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Book Review

Rebuilding Readers' Relationships with Mathematics: A Review of *The Psychology of Mathematics: A Journey of Personal Mathematical Empowerment for Educators and Curious Minds*

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When I applied to graduate school, one of my driving motivations was that I wanted to cure mathematics anxiety. I think that desire unfolds in different ways for many of us in mathematics education. When someone shares their story with me about what turned them off from learning mathematics, I have often sympathized with them. No one would enjoy an experience like what they tend to describe. Yet I have wondered, perhaps if they had a different experience with mathematics, might they have had a better relationship with mathematics. Mathematics educators are constantly striving to foster better mathematical experiences for learners. This book offers a way forward.

The *Psychology of Mathematics: A Journey of Personal Mathematical Empowerment for Educators and Curious Minds*, by Anderson Norton, provides a path for readers to rebuild their relationship with mathematics. The author offers perspectives on what mathematics is, and he helps us, the reader, see the humanity in mathematics. Norton shows us how mathematics is inherently a part of how we think and act in the world, and he illustrates how mathematical thinking connects us all through broader cultural and historical practices. Throughout his book, Norton takes readers through a journey of connections and

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relationships in the world of mathematics. He also keeps equity in mind throughout the book.

Empowering students by valuing their mathematics

One of the ways that Norton intentionally seemed to keep equity in mind is by valuing students' identities as mathematical thinkers. His entire premise honored the thinking and identities of every learner of mathematics by his focus on learners' mathematical constructions. His starting point is that mathematics does not exist without people. In his words, "mathematical objects (e.g., numbers and shapes) arise from your own activity… you create them by created by coordinating our own mental actions" (p. 2). We can all create mathematics by reflecting on our own mental activity. He communicates that we "empower students by fostering their constructions of mathematical structures" (p. 2). I agree that this can empower students when we honor their mathematics and seek to understand how they organize and make sense out of mathematical objects in their worlds through decentering our perspectives.

When we view mathematics as Norton does, we view every one of our student's ways of thinking as mathematical and valuable at all moments of making sense of mathematics. We don't see some kids as the kids who are good at math and other kids as those who as less mathematically minded. We see everyone around us as constantly engaging in valuable mathematical thinking. Math is for everyone because math is in everyone. We do not discriminate and do not assume that some thinkers are more capable because everyone is creating mathematics in some form as they reflect on their actions with mathematical objects.

I found connections between Norton's characterizations of mathematical thinking and how I think about mathematics learning. I have been working with mathematics teachers to help students experience doing mathematics in school as a process of constantly drafting and revising their thinking. Math is not only about whether answers are correct or not, and it is certainly not only about whether or not we make calculation errors. Rather,

mathematics is about what new connections and insights we develop. We can constantly grow and revise our thinking. Correct work can be revised through finding a new mathematical relationship, creating a more elegant justification, finding alternative solution, or creating a new representation of our thinking. From this perspective, all drafts and revisions have value and offer something from which we can learn, and all thinking can evolve and be extended. My perspective appears to align with Andy's. We both seem to believe that there is power in students' thinking, that people are constantly making sense of the world, and that mathematical ideas are inherently connected.

If we view mathematics as a human activity, then the work of teaching is to continually stay curious about learners' mathematics: to elicit learners' thinking, to help learners understand each other's constructions of mathematics, and to collectively build constructions of mathematics through our interactions with one another. Mathematics is inherently accessible when we are the ones constructing it. Making sense of others' constructions allows us, together, to build something new that we would not have understood without the opportunity to interact with one another.

Interconnected beauty of mathematics

If any reader has experienced school mathematics as rote calculations and as a set of seemingly disconnected topics, their view of mathematics can be transformed by reading this book. Norton supports readers with constructing a view of mathematics by beginning with the foundational concept of number and how it is constructed in the minds of people. I was surprised and delighted to encounter the range of mathematical connections throughout this book. Every reader will have opportunities to entertain new insights about mathematics while reading.

Norton illustrates that mathematics is a coherent system. Each chapter focuses on a domain of mathematics, and Norton connects each chapter by showing how the mathematics in the previous chapters connect to the mathematics in the current chapter. In this way, Andy's book makes a contribution toward

helping readers develop their mathematics knowledge for teaching. If part of mathematics knowledge for teaching is developing knowledge of mathematical coherence and connectedness, then a reader can develop that by reading this book and engaging with it. *The Psychology of Mathematics* offers a mathematical storyline to its readers about how seemingly all of mathematics is interconnected.

One of the reasons why I love mathematics is that there are always new connections to be made. Sometimes when people hear me talk about the value of revising our thinking in mathematics (c.f., Jansen, 2020), they assume I mean fixing our mistakes. Sure, that is part of what we could revise. But there are lots of ways we could revise our thinking, and one of the most powerful ways is expanding what and how we think, even with respect to ideas that we might assume we already understand deeply. This book helps us, as readers, to keep expanding our thinking about possible mathematical connections. To point out another one of my favorite quotes from this book, Norton writes that when we see something new in mathematics or revise our thinking as we make new connections, "it's not because they [the mathematical objects] have changed but because you have changed" (p. 204).

Every reader will make a new mathematics connection as they read this book, so every person will change as they read. Norton guides us toward these changes. Every chapter walks a reader through a series of mathematical explorations. You may read about certain topics in mathematics that you have not thought about recently. Norton invites you to linger, explore, slow down, and connect with the topics in each chapter. Each chapter concludes with reflection questions to take the reader further on their own mathematics journey. The inclusion of these reflection questions aligns with a perspective that learning comes from reflecting on experiences.

Mathematics is everyone's activity

Another way that Norton works toward greater equity is by highlighting mathematical discoveries beyond those of Eurocentric, western mathematical traditions. For example, he

educates us about how the base ten system is a social construct by illustrating different approaches to counting in other cultures. He writes about how the Oskapmin people in Papua New Guinea count in reference to 27 different places on the body, in contrast to counting using ten fingers. Throughout the book, he constantly situates mathematical ideas in historical and cultural contexts, and he pushes us to question: whose mathematics do we privilege and in what ways?

To read this book is to participate in doing mathematics. Throughout the book, Norton invites the reader to engage in doing mathematics. I found myself regularly pausing and working out mathematics on paper as I read. I found one of my favorite quotes in this book on page 87, when Andy wrote about what happens when students encounter mathematical proofs and proving by reading finalized proofs: "It's a bit like attending a baking class in which you are presented with cupcakes that you might consume (if you like that sort of thing), but without ever actually baking." This quote made me think about how Deborah Peart refers to "math" as a verb. (If you haven't seen her video from ShadowCon VI at the 2022 annual meeting of the National Council of Teachers of Mathematics in Los Angeles, I recommend it: https://youtu.be/KxTZqy0bQEY.) She says that writers write, readers read, and mathers math. We can all be writers and readers, and we can all be mathers. I was definitely a mather while reading this book!

Norton refers to math using verbs throughout the book. When writing about geometry, Norton writes about sweeping and shearing to create, transform, and obliterate area. The verbs provide vivid imagery that makes mathematics come alive (e.g., matrix multiplication can annihilate area, according to Chapter 8). If anyone thinks about math using primarily nouns (e.g., numbers, graphs, theorems), they will experience math as activity and actions while reading this book. Nouns, such as symbols, are a product of actions. According to Norton, "mathematical symbols provide a means for recording the products of our mental actions, so we don't have to keep them in mind all at once" (p. 104). We need the nouns, or objects of math, to continue our actions. But math itself is something we do.

What does it take for someone to see themselves as a mather? The way Norton might see it is that they already are one, so he is trying to show a reader when and how they are mathing or have mathed. They are already doing mathematics, and they have already done it in the past. He wants to show us, the readers, that mathematics does not exist without us. Maybe if we helped students view mathematics in this way, our students can come to recognize that math needs them, not that they need math.

Who should read this book? In what context?

This book could serve to help a reader experience their own mathematical power. Also, this book could support readers with gaining a broader perspective on the history of mathematics. Readers can develop and extend their mathematical understandings through reading this book. Most of all, this book helps readers develop an understanding of how mathematics is inherently a human activity.

There are multiple educational contexts where this book could be a helpful resource. Many university degree programs offer a history of mathematics course for mathematics education majors. This book could be easily integrated into such a course. Additionally, this book could be incorporated into a course for teachers, either pre-service or in-service teachers, that is designed to develop their mathematics knowledge for teaching. I can imagine the explorations in these chapters being adapted into mathematics tasks for such a course, and then these chapters being assigned as readings after students have explored mathematics together, to extend their thinking. Similarly, this book could be used as a book club selection for a group of mathematics teachers who are also interested in doing mathematics together, like members of a Math Circle, who are looking for readings to enhance their mathematics explorations.

If you enjoyed books such as *Mathematics for Human Flourishing*, by Francis Su (2020), or *Math with Bad Drawings*, by Ben Orlin (2018), you would likely also enjoy reading *The Psychology of Mathematics*. Francis Su writes about how mathematics is connected to virtues such as truth, beauty, and justice, and he also offers mathematics puzzles for the reader to

explore in his book. There are wonderful drawings in both Orlin's book and in Norton's book. (I would like to give a special shout out to Andy's daughter, Eleanor, who created some of the drawings in this book.) In all three of these books, we experience mathematics as a personal experience, as beautiful, and as intriguing, and we are drawn toward new mathematical insights as we read and explore with the text.

Humanizing this review

I read this book from the perspective of a mathematics teacher educator who wants to work with mathematics teachers to create mathematics classrooms where students' thinking is valued and centered. I long for mathematics classrooms to be spaces where students are seen and heard as being capable of contributing to building knowledge together with their peers. I am a former middle school mathematics teacher, and I currently teach future elementary and middle school teachers. I sought to consider how the ideas of this book would provide insights that would help me support classroom teachers.

The author, Andy Norton, is a contemporary of mine in the field of mathematics education. I have looked to his work over the years to gain insights into mathematical thinking and learning. One of my favorite articles of his was published in the *Journal for Research in Mathematics Education* (Norton & D'Ambrosio, 2008); he and Beatriz D'Ambrosio describe the Zone of Potential Construction, which is a helpful construct for understanding the process of learning.

Andy and I were officers of the steering committee for the North American chapter of the International Group for the Psychology of Mathematics Education (PME-NA) at the same time, and we collaborated with other members of the steering committee to improve the organization's structure. Andy played a key role in PME-NA acquiring its status as a non-profit.

I share all of this to say that I reviewed this book from a perspective of having some prior familiarity with the author's thinking, and I was excited to write this review as an opportunity to reflect on the work of a friend and colleague in the field. I have shared some specifics of how I know Andy and his work to

humanize the field of mathematics education. We are all scholars who endeavor to make a difference as we build knowledge in the field, and our field is stronger as we learn from each other and support one another in that process.

In the field of mathematics education, we share goals of wanting to foster powerful learning experiences for students, to support teachers with creating those experiences for their students, and to strive toward greater equity. I always appreciate opportunities to notice and reflect upon how my colleagues strive to achieve these goals. Norton's book will help us all improve mathematics teaching and learning in equity-minded ways. We can all expand our thinking on mathematics and mathematical thinking through exploring and reflecting as we read *The Psychology of Mathematics*.

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