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Ryan Banow

Nat Banting

Egan Chernoff

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A Review of Francis Su's *Mathematics for Human Flourishing* with reflections by Christopher Jackson

Ryan Banow[1]
University of Saskatchewan

Nat Banting[2]
University of Saskatchewan

Egan Chernoff[3]
University of Saskatchewan

Dr. Francis Su uses an autobiography (or a dual autobiography) to discuss an issue in mathematics: it is often non-flourishing. When crafting this Euler Book Prize winner, Su and his co-author, Christopher Jackson, drew on their own personal experiences to educate and inspire readers to want to do (and teach) mathematics.

Su is a Professor of Mathematics at Harvey Mudd College and the past president of the Mathematical Association of America (MAA). This book grew out of a speech he gave at the end of his term as the president of the MAA in January 2017. He writes from his perspective as a mathematics enthusiast, teacher, researcher, and learner. He explains that, despite his degrees (e.g., Ph.D. Mathematics) and positions, his pursuits of math included several obstacles and experiences of non-flourishing. These obstacles began in his early years, as he grew up in a small rural area town in south Texas with limited resources, and repeatedly cropped up, such as the time a professor in graduate school told him that he did not have what it takes to be a successful mathematician. These obstacles absolutely shape the book's message and highlight how even those that are labelled as successful in mathematics have stories of both flourishing and non-flourishing.

The co-author, Christopher Jackson, is a unique choice. The book jacket subtly mentions "with reflections by Christopher Jackson", but his contributions to this work cannot be

[1] ryan.banow@usask.ca
[2] bantingn@spsd.sk.ca
[3] egan.chernoff@usask.ca

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understated. Jackson is "an inmate in a high-security federal prison and he has been in trouble with the law since he was fourteen" (p. 1). While in prison, he has developed an affinity for math and exchanges letters with Su. These letters play a prominent role as they serve as reflections at the conclusion of each chapter. Taken together with Su's writing, readers can see two very different people flourishing through mathematics in different ways.

So, what does Su mean by "human flourishing"? Within the introduction, he describes human flourishing as "wholeness—of being and doing, or realizing one's potential and helping others do the same, of acting with honor and treating others with dignity, of living with integrity even in challenging circumstances" (p. 10). He hopes to spread this message far-and-wide; the target audience of the book is anyone and everyone. Su asserts that anyone can develop an affection for math, including the demoralized and disenchanted.

As mathematics educators, we find the book compelling, but also familiar. Familiar because the roadmap of flourishing that Su and Jackson present is one that mathematics education has championed for years. The core question that the book is trying to answer is, "Why do mathematics?" or, in other words, "When am I ever going to value [mathematics]?" For those in our field, these are reworkings of the common student adage "When am I ever going to use this?" (p. 11). The book reads as a compilation of many of the great tasks and calls to action in mathematics education from the past decades. In presenting his stories and examples, Su draws on the work of many other popularizers. The concepts that he calls desires and virtues are commonly found within math education research, curricula, and policy documents. As such, we can unequivocally support what Su writes and are thrilled to see it presented using this framing.

The book is presented in thirteen chapters: an introduction, which sets the stage, and then twelve chapters, each delving into a human desire. The twelve desires are exploration, meaning, play, beauty, permanence, truth, struggle, power, justice, freedom, community, and love. He contends that each of these desires can be achieved through engagement with mathematics and lead to human flourishing. Within each desire exists a subset of virtues; for example, within exploration are the virtues of imagination, creativity, and

expectation of enchantment. The general structure is that each chapter opens with an anecdote, which in most cases are Su's personal experiences and stories, and then the anecdote is tied to examples or culture. The examples are typically drawn from mathematics education and mathematics, and do not stray into commonly used applications, such as sports statistics and politics. Upon reflecting on the book, the personal anecdotes are most memorable as they serve as metaphors to appreciate what Su intends with each desire.

Most chapters also include challenging puzzles (with hints and solutions available in the appendices). Each chapter ends with a letter sent from Jackson, in prison, to Su. The letters serve as a bridge between the concluding chapter and the next. Jackson's letters inspire answers to the "Why do mathematics?" question because if someone spending the next 20 years in prison can find significant value in doing mathematics, then surely anyone can.

Each desire that appears as a chapter in this book certainly has a history within and implications for mathematics education. We wish to highlight specific desires that have particularly strong ties to mathematics education: exploration, play, struggle, justice, and community. We delve into each of these five desires by exploring their role and history in mathematics education and how Su (re)presents them in this book.

Desires with Strong Ties to Mathematics Education

Exploration

Within mathematics education, the concept of exploration has been popular for many years and many modern curricula are designed with constructivist approaches to learning. This is rooted in what Stinson and Walshaw (2017) refer to as the Interpretivist-Constructivist Moment which began in the 1980s. Exploration is at the heart of constructivism and, in constructivist classrooms, students are provided with the opportunity to learn autonomously and find their own viable processes and solutions to problems. One need not look any further than the National Council of Teachers of Mathematics (NCTM) Process Standards to find highlighting of student exploration.

Within the description of Reasoning and Proof, students are expected to explore phenomena, justify results, and use mathematical conjectures (NTCM, 2000). This aligns perfectly with how Su presents the desire for exploration.

He opens this chapter on the desire for exploration with a thorough introduction to the unlikely math explorer that is Christopher Jackson. He does this to stress the idea that anyone can be a math explorer. Su then recalls his own childhood fascination with astronomy and space exploration and draws connections between astronomy, space exploration, and mathematics. He suggests that mathematical exploration is like space exploration, such that as a math explorer you do not know what you will find out; you send out probes to test ideas and theories, and you make discoveries at a distance, as mathematical findings are typically not physical.

Another great comparison is proposed between math and basketball to further illustrate his point. He also draws on Lockhart's (2002) comparison between math and basketball: "picture what it would be like to learn the rules of basketball and practice only free throws but never see a game and never play—until you're ready to go professional" (Su, 2020, p. 23). Considering school math through this lens is very disheartening and poses an important question to math educators: how can we provide structures and opportunities for students to be math explorers in our classrooms? How can students do math instead of simply learning and practicing the rules of math? Su goes on to try to answer the question by exploring a handful of examples, including a helpful reference to Ben Orlin's book *Math with Bad Drawings*.

Jackson's letter that closes this chapter examines who he is and why he chooses to explore math. He explains that in a practical sense it helps him pass the time and gives him a near-term goal to focus on. Beyond that, he provides an eloquent statement that "its importance in all things practical is what has me mystified and curious about mathematics" (p. 33). Inspiring gems, like this quote, are found throughout his letters and provide a fresh perspective.

For those steeped in mathematics education, you are not likely to leave this chapter with new ideas, but you may have new ways of presenting the idea of exploration or of seeing who should qualify as a math explorer. Su eloquently asserts that students need to learn to expect enchantment around every corner while performing math. If we could set up our classrooms with that as the goal, we can only imagine how differently students and society would view the study of mathematics.

Play

The chapter on the desire for play begins with an explanation of how humans, from birth, have a desire to play. Su goes on to describe what he sees as different features of play: being fun; having some structure to follow; exploration within the bounds of the provided structure (this re-stating of the human desire for exploration is one of many interconnections woven throughout the chapters); surprising results; and using the creative mind and the imagination.

He describes play as occurring through a two-phase cycle. The first phase is the inquiry phase. Once again, Lockhart (2002) is drawn upon. In this case, a comparison is made between call-and-response, such as in music, military, and tennis, and this inquiry phase. Su expands one call-and-response connection through a description of inquiring into the squares of numbers that end in 5 (i.e., $15^2=225$, $25^2= 625$, and so on). During this description, Su makes another explicit connection to mathematics education by invoking the classroom questions: “What do you notice?” and “What do you wonder?”. This, once again, highlights the connection between this book and mathematics education as these questions stem from the work of NCTM’s Math Forum.

The second phase in Su’s cycle of math play is called the justification phase. In this phase, learners focus on deductive reasoning to provide a logical explanation for conjectures put forward in the first stage. These two stages of play align exceptionally well with mathematics educator Brousseau’s Theory of Didactical Situations (1997) and there are many more examples of play within the field of mathematics education that could be mentioned.

Struggle

The concept of struggle, particularly productive struggle, has become increasingly popular in the mathematics education community over the past two decades (e.g., SanGiovanni, Katt, & Dykema, 2020). It has almost become a mantra for students. Educators often get students to read about and reflect on the productive struggle at the onset of difficult courses to persuade them that it is necessary to struggle, things worth learning take effort, and that struggling builds endurance, character, competence, and self-confidence.

Su opens the chapter by providing another personal anecdote. He recounts how he caught two students who had cheated on an assignment in his college course. These students obviously copied their solution from an online source. In response, he contacted everyone in the course and asked those who offended to come forward. Surprisingly, ten students confessed! When describing why they cheated, one student expressed that they did not know if they would ever get the solution on their own. This is where the concept of struggle emerges; although Su required a few pages of persuasion to convince the reader that struggle is truly a human desire. He argues that humans desire to "struggle to grow" (p. 119). In the end, struggling through tough problems leads to mastery. Jackson, too, highlights this sentiment in one of his letters: "I enjoy the 'fight' or struggle" (p. 114).

Justice

The chapter on the desire for justice is filled with many challenging anecdotes and stories that must be considered, reflected upon, and acted on to improve mathematics education. Within this chapter, Su directly connects to justice efforts within mathematics education, including the efforts of Gutiérrez, Boaler, and Tate. This has been underway in mathematics education for decades using critical theory and critical-race theory. Connecting back to Stinson and Walshaw (2017), these efforts are marked by the Social-Turn Moment that began in the mid-1980s. This moment also marked the "Mathematics for All" movement developed in the 1980s and increased efforts over the last two decades on teaching mathematics for social justice (e.g., Gutstein & Peterson, 2005). Currently, the NCTM lists equity as the first of the Six Principles for School Mathematics (NCTM,

2000). Those in mathematics education know that humans have a powerful desire for justice, and if justice is not found within classrooms, students and society will not flourish.

This chapter is preceded by a letter from Jackson that describes his five months in solitary confinement without a clear understanding of what has caused him to be put in there. What a vivid demonstration of the human desire for justice! Directly following Jackson's letter, Su launches into the chapter with a most memorable anecdote. He tells of his favourite Chinese restaurant that keeps a "secret menu" for those that speak Chinese. Despite Su being of Chinese descent, he does not receive this menu due to his lack of ability to speak the language. For the longest time, he did not even know that this menu existed. The restaurant simply assumes that he will not like the items on that menu. Su masterfully pivots from this personal story to an analysis of mathematical spaces. He poses tough questions: "Whom do we allow a peek at the secret mathematical menu? With whom do we share mathematical delights–puzzles, games, toys? [...] Whom do we shepherd toward doing more mathematics, and whom do we discourage? What conscious or unconscious assumptions are we making?" (p. 148). These questions force contemplation, particularly when it comes to our classroom practices.

Community

The final desire we will feature is that of community. These ideas of community and collaboration have been a staple of mathematics education for decades. During the 1990s, mathematics educators, such as Steve Lerman and Mariolina Bartolini Bussi, developed sociocultural theories of learning that are rooted in the idea that learning occurs through social processes. This desire shows up, once again, in the NCTM Process Standard of communication (NCTM, 2000). For students to develop these communication skills, they must learn within a community.

We come to know of Jackson's desire for community as he examines his struggles to find one within prison. This is especially challenging as he gets transferred from one institution to another. Su, on the other hand, explores the desire for community through a few stories. The first story is of Ricardo Gutierrez, a Grammy-nominated audio engineer. Gutierrez was drawn back into school at the age of 40 out of a desire to study mathematics.

Upon his return, he found the rigour of the work to be difficult, but he was most significantly challenged by feeling that he did not belong. Su uses Gutierrez's story to highlight the desire for community and how powerful it can be in supporting, or preventing, the pursuit of mathematics.

Su perceives that society identifies mathematics as a solitary endeavor. He tries to combat this by highlighting the collaborative nature of the professional mathematics community. One example he provides is Tim Gowers's 2009 Internet collaboration to find an elementary proof of the Hales-Jewett Theorem.

The chapter concludes with a description of a flourishing mathematical community. Su, when writing this, is focused on professional mathematics, but we feel that this vision can also be used to describe a well-functioning classroom:

> People who have joined together in a common mission of exploration and play, bouncing ideas off each other, valuing one another's input, getting excited about the directions their ideas are taking them, and embodying a wide array of mathematical virtues along the way. (p. 197)

Conclusion

Mathematics for Human Flourishing is a well-written book that brings together numerous aspects of the study and appreciation of mathematics. It draws upon personal experiences, particularly those of the two co-authors, to craft a powerful message of human flourishing. In a way, it also tells the story of mathematics education by highlighting many of the pillars of this community. Members of the mathematics education community should welcome the attractive way the ideas are presented; even though the ideas will already be familiar to them. The book is written to attract the attention of the general public, but a prior curiosity for mathematics is a recommended prerequisite to genuinely enjoying the read.

Christopher Jackson's contributions set this book apart from others. His letters provide grounding and relevance to everything that Su expands on throughout the chapters.

Despite his difficult circumstances, he embodies the pursuit of mathematics for human flourishing. Mathematics educators cannot help but be encouraged by his motivation and, in turn, be inspired to revisit their own teaching practice to ensure that they are acting in ways to enable their learners to fulfill their desires and flourish.

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