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**A Math Ed Take on a Love-Hate Relationship**  
**A Review of Reuben Hersh and Vera John-Steiner's *Loving + Hating Mathematics: Challenging the Myths of Mathematical Life***

*Jennifer Holm<sup>1</sup>*  
*Wilfrid Laurier University*

I found that *Loving + Hating Mathematics: Challenging the Myths of Mathematical Life* ended up being an interesting choice for me to write a review on from the perspective of a mathematics educator. My research has focused on the perceptions that individuals bring about mathematics to a teacher education program. I have found it interesting that every year the majority of the future teachers either focus on the negatives of mathematics or the rules and formulas that they see as the foundation (Holm, 2018). Rarely am I told about the beauty and elegance of the subject that seems to drive the mathematicians to live and breathe this field. For this review, I have chosen to focus on how the teaching of mathematics could be conceptualized in a way that allows the learners to experience what seems to drive the mathematicians whose stories are told in this book. Through the words of Hersh and John-Steiner as well as my observations of the book, I will also discuss some of the inequities that are a struggle in the field of mathematics as a whole in order to ponder why there seems to be a push and pull between many mathematicians and mathematics educators when it comes to the teaching and learning of mathematics.

If you think about the mathematics classroom where you grew up or in your university career, what was it like? In mine, we were sat in individual rows and were handed worksheets. The teacher would go through endless descriptions of how to solve problems or the different formulas, and then my role was to painstakingly recreate it over and over by hand until the worksheet was complete. The only thinking was to determine which of the countless formulas I had learned would be helpful. Although there are many elementary and some high school teachers who are challenging this vision, there is still a prevailing thought that this is the only way to teach mathematics. As Hersh and John-Steiner (2011) note, “The current dominant model of math instruction is mechanical and

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<sup>1</sup> [jholm@wlu.ca](mailto:jholm@wlu.ca)

inflexible and results for many in lifelong avoidance of mathematics” (p. 329). This certainly was the case for me and is for many of the teachers and future teachers that I work with now in my career. In this model, students need to be told formulas and how to solve problems, and once they have these “tools” they can work on mathematics. I feel like so much of this book challenged why this is such a damaging mentality for mathematics and the future of mathematicians in our society.

As I read the book, I was both inspired and angry by the pages that I read. Throughout stories of triumphs in mathematics and the blinding passion and love for mathematics that were told through stories of heroes of the mathematics community, there were the stereotypes, societal pressures, and biases that played a role in shaping many of the individuals in the book. It was hard to read the stories and not see how the outside influences shaped the roles of the individuals, both positively and negatively. In some ways, it was inspirational to learn of the triumphs and heartaches, but on the other hand, it was infuriating to know how some of these damaging traditions are continued to be pushed onto individuals. It became apparent that although great strides have been made toward equity in mathematics, there are still bigger ones that deal with more insidious issues to tackle. As a mathematics educator, I believe that our role in teaching mathematics is to support all students and help them learn mathematics but also to appreciate the beauty of it, and I felt that this book could potentially serve as a reminder of why this is so important. It reminded me that mathematicians have this duty too if they want their field to grow and innovate; the two fields are not and should not be at odds.

Although what was plain in most of the stories was where we differed: as mathematics educators, there is a belief that all should be allowed to learn mathematics, and many mathematicians believe only those who would be mathematicians should be supported. It has also made me realize that the stories of the mathematicians in the book actually support the cause that I have strived to champion even while at turns being challenged by the very mathematicians who I thought would have been supportive since the overall goal is the good of mathematics teaching and learning. Creating this review became deeply personal to me, and I felt that this book set an incredible groundwork for some thoughts about how to shift the culture of mathematics to allow all to experience and appreciate

the beauty and artistry of this incredibly powerful subject, and how we can all potentially work towards this goal.

I start my review at the end of the book and build forward because in some ways I felt like the book was reversed to make it a powerful tool in a revolution of mathematics. They end with a discussion of teaching and learning mathematics, and since this is the way to nurture, support, or even create future mathematicians, it seemed to me like an impressive tool to start the discussion about the future of mathematics. Although these last two chapters shared a lot of stories around mathematics teaching and learning, in some ways they overlook how the stories of the mathematicians could be used as starting points for classroom learning. The one powerful message from the end though, was that there is a bigger issue than just how to teach mathematics that needs to be tackled in order to make lasting changes. I will reserve the rest of the review to a discussion around the teaching of mathematics, but first, the imperative from the novel needs to be discussed to lay the groundwork.

Hersh and John-Steiner challenge the notion that mathematics, and in particular algebra and calculus, should be the gatekeeper for many professions and career trajectories. They ask why it is important in professions, like medicine, that do not use these mathematics skills in their daily practices to require students successfully pass calculus courses, wondering what doctors we are missing out on because of this stumbling block. Boaler (2020) has advocated strongly for bringing a Data Science stream to the high school curriculum as this would both support future careers and bring in mathematics that is strongly connected to daily life. She notes that greater equity would be created through this stream for all students, especially those who are currently disadvantaged by the system. Even so, the prevailing stereotype that somehow algebra classes are “better” and these students are “smarter” would need to be dismantled before this successful revolution could take place because otherwise there is a perception that this is just another “easy” way through mathematics. Hersh & John-Steiner (2011) state:

By making mathematics more accessible and relevant to daily life and by having teachers who are passionate about the subject, we may succeed in decreasing the number of individuals who see themselves as incapable of dealing with numbers and numerical abstractions and help all learners to practice careful reasoning. (p. 323)

It is with this thought in mind that we turn to looking at the classroom practices that are supported and ones that are destroyed by this book.

Every year I am faced with future teachers who tell me that mathematics is “black and white” or that they cannot do it. The stories range from heartbreaking tales of someone telling them they cannot do mathematics because they could not memorize formulas to feelings of failure when they try. In one of the last chapters of the book, Hersh and John-Steiner bring up the contrasting teaching styles of Robert Lee Moore and Clarence Stephens. The work of Stephens hinged on the idea that given the right environment, everyone can learn mathematics. He believed that with nurturing teaching and a belief that all students can learn, any student can be successful in mathematics. What made the story even more impactful was that they were not reducing the mathematics bar for these students and yet their college graduated more mathematics majors than other places. What was sad were the comments from those who visited who admired what was happening at Potsdam but then left saying it would not work where they were. Why not? Why is this not a mantra that has been adopted by all mathematics departments? Are all students in the class going to be the next Carl Friedrich Gauss or Marie-Sophie Germain, maybe not, but does that mean it is not worth seeing where they could go? The students may not revolutionize the mathematics field, but who knows if with the right environment and mentor, that they just might. Even if they do not, why not support them in unlocking the power and beauty of mathematics? Moore had the opposite teaching philosophy from Stephens in many ways. At the core, his “teaching” was putting up a task and allowing the student to battle it out to prove the theorem. He used extreme bigotry in deciding who would enter his classes. The mathematically gifted rose to the top in the environment and the rest would necessarily wash out of the class or be used as examples of wrong theorems. The extreme competitive nature would attract those who were strong in mathematics and needing a challenge and exclude those who needed more time or support. By contrast, it

was clear that Moore catered to the mathematically gifted and Stephens focused on learning for all. The individuals with an early genius in mathematics are one thing, but what about the ones who have a slower start but could develop an aptitude? It is easier to teach someone with a gift, but it is so much more rewarding to mentor someone who did not think it was possible. In the words of Poland: “The recipe for success at Potsdam is very simple: instill self-confidence and a sense of achievement through an open, caring environment” (cited in Hersh & John-Steiner, 2011, p. 294).

The discourse over teaching styles led to a pondering of another problematic issue at the core of mathematics: inequity. Although not explicitly noted as problematic, one area that came out strikingly in the book were the hierarchies in mathematics communities, and the discrimination against women and the old. The use of “grandfather” and the ability to trace a lineage seemed also important. Is this too important though? Is this the reason there are Math Wars and fights between mathematicians and well-known mathematics educators? Is the elitism in mathematics too entrenched to be changed or too inbred to stand up to the challenge that there may be more people who could do mathematics if given half the chance? Even Hersh and John-Steiner (2011) comment that there is “more than one kind of mathematical talent and mathematical thinking” (p. 54), yet there still seems to be lasting hierarchies within the field.

The initial chapters are full of why mathematicians love mathematics. The stories were of young children who did not have to be “taught the rules” first, such as Stan Ulam who became fascinated with the patterns on an oriental rug to Sofia Kovalskaya noticing the wallpaper in her nursery. The chapters throughout are filled with stories of mathematicians who feel a sense of awe and accomplishment when they figured something out for themselves. Yet there is still a prevalent movement with some mathematicians that what is needed in schools is more and better formulas because they cannot possibly do the “mathematics” without them. Why not focus on this sense of wonder? The book expresses the stories of individuals who used mathematics as an escape from their literal prisons, such as André Weil, and to pass the time while keeping their minds sharp. If mathematics is this powerful tool, do we not have an obligation to the world to make it accessible to all individuals in some capacity? I think we can all agree

that not a day goes by where mathematics does not play some part, yet we still have the concept of “school mathematics”. Hersh and John-Steiner aptly name their final chapter “Loving and Hating School Mathematics” and I still struggle that this should even be a thing. Why is “school mathematics” still so important? Why can it not be just “mathematics” that we use to teach and inspire?

Hersh and John-Steiner do call attention to the nature of reform in their chapter on the state of the classroom and provide a summary of the movement to bring more of the real world into the mathematics classroom. What I felt was missing from this chapter was the connection to how these ideas are what mathematicians naturally do in their pursuit of mathematics. The “reform” movement as it is called in the book speaks about supporting an understanding of mathematics and a need for discussion. “The primary emphasis of reform programs is making mathematics *cognitively* accessible to learners” (Hersh & John-Steiner, 2011, p. 312). Not once in the book does it mention a mathematician who learned through a drill and practice environment or had a breakthrough by being told how to solve the problem first and completing examples. Instead, they relied on ingenuity, creativity, and their own thoughts about the mathematics, looking at it through their own perspectives. This tenet sounds like a solid way to base a classroom: challenging students to use their own understandings to work through appropriate problems with the support of the teacher.

Two chapters of the book are dedicated to the importance of collaboration and friendships in mathematics. These two themes continue to permeate the rest of the book in discussions of how to continue progressing the field of mathematics. They note that mathematicians also need quiet opportunities to work as well. Based on these stories, it supports the idea that the mathematics classroom should foster times for students to quietly think about the mathematics, but also moments for collaboration and discussion as needed to consider the problems. The timings of these activities would be individually driven to help support intense concentration while also expanding and fostering ideas. In the end, the work of the mathematician is not about calculating answers with set formulas but deeply understanding what they are doing and finding new and exciting ways to continue the work. As Hersh and John-Steiner (2011) note, mathematics classrooms

“require strong teaching, with an emphasis on conceptual understanding, and most important, with connections to activities that are relevant to children’s lives” (p. 307). Throughout the book are stories of individuals who are shaped and inspired by teachers who had an impact on their own growth and career. These stories serve as a motivating example for the important role of the teacher, but also the necessary components for “good” mathematics work that can be brought to the classroom. Many teachers talk about asking their students to act like “mathematicians” and the story in this novel serves as a reminder of just how we might foster these ideas in our classrooms.

Although the book did an amazing job of highlighting the beautiful stories of mathematicians, they did also explore the darker side of the work. The relentless drive for an answer or solution to a problem can lead to a singular focus that destroys minds and individuals. As Hersh and John-Steiner (2011) point out, “mathematical work, like every other kind of deeply engaged intellectual or artistic work, is deeply emotional. It relies on intense motivation; it brings with it elation and disappointment, happiness and grief” (p. 334). This darker edge could be used as a cautionary tale in the classroom to guide learners to seek balance and find healthy ways to work within this incredible field. They do also lament the problem within schools to be a lack of teachers who have the passion and understanding for the field of mathematics to support learners. This seems like an understandable problem: the individuals who are charged to change and support the system are oftentimes the individuals who the system has already failed.

In the end, I now wonder if the debate, or the Math Wars, is not really fought over the teaching of mathematics, but rather the purpose of mathematics education as the actual point of conflict, that are rooted in some of the more basic beliefs about the fields of mathematics and the hierarchies they engender. If the focus of mathematics education is on harvesting and growing new mathematicians, then everything is fine; that genius seems to continue to rise to the top despite everything. The stories told throughout Hersh and John-Steiner’s book say that someone with an extreme love and passion for mathematics will find a way against all odds. If the focus of mathematics education is on equity issues and creating situations that allow for the learning and success of all in mathematics, then shifts must take place. Much like the example of Potsdam and the work



of Stephens, we need to engender the idea that all can learn mathematics with the right environment. Classroom environments would need to shift to allow for a different type of mathematics learning to occur where the focus is on understanding and exploring the mathematics, not just memorizing formulas. We need to look at teaching as a place to make changes, but we do need to keep in mind that looking beyond the teaching is also necessary for change. As long as there are pathways and hierarchies that are valued and supported within the system, then true change cannot occur. Hersh and John-Steiner use the stories of the mathematicians to challenge the myths held about these individuals and humanize a subject that is often perceived to be cold and calculating. In doing so, they prove that mathematics is not without beauty and emotion, but also that it is something that can be accessed and appreciated by all. I leave with this final question: what is the purpose of mathematics education in the system? The answer to this question will lead to what needs to happen next in the field of mathematics education.

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