Queer Readings of Mathematical Proof: Appropriating Norms in the Pursuit of Epistemic Justice and Queer Joy

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The enculturation of mathematics students into the mathematical norms of proof can be a source of epistemic injustice when personal, social, and cultural norms are in tension with those held by the mathematics community. This injustice can be addressed through students' conscious appropriation of these norms, and I argue that queer readings, a form of critical textual analysis originating in queer theory, offers relevant analytical tools for this appropriation. In this paper, I present findings from a study on queer readings of mathematical proof and illustrate how our queer appropriations of mathematical norms resulted in an epistemically just interaction with proof and invited queer joy into the proof reading process.

Keywords: Queer pedagogy, Epistemic justice, Proof, Proof reading

Many scholars have examined student and expert approaches to proof reading (Dawkins & Weber, 2017; Inglis & Alcock, 2012; Panse et al., 2018) in an effort to understand the "interactional accomplishment" (Weber & Mejía-Ramos, 2014, p. 90) between reader and text. However, this research often functions under an apprenticeship model where learners are expected to develop the same norms for proof as are held by professional mathematicians (Dawkins & Weber, 2017). As Tanswell and Rittberg (2020) explain, the enforcement of these norms during the learning process can create systemic disadvantages; "mathematics learners are not little research mathematicians and demanding that they operate in the same ethical order is a source of epistemic injustice" (p. 1209). Tanswell and Rittberg do not propose that the norms of proof necessarily need to shift, but that learners should "appropriate norms in order to experience the values these norms are intended to uphold" (p. 1207). In other words, mathematics students should be encouraged to explore and push back against norms of proof so that they may find when those norms are in tension with their personal background and understand why these norms are ubiquitous within mathematics. I argue that queer reading is a pedagogical method well suited to this appropriation. In this paper I investigate: [1] How do queer readings of proof encourage readers to interact with proof in epistemically just ways? [2] How does queer joy emerge during queer readings of proof?

Theoretical Perspectives

My work is grounded in the theoretical relationship between epistemic injustice and norms of proof as presented by Tanswell and Rittberg (2020), and in my conceptualization of queer readings as a proof reading strategy which encourages queer joy and epistemic justice.

Epistemic Injustice and Acontextual Norms of Proof

Epistemic injustice is a philosophical framework popularized by Fricker (2007) which exists at the intersection of epistemology, politics, and ethics. Epistemic injustice is used to discuss how systemic inequities, power dynamics and social relations negatively "affect humans…in their roles as epistemic agents" (Tanswell & Rittberg, 2020, p. 1200). For example, epistemic injustice highlights that when curricula fail to recognize Indigenous ways of knowing they discredit a culture's intellectual traditions (Pohlhaus, 2017).

Dawkins and Weber (2017) claim that norms of proof uphold four epistemological values central to mathematics. Of concern to Tanswell and Rittberg (2020), and therefore to this paper, is the second epistemological value proposed by Dawkins and Weber (2017) which states that "mathematical knowledge and justifications should be a-contextual and specifically be independent of time and author" (p. 128). Tanswell and Rittberg (2020) argue that the norms for proof upholding this epistemic value can perpetuate epistemic injustice in classroom environments by discouraging references to the agency of either reader or author and ignoring the collaborative and less formalized contexts in which proofs are frequently read and created.

Queer Readings of Proof

Reading strategies can be described as "goal-directed actions which are undertaken by readers for planning and monitoring their efforts in order to decode a text, understand words, and construct meanings of texts" (Alexander & Judy, 1988; Pereira-Laird & Deane, 1997; as cited in Yang, 2012, p. 309). The goal of proof reading is often proof comprehension or proof validation (e.g. Dawkins & Zazkis, 2021; Hodds et al., 2014; Yang, 2012) and proof reading strategies include self-explanation (Hodds et al., 2014), summarization (Davies & Jones, 2022), and attempting to prove a theorem before reading its proof (Weber, 2015). Given proof reading strategies include any activity which readers use to "decode a text" and "construct meaning" (Yang, 2012, p. 309), they can be extended to include annotation, construction and deconstruction. For this reason, I expand queer readings into the field of mathematics as a proof reading strategy.

Queer reading is a pedagogical practice originating in queer theory which intentionally explores the "interpretive performance" (Britzman, 1995, p. 222) between reader and text while attending to a text's hidden meanings, implicit messages, and cultural, political or societal norms (Björklund, 2018; Britzman, 1995; M. Morris, 1998). Common misconceptions of queer readings is that they require queer intentions on the part of the author and/or that they must center sexuality and gender. However, many queer theorists argue that queer readings "can be just as useful in analyses of how other norms are produced in texts" (Björklund, 2018, p. 9). Consequently, queer readings of proof may invite readers to critically examine the structure and nature of a proof's argument(s), address the implicit relationship(s) between reader, author, and mathematical content, and to critique and appropriate norms of proving.

Epistemic Justice and Queer Joy

As an extension of the argument by Tanswell and Rittberg (2020), I propose that epistemically just interactions with proof are those which allow learners to appropriate norms of proof valuing acontextuality by introducing social or mathematical context, referencing author and/or reader agency, and valuing casual language and collaborative efforts. Given queer readings are strategies that explicitly work to uncover hidden meanings, consider implicit messages, and monitor norms present within a text, my work is grounded in the theoretical idea that queer readings of proof provide opportunities for readers to appropriate proof in epistemically just ways. Additionally, I consider queer joy to be a source of epistemic justice specific to members of the queer community.

Queer joy counters narratives of oppression, abuse, and isolation that are common within discussions of the queer community (Morris et al., 2022) by promoting stories of resilience, joy, and power. In educational research, Duran and Coloma (2023) invite researchers to prioritize queer joy in order to "render LGBTQ individuals as complex vibrant beings, underscore the educational and lived conditions that accept and embrace them, and prioritize our happiness, wellbeing, and the actualization of our full potential" (p. 122). In this project, I see queer joy as a form of epistemically just interaction with proof because it embraces the identity of the reader and invites them to contextualize their gender and sexuality alongside the mathematical content so that mathematics can "meet the learners half way" (Tanswell & Rittberg, 2020, p. 1208).

Methods

Data for this paper comes from a 2025 study conducted at a large university in the American Midwest. Data was created across three phases, all of which were methodologically informed by Jeong-eun Rhee's (2020) post-qualitative writings on rememory, my personal queer research aesthetics (Author, Year), and the knowledge that "queer lives can be addressed through a plethora of methods, and all methods can be put to the task of questioning normativities" (Nash & Browne, 2010, p.12). This paper's analysis is focused on phase two, a task based group interview (Goldin, 2012) where the queer readings took place. I describe my participants and outline my methods for preparing and conducting the task based group interview below.

Participants

Four participants took part in the study. Atticus (he/him) and Jeremy (he/him) were both completing their third year of a bachelor's degree in mathematics. Audrey (she/her) was a third year graduate student working towards her PhD in nuclear physics after earning a dual bachelor's degree in physics and mathematics. The fourth participant was myself (Author, Pronouns); I was a second year graduate student working towards a PhD in mathematics education and a master's in applied mathematics. All of us had completed at least two years of mathematics coursework and identified as queer. The choice to use queer participants stems not from a belief that only queer individuals can perform queer readings, but from a belief that queer methods of doing mathematics should originate from within the queer mathematics community.

Data Creation

Prior to the task-based interview, I conducted an unstructured group interview in which I used Rhee's (2020) rememory-based methodology as an access point to the social, political, and theoretical underpinnings of queer readings. This allowed us to collectively define our intended queer readings of proof as a way to "bridge the gap" (Jeremy) between theory and "what I can actually see going on" (Atticus), make proofs "explode" (Jeremy), acknowledge the queerness of proof's "funny little symbols" (Audrey), play with "what a proof can be" (Author), and "get the arts and crafts going" (Jeremy) so that proof does not seem "so far away" (Author).

Two proofs were selected for the task-based interview on the basis that they are present in other studies on proof reading. The majority of our time was spent reading the proof taken from Mejía-Ramos et al. (2012) (see figure 1) and all findings shared are in reference to this proof.

(1) **Theorem:** There are infinitely many triadic primes.

(2) **Proof:** Consider a product of two monadic numbers: $(4j+1)(4k+1)$
(3) $= 4j \cdot 4k + 4j + 4k + 1$
(4) $= 4(4jk + j + k) + 1$

(5) which again is monadic.
(6) Similarly, the product of any number of monadic numbers is monadic.
(7) Now, assume the theorem is false, so there are only finitely many triadic primes, say $p_1, p_2, \dots, p_n$.
(8) Let $M = 4p_2 \dots p_n + 3$, where $p_1 = 3$
(9) $p_2, p_3, \dots, p_n$ do not divide M as they leave a remainder 3, and 3 does not divide M as it does not divide $4p_2 \dots p_n$.
(10) We conclude that no triadic prime divides M.

(11) Also, 2 does not divide M since M is odd.
(12) Thus all of M's prime factors are monadic, hence M itself must be monadic. But M is clearly triadic, a contradiction. ■

Figure 1. Proof of infinitely many triadic primes. Line numbers included for readability of findings.

During the interview we had access to multiple copies of this proof as well as a variety of art supplies. The interview took place in a queer community center, lasted approximately ninety minutes, and was filmed from multiple angles to ensure that facial expressions, body language, and any manipulation of the proofs would be visible. At the start of the interview we reviewed our discussion from the unstructured group interview and agreed that even if we "don't know what it's going to look like" (Jeremy) we were ready to begin our queer readings based on the desires and guidelines we had previously co-created.

Data Analysis

In order to analyze the second task-based group interview I immersed myself in the data through repeated relistening and rewatching. This strategy of data immersion was inspired by the work of post-qualitative researchers who describe data analysis not as a "recipe" or "process" but as a form of experimentation grounded in the theoretical underpinnings of the work (St. Pierre, 2018, p. 604). For me, this meant inviting the data into my life outside of the academy by consciously relistening and rewatching the data while cooking, driving, and participating in my favorite hobbies; by the end of this phase of data analysis I estimate that I had relistened/rewatched the second task-based interview upwards of fifteen times.

Having built a strong internal relationship with the data, the next step of data analysis took the form of externalizing my noticings. For the purpose of this paper, I reviewed the task-based interview again, this time pausing to take notes when I observed moments where we interacted with the proof in epistemically just ways. For example, moments in which we contributed contextual annotations (e.g. "p_1 must be 3!", "b/c primes") represent an epistemically just interaction by appropriating norms valuing acontextuality. I also noted moments when we experienced queer joy while conducting the queer reading, as evidenced by our laughter, facial expressions, and implicit or explicit connections between our identities and the proof. After collecting these notes, I watched the interview again and selected specific instances of epistemic justice and queer joy that I felt most clearly demonstrated how the queer reading process was conducive to the emergence of these moments. I then began drafting my findings with the knowledge that the act of writing is another phase of analysis which allows the writer to explore their findings through the externalization process (St. Pierre, 2018).

Findings

During our queer readings of mathematical proof, the participants and I were inspired to physically deconstruct and reconstruct part of the proof for infinitely many triadic primes by cutting apart the existing proof (figure 1) and rearranging it onto a poster while adding our own context, notes, definitions, arrows, and other forms of annotation (figure 2). Through this de/reconstruction we were able to engage in proof reading in epistemically just ways by reintroducing agency and context to the mathematical text. This de/reconstruction of proof and the appropriation of proof norms also invited moments of queer joy in which we saw our queer experiences mirrored in mathematical proof and proving. Given my understanding of queer joy as an extension of epistemic justice, these findings are shared in the second subsection. However this ordering does not imply that our experiences of queer joy are secondary in importance.

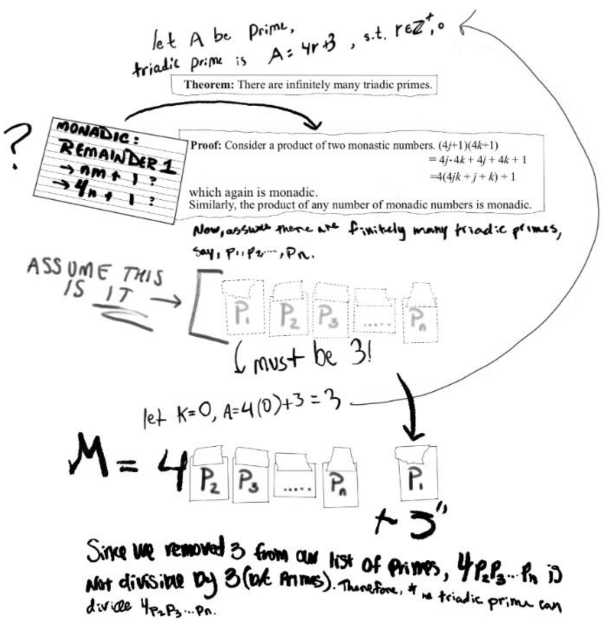

Figure 2. Partial proof de/reconstruction; digitally rendered for legibility

Moments of Epistemic Justice in the Queer Reading Process

One moment in which we experienced epistemic justice through appropriating proof norms valuing acontextuality was while discussing the assertion in line 7 and its relationship to line 8 and the overall proof by contradiction.

Audrey: So, the $p_1, p_2,$ all the way to p_n …are we assuming that *those* are the triadic primes? [she makes a chopping gesture with her hand] Are we assuming that that's all of them?

Author: Yeah, like if there was finitely many, that's it. That's our—like we could create a list and then this would be the list.

Audrey: Okay, okay. So, this is [her hands make a large sweeping gesture] all of them.

Author: All of them. [Laughing] We've done it. We've found them all.

Audrey: [She laughs and then frowns] What's the point of M though?

Author: Um…[Everyone is quiet for a moment]

Audrey: I think they're just trying to show that you can create a new triadic prime using the ones you've already created in the finite list?

Jeremy: Ohhh…

Audrey: You prove that that new product is a triadic prime…

Jeremy: Oh…okay, no I understand what you're saying.

Author: Right so it can't be finite.

Jeremy: Cause we already assumed it was finite, [He adopts a sassy tone and holds up his pencil] but actually, there's one more!

In this interaction we discuss line 7, emphasizing the proof's certainty that the list is finite while knowing that this assertion will quickly be disproven. In this way, we are acknowledging our agency as readers; we are not bound by the proof's linearity because we are able to look forward to line 12 as we read line 7. This allows us to find humor and curiosity in line 7's assertion, contextualizing the statement as it relates to the proof by contradiction. During our de/reconstruction of line 7 for our poster, Atticus, likely recalling the conversation shared above, suggested that we emphasize the finiteness of our p's with an annotation. I wrote "ASSUME THIS IS IT" to the left of the list of p's as a playful reminder of the upcoming contradiction.

Shortly after this discussion, and as part of our de/reconstruction of line 7, I was drawn to create a physical representation of the p's, cutting out p_1, p_2, etc. and taping them on our poster. This resulted in Audrey reaching out to physically move the p's from line 7 into the equation for M on line 8 as we progressed in our de/reconstruction. Her choice to physically relocate the p's to line 8 demonstrates her understanding of their equivalency and her sense of agency as a reader. Our queer reading method of de/reconstruction invited her to treat the elements from line 7 as tangible constructions which she is capable of manipulating and redefining, giving her agency over the proof in tangible ways.

Later, during our de/reconstruction of line 9, we felt the need to contextualize the conclusions being made about the terms within the equation for *M (*defined in line 8) which are central to the proof by contradiction.

Atticus: So what is it [line 8] even saying?

Audrey: Okay okay okay…so it's two [she raises her hands in a grasping gesture and then frowns, dropping her face in her hands] what's it called when things are…? [she perks up and holds her hands forward again] Terms, yes! Two terms! So we have to prove both are not—cannot—be divided by three.

Jeremy: Okay. [He uses his pinky to poke at the first term in the equation for *M*] And this one can't because we already pulled three out [he slides his pinky to the second term].

Author: And this one [I gesture to the first term for *M*] is just four and a bunch of primes.

Jeremy: Okay.

Author: So if this is four and a bunch of prime numbers…

Audrey: Yeah.

Atticus: [Slowly, while rubbing his chin] Right…then they're only divisible by four and the same prime numbers. Not three.

Jeremy: Exactly. [He leans forward and writes: Since we removed 3 from our list of primes, $4p_2p_3 \dots p_n$ is Not divisible by 3]

Author: That makes sense to me.

Jeremy: I'm gonna say…[he adds the parenthetical (b/c primes) to the poster, and we all laugh]

In this excerpt, we discuss why the first term in the equation for M in line 8 is not divisible by three, a discussion which Jeremy summarizes by rewriting line 9 with additional mathematical context and consideration for the reader. His choice to add the phrases "since we removed 3 from our list of primes" and "(b/c primes)" demonstrate a preference for casual narrative language which guides readers towards the line's main idea and explicitly addresses the logical jumps which were implicit in the original proof. This appropriation of norms valuing acontextuality allowed us to reconstruct the proof in a manner that was more comfortable for our reading process and more closely resembled our conversations surrounding the topic.

Moments of Queer Joy in the Queer Reading Process

As our queer readings led us to de/reconstruct the proof for infinitely many triadic primes, we paused to consider the separation we felt was visible between lines 2-6 of the proof and lines 7-12 of the proof.

Author: So we have a piece of the proof that feels unrelated?

Jeremy: We need a better transition for sure

Author: [Referencing those who identified as transgender (trans) within the group] Don't we all want a better transition? [Everyone laughs]

Atticus: [Emphatically] Yes! Yes, I do!

The word transition can refer to the narrative flow between lines of text, but it is also used by the trans community to refer to the actions and experiences of modifying one's gender presentation in gender affirming ways (e.g. cutting one's hair, changing one's name). This play on words which was evoked during our queer de/reconstruction of the proof allowed us to connect to the proof on a more personal level; we were able to see our identities as relevant in a mathematical context in which acontextuality frequently disguises the existence of queer readers and queer authors of mathematics.

Other examples of queer joy were visible in our discussion of broader mathematical concepts relevant to the proof. At the start of our de/reconstruction Audrey noted that primes as a mathematical concept felt queer to her, saying "primes are queer…they're special and there are infinitely many of them." As she spoke, she smiled and wiggled side to side in her seat. I remember feeling briefly emotional about this concept; delighted that, like primes, queerness extends into an infinity of experiences within an infinity of individuals. Similarly, Jeremy pointed out that proof by contradiction is a queer way to prove a theorem, laughing and gesturing at the proof as he exclaimed "like, we said there are infinitely many of them…JK!" Again, this moment of humor represents a deeper connection between our identities as queer doers of mathematics and the mathematics itself. This identity-forward interaction with proof is evidence of an epistemically just interaction with proof since it values the context and the community that we bring with us as proof readers.

Discussion

In order to uphold epistemic values of acontextuality, norms of proof discourage reference to time, place, reader or author agency, and the realities of proof as a human creation, and these norms perpetuate epistemic injustice for students (Tanswell & Rittberg, 2020). Queer readings, a practice which celebrates reader agency and invites the deconstruction of texts for the purpose of critique, exploration, and personal meaning-making is a pedagogical tool that encourages the subversion of these acontextual proof norms. And by subverting these norms, students are able to interact with proof in epistemically just ways, which for queer students, can include epistemic justice through the cultivation and acknowledgement of queer joy.

Much of the existing literature discussing proof reading focuses on student's cognitive behavior and/or the quantifiable outcomes of specific proof reading strategies such as improved proof comprehension or proof validation (e.g. Lew et al., 2024; Mejía-Ramos et al., 2012; Panse et al., 2018; Weber et al., 2012; Yang, 2012). But in recent years researchers and educators have begun considering the humanization of proof instruction (e.g. Contreras et al., 2025; Dahlgren, 2024) and how one might incorporate equitable pedagogical practices into proof based courses (e.g. Melhuish et al., 2024). I present queer reading as a supportive critical tool in advancing these agendas, as well as an enticement for students to experience joy and justice in proof classrooms. As Atticus expressed in his reflection exercise, "this process was so, so healing for me and my math soul! I feel like I can embrace looking deeper into proofs, and even rewriting them so they make sense to me."

There is still much to conceptualize about the practice of reading proofs queerly and how it might support students of mathematics, and I plan on continuing this work with the belief that queer pedagogy can be critical, subversive, and uplifting for students regardless of their identity (Author, Year). As we continue to ask ourselves how undergraduate mathematics education might become more equitable, just, accessible, joyful, and humanizing, I offer queer pedagogies as complementary frameworks deserving of continued study.

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