recuperation and social justice.

Hodges (2014) first published *Alan Turing: The Enigma* in 1983, a biography that is distinguished as much by its unflinching commitment to mathematical knowledge as by its extensive scholarly research. Throughout, Hodges' work also remains faithful to examining Turing's sexual orientation in relation to aspects of British social history associated with the criminalization of sex between men. Equally noteworthy, the book also serves as the foundation for several popularizations of Turing's life, including the film *The Imitation Game* (Grossman et al. 2014) discussed below. Since Hodges, and among others, Copeland (2004, 2017) has produced books and materials that focus primarily on Turing's accomplishments in the field of mathematics, the development of computing technology, and the area now commonly referred to as artificial intelligence. New resources and perspectives can be found in Copeland's biography, *Turing: A Pioneer for the Information Age* (2012), particularly with respect to the untimely and ambiguous aspects of Turing's death. The work of Hodges and Copeland has the potential to be incorporated into courses that consider the modern history of mathematics, in general, or cryptography, more specifically. Both writers encourage queer considerations, though Hodges' biography brings these to the fore with greater intent.

Other resources and readings can supplement these extensive biographies or provide specific points of entry that are more easily incorporated into a syllabus. The Turing Digital Archives (n.d.), like others that have similarly enhanced access, provides an online and searchable interface to a wealth of primary documents that can be consulted by those interested in his work. Regarding supplementary readings and reflecting other aspects of accessibility, Valente (2012) revisited Turing's legacy with the specific intention of adopting perspectives that are typically associated with queer theory. Indeed, his examination embraces an expansive understanding of queer, as highlighted in an earlier section of this chapter, by considering Turing as a "doubly queer" subject (p. 219). The more dynamic aspects of queer deployments – those exposing "disruptions that serve to expose the multiple ways subjectivities are constructed ..., experiences are imbued with meaning, and situations are interpreted" – provide a lens through which one can consider Turing's efforts in relation to the Decidability Problem, cryptography and code-breaking, thinking machines, and modeling morphogenesis (p. 220). The work goes on to consider popular (mis)appropriations of Turing's life that have helped engender renewed interest in his legacy.

Two popular representations of Turing are particularly suitable for queerly supplementing mathematical course content. Hugh Whitemore's play *Breaking the Code* (1987), which is based on Hodges' biography, can be easily assigned to students as an outside reading. It effectively embraces both Turing's work and sexuality, distilling ideas and events into a compelling performative narrative. *The Imitation Game* (Grossman et al. 2014) provides a recent cinematic treatment that similarly helps to communicate serious mathematical ideas to popular audiences. Reflecting Hodges' influence to a significant degree, this also explicitly portrays

both Turing's sexuality and the legal jeopardy to which this exposed him throughout his life. As supplementary "texts," both the play and the film can open up spaces for queer discussions. Questions that might be considered include, for example: To what extent is it possible or acceptable to examine the mathematical legacy of Turing without acknowledging his homosexuality? How effective are these treatments in popularizing mathematics? In what ways, if any, is mathematical knowledge enhanced or diminished by being popularized in these ways? The latter questions echo, in a way, concerns that motivate a critical contribution by Doan (2017) to interrogating queer history and memory. Central to the analysis she undertakes is the tension that exists between historical (disciplinary) practice and the affective work of memory and memory making (as but one aspect of producing popular representations). Her reflections provide food for thought, especially for mathematics instructors who feel compelled to respond responsibly to the "Add-Queers-and-Stir" approach highlighted by Rands (2016, p. 184).

Impulses connected with memorializing expose yet another aspect of Turing's recuperation as a queer mathematical icon that deserves note. In particular, Turing was officially – and posthumously – pardoned for his sexual offences by the British government in 2013. As welcomed as this was, the act only served to encourage many to seek "justice" for the estimated 49,000 men similarly prosecuted for gross indecency in Britain. The Policing and Crime Act of 2017 – the so-called Alan Turing Law – effectively extended posthumous pardons to other men (Stonewall UK 2017). Even so, one has to wonder whether Turing would want to be remembered in this way, given the questionable logic and rhetoric underpinning the act. Why were pardons offered only to deceased individuals, especially when many prosecuted before the 1967 decriminalization of consensual and private sex between adult men were still alive in 2017? Also, the word "pardon" continues to stigmatize individuals as lawbreakers and deflects attention from foundational questions related to the policing or persecution of sexuality in the past and present.

Further exploring the ways by which his work and legacy can be queered, Fancher (2018) critically examines the rhetorical elements of Turing's writing that speak to digital computing and machine intelligence. In particular, Fancher underscores the extent to which his work "resists norms in technical communication that expect stable and complete knowledge" by positioning Turing as "an outlier who reminds us that queer ... rhetorics can complicate and expand our understanding of technical and scientific communication" (p. 90). Her compelling interest in the ways knowledge is presented – and can be read – opens up a space in which to consider another writer with mathematical credentials who invites a similarly queer assessment.

Reuben Hersh: What Is Mathematics, Really?

Many members of the mathematical community are familiar with the work of Reuben Hersh. He earned his PhD in mathematics from New York University in 1962, and his extensive research record includes publications in the areas of partial

differential equations, probability, and linear operator equations (Hersh 2010). Some, however, may not be aware of what might be considered among the more unusual aspects of his professional trajectory: his Harvard Bachelor of Arts degree was awarded in 1946 in English Literature, and, before pursuing mathematics as a graduate student, he worked both as a writer for *Scientific American* and as a machinist. Such rich life experiences perhaps explain the fact that his publication record includes numerous works dedicated to "[m]athematical practice and life" as well as "[p]edagogy and philosophy" (Hersh 2010). His private and particular intentions notwithstanding, Hersh's unusual career trajectory and bibliography may help in understanding the "maverick" spirit that imbues his work about, rather than in, mathematics (Hersh 1997, p. 13).

By his own admission, Hersh began to question the nature of mathematical knowledge, particularly as understood by practitioners of mathematics, when first teaching a course on foundations in the 1970s (AMS 2014a). Impelled in part by the disconnection between what he understood doing mathematics to entail and the more philosophical programs and perspectives discussed in relation to the foundations of mathematics, his reflections extended for over four decades and resulted in three notable texts. Among these disciplinary efforts – or what many queer theorists might describe as disciplinary "interventions" – *What is Mathematics, Really?* (1997) is possibly the queerest; in it, Hersh decenters Platonism by examining, interrogating, and positing other perspectives that can account for the production of mathematical knowledge.

The humanist account that Hersh articulates as a robust alternative to more formal foundational perspectives prioritizes the importance of shared commitments and engagements to understanding the true nature of mathematics. In this, it reflects tenets of social constructivism, an analytic framework embraced by many social scientists in the second half of the twentieth century. Moreover, by focusing attention on the social construction of knowledge, which necessarily concerns the typically implicit dynamics of power associated with knowledge production, Hersh shares affinities with queer intellectual pioneers such as Butler, Foucault, and Sedgwick, even if he doesn't explicitly identify their far-reaching influences. These points of connection can be found in particular content. Moreover, they also arise when taking a more holistic and rhetorical view of Hersh's text, especially in terms of his voice and presentation.

As part of his provocative undertaking, Hersh sought to dispel myths and misunderstanding by asserting that "mathematics has a front and a back" (1997, p. 33). This characterization, which he animates though what takes place in a restaurant, allows him to locate more public-facing concerns related to the discipline within a domain at some remove from the work and activities that account for its production. The artifacts of the knowledge produced belong to the "front" – the established truths and their presentation to a discerning clientele. The "front," for Hersh, also includes philosophical assessments of the knowledge which, adopting the analogy he establishes with a restaurant, are akin to reviews that might be offered by food critics. The "back" reflects the messy and contingent dynamics that, while crucially important to the enterprise, are purposefully obscured from the public

gaze (or at least this was more often the case before the trend for "open" kitchens currently embraced by many restaurateurs).

Hersh justifiably acknowledges the thinking of the sociologist Erving Goffman in presenting his front/back argument. However, it is useful to note here that Goffman's seminal work on *The Presentation of Self in Everyday Life* (1959) communicates an analogy related to the front and the back of "the house" more common when discussing a theatrical production. In this way Goffman – and, by extension, Hersh – draw attention to performance. Re-establishing this intellectual linkage allows one to reimagine the myth-dispelling distinction Hersh pursued regarding mathematical knowledge as one related to performative dynamics. That is, it permits a line of inquiry to shift to how the "scripts" that shape personal and professional engagements are both called into being and subsequently performed. There is much aligned with this perspective that might be productively contemplated, when discussing the nature of mathematical knowledge, by making students aware of the thinking that informs Butler's *Gender Trouble* (1990) and Sedgwick's *Epistemology of the Closet* (1990). One could, for example, pursue with them the extent to which disciplinary practices operate like a script to be performed. What would it take to rewrite the script? Is improvisation permitted? If so, what set of circumstances or potential sanctions might be called upon when attempting to deviate from the script presented? Questions along these lines highlight the sympathies that Hersh shares with both Butler and Sedgwick. Moreover, his account of mathematical knowledge is essentially contemporaneous with their work and similarly emphasizes the significance of social constructivism and performativity, all of which enhances its potential for queering mathematics.

Other aspects of its content notwithstanding, Hersh's undertaking, viewed holistically, can be read in queer ways. As if to mark a rupture with academic conventions, the text maintains a conversational tone that seems little concerned with establishing an authoritative position on the topic under consideration in any formal sense. Rather, it promotes an appreciation of the experiences of one who does mathematics. The perspective adopted in doing so aligns itself with scholarship in queer theory that elevates the value of the quotidian as a way of examining identities and activism. In the case of Hersh, the doing of mathematics that significantly shapes his own lived experience is the impetus for both the philosophical concerns raised as well as the intellectual "activism" represented by his attempt to resolve them in the context of shared social constructs.

Beyond a quotidian perspective that frames his reasoning around the everyday, Hersh also adopts the voice of an outsider-insider in developing his position. The tone is earnest, heartfelt, and contingent rather than scholarly. It speaks to a kind of bottom-up intervention that is familiar to historians of recent LGBTQ rights movements, even as it serves to disrupt inclinations to view mathematical knowledge as monolithic. Exposing and expounding on intellectual dissatisfactions in this way are reminiscent of the dynamics associated with reverse discourse as articulated by Foucault (1990). It is interesting to note that Hersh himself later acknowledged the somewhat subversive nature of his intervention during a videotaped interview with the AMS (2014a). Indeed, he addressed the extent to which he deliberated on the

concerns of philosophy without a legitimacy or authority grounded by expertise in that discipline. Still, as one whose work retained intimate links to such concerns, he claimed the opportunity to speak to and about them.

It is worth noting that Hersh's book-length treatment on the nature of mathematical knowledge was published months before a shorter article he wrote on the subject, one that shared the same title and appeared in a publication primarily aimed at German mathematicians (Hersh 1998). As such, the latter piece clearly addresses a professional audience; still, its concluding sentences reiterate a provocation even as they extend an apology of sorts to the mathematical community. In these, Hersh asserted: "I am not trying to upset anybody. Just face the facts" (p. 14). One can certainly debate the extent to which this short piece can be read as a one-man manifesto. Still, there are compelling echoes in it to the distinctly unapologetic slogan that was adopted by Queer Nation and modified throughout the 1990s: "We're queer! We're here! Get used to it!" Evidencing the depth of his commitment, Hersh (2013) revisited and refined his epistemological position for an AMS publication that, again, is written primarily for a mathematical audience. He also acknowledged his personal belief that it best addresses the potentially subversive concerns and questions that gave rise to decades of reflection (2014b).

Imre Lakatos: Proofs and Refutations

Some might say that it takes a maverick to spot the maverick inclinations in others. If so, then it should come as little surprise that Hersh (1978) seized on an opportunity in the inaugural issue of the *Mathematical Intelligencer* to introduce Imre Lakatos to the wider mathematical community. This "introduction" is in some ways an act of reclamation, not least because Lakatos died in 1974, 4 years earlier. Moreover, much of Hersh's commentary speaks to Lakatos' long-overlooked work, *Proofs and Refutations: The Logic of Mathematical Discovery* (1976). This imaginative treatment of the history and philosophy of mathematics was first written as Lakatos' PhD dissertation; it was serially published in the 1960s before being reprinted in 1976. Despite the shortcomings that Hersh acknowledged when promoting the work and mindful that others have since questioned whether or not it actually addresses a logic of mathematical discovery (Kiss 2006), *Proofs and Refutations* is worthy of consideration, once again, for the queer potential it represents.

There is a seriousness of purpose underpinning *Proofs and Refutations* that Lakatos handled in a very ingenious and unconventional way. Specifically, he presented a revisionary perspective on the production of mathematical knowledge that pays particular and primary attention to the ways by which conjectures emerge; are tested for their situational suitability and accuracy; are revised, if necessary, through refutation; and eventually solidify to become pieces of established and reliable knowledge that are accepted by the mathematical community. His position owes much to the reformulations of scientific knowledge articulated earlier in the twentieth century by Karl Popper and others. Still, translating these to a mathematical context meant exposing and underscoring the extent to which its

knowledge is predicated on experimentation, fallibility, and contingency. Even if practitioners might privately share such sympathies with Lakatos, the fact that he espoused these dynamics publicly as central to an appropriate framework for appreciating mathematical knowledge represents a disruptive intervention that destabilizes many monolithic notions regarding mathematical certainty.

If his message was subversive, then so was the way Lakatos communicated it. His is not a formal academic treatment that one might expect to find serialized in the *British Journal for the Philosophy of Science*, where *Proofs and Refutations* first appeared. Instead, Lakatos chose to convey his ideas through historically relevant footnotes to a lively "play" that dramatizes the development of the Euler-Descartes formula. This subversion literally turns a typically intellectual narrative on its head in order to elevate the dynamics of knowledge production. The playful historicization and performative rhetorical structure do more than call attention to recent pedagogical investments in inquiry-based learning (Larsen and Zandieh 2008; von Renesse and Volker 2015). His treatment decenters a perspective that sees mathematics possessing, in the words of Russell (1918, p. 60), "a beauty cold and austere, like that of sculpture" by dramatizing, instead, the messy and contingent dialectic energy that produces it. Lakatos celebrated the process of chipping away that is as essential to creating a sculpture as the work eventually produced.

Lakatos' positioning of the significance of discursive dynamics in many ways underscores the importance that Foucault's theorizations attached to these in terms of knowledge production and which Hersh later echoed in an interview with the AMS (2014b). It also reflects aspects of queer failure as recently examined by Halberstam (2011). In particular, *Proofs and Refutations* invites a reorientation in thinking that makes it easier to see and find the potential for reward in failure. Its narrative structure conveys a sense of the "wonderous anarchy" that leverages "disappointment, disillusionment, and despair" in order to "poke holes" in ways of thinking through which new possibilities emerge (Halberstam 2011, p. 3). Its playful rending of knowledge production is a testament to the "undisciplined" impulse that Halberstam's work both embraces and frames, in part, through mathematics (pp. 6–7). Neither Lakatos nor Halberstam explicitly deny discipline(s) in the works under consideration; rather, these reinforce each other in serving as reminders that intellectual potential can be effectively leveraged by selectively or strategically detaching from disciplinary conventions, constraints, or expectations. Perhaps it is within this undisciplined context, and through the anxiety it might engender in some, that one can best appreciate the professional and critical assessment made by George Polya, who, according to Hersh (1978, p. 149), found *Proofs and Refutations* "too witty."

Moving from shared perspectives to a particular intersection in their content, the work of both Lakatos and Halberstam encourages readers to consider the queer potential of animating the monstrous. The dialogue of *Proofs and Refutations* resounds with phrases like "hopeful monsters" and "monster-barring." The narrative purpose served by the monstrous is most clearly articulated when a student from among the cast of characters asserts that one cannot deeply appreciate normality without being thoroughly versed in the abnormal (Lakatos 1976, p. 23). This

sentiment has clear resonances in LGBTQ history, insofar as the medicolegal conception of homosexuality that emerged in Western cultures during the nineteenth century predated, by many decades, any serious contemplation of heterosexuality, not to mention the dynamics of heteronormativity that stealthily pervade and operate within systems of power and authority. Moreover, and reflecting the extent to which the preoccupation with and identification of queer subjects historically served social purposes, Lakatos' mathematical abnormalities provide the counterexamples that, once recognized, must be purged in order to arrive at the productive formulations destined to become sanctioned contributions to mathematical knowledge. Though much of contemporary queer activism, history, and theory is justifiably committed to the notion of resistance and resilience, one finds in Lakatos' dramatization something akin to the "monstrous martyrdoms" that Wilde (Wilde and Hart-Davis 1962, p. 1044) painfully understood would be required in order to secure social reforms to homosexual persecution. Whether in theoretical or real-world contexts – both of which can be explored through *Proofs and Refutations* – monstrosities play a critically vital role in productively exposing, telling, and living truths.

Concluding Remarks

Whether reclaiming particular subjects or laying claim to unconventional perspectives, it is possible to queer mathematics. Efforts may be met with varying degrees of reluctance or even derision, but this does not mean that the discipline can or should remain immune from such interventions. Queer mathematicians, and their colleagues in STEM subjects, are creating spaces for support and enhanced inclusivity. At the same time, others are continuing to imagine and employ pedagogies that encourage students to see themselves, as well as their experiences, in the study of mathematics. These efforts, like many found when exploring and excavating queer history, are simultaneously responsive and spontaneous. Put another way, queer potential is always and already present in mathematics; what is required is the spark that ignites the engagement or the sideways glance that encourages one to bring the peripheral presence into sharper focus. It doesn't seem overly subversive to think that Wittgenstein would likely have appreciated this potential with respect to current connotations and contexts: There is something queer about mathematics, after all.

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