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Mathematics Education (and Other) Perspectives
A Review of Nassim Taleb's *The Black Swan: The Impact of the Highly Improbable*

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The biggest problem I have with reviewing *The Black Swan: The Impact of the Highly Improbable* (Taleb, 2010) is deciding from what perspective to write. There are a number of lenses through which I considered this work in relation to mathematics education: the Associate Professor, always searching for new resources for mathematics education classes; the teacher, always looking for new messages and ways of speaking to students (including pre-service teachers) about what mathematics is, what purposes it serves, and what limitations it inherently carries; the learner-teacher, always looking for a greater depth of understanding of the mathematics we are charged with teaching; the curriculum and pedagogy researcher and theorist, always looking for new ideas that might be applied to or impact education within and beyond the mathematics classroom; and the learning ally, always critiquing what is included or not for diversity of voice and ways of knowing. In the review that follows, I will speak to what I “saw” in looking through these various lenses.

Before starting into these discussions, however, a brief summary is likely in order. Black Swans, as Taleb (2010) defines them, are events that meet the following three specific criteria: “rarity, extreme impact, and retrospective (though not prospective) predictability” (p. 15). Primarily, Taleb explores the perilous relationship between Black Swans and prediction in the field of economics. To help illustrate his many points about Black Swans, Taleb builds a dichotomous split of the world in which he categorizes events of uncertainty into Mediocristan and Extremistan, or those events that are not susceptible to the possibility of Black Swans and those that are, respectively. For example, Mediocristan houses events for which “[w]hen your sample is large, no single instance will significantly change the aggregate or the total. The largest observation will remain

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impressive, but eventually insignificant, to the sum” (p. 65). Height and weight are two examples of events that Taleb ascribes to Mediocristan. Extremistan, on the other hand, is where:

inequalities are such that one single observation can disproportionately impact the aggregate, or the total. ... Almost all social matters are from Extremistan. Another way to say it is that social quantities are informational, not physical: you cannot touch them. (p. 66)

It is in Extremistan that events such as those related to the weather and stock market live. As an example of a Black Swan event, Taleb often references the stock market crash of 1987. It was an extremely rare event that had catastrophic impacts for the economy and consequently for the world. In addition, in the aftermath of the event, many claims were made to justify why economists should have known it was going to happen and when. Taleb also argues that we are now living in a world that exists in Extremistan more than Mediocristan, and that we need to learn how to live in this world of different uncertainty.

As a further background to his arguments, Taleb (2010) points to what he names Platonicity:

our tendency to mistake the map for the territory, to focus on pure and well-defined ‘forms,’ ... When these ideas and crisp constructs inhabit our minds we privilege them over the less elegant objects, those with messier and less tractable structures. (p. 24)

This is a major impedance to our successful existence in Extremistan. Further, he defines the Platonic fold as “the explosive boundary where the Platonic mind-set enters in contact with messy reality, where the gap between what you know and what you think you know becomes dangerously wide. It is here that the Black Swan is produced” (p. 24). The Platonic fold, Taleb argues, is where the models and representations of Platonicity, which help us negotiate the terrain of events in Mediocristan, cannot be assumed to model expectations and likelihood in Extremistan. The Platonic fold is like a door between Mediocristan and Extremistan, through which the statistical models of Mediocristan should not be relocated to Extremistan. In particular, Taleb focuses on the Gaussian curve (the bell curve), an object of Mediocristan that has been migrated through that doorway

to Extremistan; where he argues it is not only ineffective, its use is highly susceptible to great risk. To provide evidence and reasoning for his claims against the application of the bell curve to events in Extremistan, Taleb takes the reader on a journey of many logical fallacies that he sees at play: from the error of confirmation, “the tendency to look at what confirms our knowledge, not our ignorance” (p. 31); to the narrative fallacy, “how we fool ourselves with stories and anecdotes” (p. 31); to the problem of silent evidence, “the tricks history uses to hide Black Swans from us” (p. 31); the round-trip fallacy, “the confusion of absence of evidence... for evidence of absence” (p. 460); and the “Ludic fallacy (or uncertainty of the nerd): the manifestation of the Platonic fallacy in the study of uncertainty” (p. 459). This book is a logical and mathematical journey from assumed reasonable uncertainty to volatile and destructive uncertainty. Although what I have presented here is a far cry from the depth of the arguments and reasoning present in this text, it should provide enough of a context to ground the remainder of this review, and so I begin with the question of whether this is a book that I would have as a required text in the classes I teach.

The simple answer is no; and here is why. First, the focus is on economics, and although there are parts in the book that can make a nice shift into discussions about mathematics and the teaching and learning of mathematics, it is not enough to warrant making this a key resource for any of my classes. Even if this was not the case though, I would struggle with having my students buy and read this text. The Prologue, one of the longest I have ever encountered (which is not a criticism, but a statement of fact), at times made me want to scream “STOP THAT!!!!” and stomp my feet (in private, of course). I found Taleb’s writing to be explicitly arrogant and unnecessarily disparaging of the personalities of the people whose work he was criticizing. I suspect the intention was sarcasm and humour, but it was almost too much. I work in a Faculty of Education where we center our work and interactions with others in frameworks of anti-racism, anti-discrimination, and social justice; we center the treatment of people on respect, and we differentiate behaviors, beliefs, and work from the person. This book, and most significantly the Prologue, often does not do this. Despite my frustration, I pushed on, and after emerging from the Prologue, the level of condescension settled to a simmer (more or less). Unfortunately,

skipping over the Prologue would not be a solution, as the core ideas developed in it are essential for the rest of the reading.

Consider the definition of Platonicity I provided earlier. I purposefully chose not to include the entire sentence because I did not want to distract from the essence of Taleb's point by including his attack on Plato as a person: "What I call *Platonicity*, after the ideas (and personality) of the philosopher Plato" (Taleb, 2010, p. 24). This attack on Plato's character serves no purpose to Taleb's development of the concept of the Black Swan, nor his theories about how to limit the impact of such events. I know that this analysis might seem petty on my behalf, but these kinds of personal jabs, of which this is definitely on the tamer side, much too frequently, for my liking, rear their ugly heads throughout the book. It is the only thing that I found detracting from the value of the writing.

Despite my previously stated concern, I would definitely include *The Black Swan: The Impact of the Highly Improbable* (Taleb, 2010) in my collection of "book club" suggestions for use in my classes by small groups of individuals with a keen interest in a particular topic. I found the plethora of examples and thought experiments throughout the text to be rich in meaning and exploration. Note, I will also encourage any of my students who choose to read it to critique Taleb's conflating of who a person is with their work; respectful treatment of others is, for me, foundational to mathematics teaching and learning (or life, in general).

Moving on, I now consider *The Black Swan: The Impact of the Highly Improbable* (Taleb, 2010), from the perspective of the university instructor, always looking for important messages and ways of speaking to students about what mathematics is, what purposes it serves, and what limitations it inherently carries. In this regard, I found this book to excel. Like Taleb, I too have felt for a long time that our approach to thinking about statistics and probability (and I would like to add all mathematics), has become too passive and unquestioning. We have become so accepting of the statistical (and mathematical) tools that have been developed that we blindly accept rules without questioning whether any particular conclusion based upon that rule might be influenced by incorrect assumptions about the context or other factors. It has also become very clear to me, that my students

and I (and friends, if I am fully transparent here), do not understand randomness very well, let alone that there are different kinds of randomness, and this is definitely something that comes through clearly in Taleb's work.

As well, there are many examples throughout the book that could easily be brought into the classroom for consideration and scrutinizing in relation to the ideas of limitations in our thinking and doing of mathematics and statistics. Of course, Taleb's (2010) focus on why the bell curve should not be applied or trusted in predicting events in Extremistan is an obvious example that could be used. In particular, I would love to have my students discuss IQ scores and how we use them in our society to determine the value and ability of individuals. Personally, I contend that the IQ test scores are social quantities, ones that have been shown time and again to be culturally biased, and therefore, by Taleb's definition above, part of Extremistan. However, Taleb actually contends that they are part of Mediocristan with the restriction of considering the scores "as measured" (p. 35). I see the possibility of some great classroom debates with this topic.

For me, however, it is Taleb's (2010) introduction and discussion of Platonicity that has the greatest pull. Often, I find pre-service teachers come to my classes believing in the absolute applicability and truth of the mathematics that they have learned and that they are hoping to teach. It is often a comfortable space for them (and me), knowing that mathematics can solve all of the world's problems in consistent and predictable ways. The problem is, that all mathematics, however, even that which has been proven, is built upon assumptions, and as situations become more and more complex, the impact of the assumptions can become great. My students' enthusiasm (and at times mine) about mathematics is based upon seeing it as a place where we can get a single, clean solution. And that, as Taleb clearly illustrates in various ways, is a problem. In my classes, we both celebrate what mathematics can do for us, but we also learn to question what must be assumed in order for that mathematics to "work." The notion of Platonicity that Taleb introduced is really about the reification of mathematics, and I am excited to try this new way of speaking to the limitations of the mathematics that we are teaching and studying, and recognizing that all mathematics has a platonic fold to keep in sight, where formulas and algorithms fail to produce the predicted and desired results, where the results can

quite literally be catastrophic. The lesson that all of us who love, use, or some combination of both, mathematical formulas and algorithms need to learn is to prevent total reification (Platonification) of our mathematical objects, models, and concepts. In representing the world around us mathematically, we cannot lose sight that those representations are intrinsically connected to the place, time, and assumed truths of the moment that they are created.

I also cannot wait to engage my students in an exploration of Taleb's (2010) turkey example:

[A] turkey ... is fed every day. Every single feeding will firm up the bird's belief that it is the general rule of life to be fed every day by friendly members of the human race ... On the afternoon of the Wednesday before Thanksgiving, something unexpected will happen to the turkey. It will incur a revision of belief. (p. 75)

For the vegans and vegetarians in my classes, perhaps this is not the best example, but it does illustrate one of Taleb's points - how we too, like the turkey, can fall victim to "when science turns normal citizens into suckers" (p. 79), and that this happens because we trust our Platonic mathematical models to always hold. It also serves as an avenue for understanding the inductive and deductive reasoning cycle that occurs in the development of much mathematics. Unfortunately, the turkey in the example neither realizes in time that deductive reasoning might be apropos in its situation, nor does it get the chance to engage in that deductive reasoning after it has seen "the light." As well, linked to this interplay between the two kinds of reasoning is a demonstration of how one's perspective, language, and ways of knowing (rather than genes) can, at times, limit what you know. The turkey's perspective of its life, how it knows about life, and the language barrier between it and its feeders, prevent the turkey from avoiding its very personal Black Swan event. The turkey example, along with many others within Taleb's book, can thus act as a fruitful springboard into a classroom exploration of what are possible and actual limitations in the way that mathematics has been defined, taught and learned, used, and in essence, what is accepted and valued under the banner of mathematics.

It was in contemplating Taleb's (2010) discussions of the issues between Platonicity and Extremistan, as well as the turkey example, that I first considered whose voices were present and whose were not. My own engagement in coming to understand an Indigenous worldview had already taught me that Indigenous ways of knowing, including oral traditions, can often offer solutions to problems (mathematical or otherwise) where Western ways of knowing have failed (see Russell, 2015 for statistical examples); which struck me as being the kind of situation that Taleb was exploring. Much later in the book, as I read Taleb's "rules of 'wisdom'" (p. 370) for the mitigation of negative impacts of Black Swans, I was again brought back to my thinking about the knowledge and ways of knowing of Indigenous peoples, and more specifically about their relevance to Taleb's own rules and the (likely unintentional) omission of that knowledge and ways of knowing from the book. Although much could likely be said in relation to some, or even all of Taleb's rules from the perspective of Indigenous knowledges and ways of knowing, I have chosen to focus specifically on only one rule and its relationship to one incident, which is briefly presented here (see Russell, 2015 for more details).

Taleb's fourth rule is: "Beware the 'atypicality' of remote events" (p. 372), and it is a rule that should have been learned (but was not) by the Center for Disease Control (CDC), and consequently the so-called Western academic world, during the 1993 "Navajo Plague." In that year, a mysterious and deadly disease was killing Navajo people living on the reserves of the Four Corners in the United States. A Navajo healer, through his sand paintings, revealed to a CDC worker a detailed description of the events that lead to a particular kind of mouse moving onto their lands and the horrifying disease that results from people being exposed to the feces and urine of these mice. The CDC ignored the healer's knowledge, as their own statistical data and analysis told them that the kind of mouse that carried that virus was not endemic to the Navajo lands. The CDC eventually tested for the virus (after months of deaths of Navajo people and numerous tests for other possible causes) only to realize they had been wrong; however, even on CDC's own website, the knowledge of the healer is downplayed as being not much more than an interesting coincidence:

The Navajo Indians, a number of whom contracted HPS during the 1993 outbreak, recognize a similar disease in their medical traditions, and actually associate its occurrence with mice. As strikingly, Navajo medical beliefs concur with public health recommendations for preventing the disease. (CDC, 2020, para. 15).

The knowledge of the Navajo healer was exactly the kind of knowledge that Taleb's fourth rule promotes, yet even the Navajo people of the Four Corners had stopped trusting their traditional knowledge and instead looked only to Western science for answers. In a similar way, although Taleb acknowledges and promotes the valuing of the knowledge of Mother Earth (p. 371), he too has failed to recognize that there are people who have and live with and according to that knowledge. Although I do not condemn Taleb for this oversight, I would have been remiss to not bring forward these considerations. As we journey down this path of questioning the authority of the reification or Platonicity of mathematical models and formulas, it is important that we also remember to consider the silenced voices for the knowledge and ways of knowing that they have authored.

As a final point of review, I would like to dig a bit deeper into one of Taleb's (2010) discussions of logical fallacies. Although all of the discussions could easily be used within a mathematics classroom to explore and engage in rich mathematical discussions, I want to focus on one of Taleb's examples of the "round-trip" fallacy:

Doctors in the midst of the scientific arrogance of the 1960s looked down at mothers' milk as something primitive, as if it could be replicated by their laboratories ... not realizing that mothers' milk might include useful components that could have eluded their scientific understanding – a simple confusion of *absence of evidence* of the benefits of mothers' milk with *evidence of absence* of the benefits (another case of the Platonicity as 'it did not make sense' to breast-feed when we could simply use bottles). (p. 92)

Taleb goes on to explain how those people "who were not breast-fed as infants turned out to be at an increased risk of a collection of health problems" (p. 92), and from there concludes that the lack of breast milk was the problem at play: "there had to be in mothers' milk some necessary nutrients that still elude us" (p. 92). Although I do not doubt mothers' milk does serve a necessary role in our development and health, Taleb, in his own enthusiasm to point out the confusion of the absence of evidence with evidence of

absence has, in fact, fallen prey to the very same fallacy. In failing to research, consider, or even acknowledge the existence of other factors that may have been contributing to the noted health declines, such as lead paint used in homes, the increasing uptake of hydrocarbon emissions, the dramatic rise in smoking, or new mining and farming practices, Taleb has himself confused the absence of evidence with evidence of absence. The reality is that we do not know for sure what (all) caused the increase in susceptibility for these health risks, and the lack of evidence that other factors might have been involved does not mean that other factors were not involved. This is a very important lesson for my students and myself ... we are all susceptible to this kind of reasoning trap. It is also a wonderful example of how making mistakes in learning (mathematics or otherwise) is beneficial and an important part of the learning process (for more detail, see Boaler, 2016).

So, despite my warnings about the sometimes overwhelming and stifling arrogance of Taleb, particularly in relation to his written attacks on people rather than just their ideas or work, I did, in the end find *The Black Swan: The Impact of the Highly Improbable* (Taleb, 2010) worthwhile reading. Moreover, I believe that there are many parts of this book (I have only scratched the surface in this review) that can be used to engage students (and others) in rich and meaningful mathematical (and related) discussions. There are also many points that ultimately should be considered as mathematics curricula continue to be reviewed, such as including the fallibility of statistical (and mathematical) methods under certain conditions and the variability of randomness. Personally, I am always looking for ways to engage students in mathematics beyond just applying and (re)proving. I want students to critique the roles that mathematics plays in our society. I want everyone to learn to challenge our blind dependence and belief in the power and assumed truths of mathematical objects and formulas so that what we do, and how we do it with mathematics, is always of value. *The Black Swan: The Impact of the Highly Improbable* provides lots of starting points and background information for such engagements. Part of this type of engagement also means learning to accept different mathematical representations, such as in the traditional stories of knowledge keepers and healers, as being equally valuable sources of knowing and learning. As I said earlier, I do not fault Taleb for not including these voices in his book, but I do invite those of you who choose

to (re)read this book to think about the other ways of knowing that might also inform how we understand and deal with the Black Swans that Taleb has identified and explored. I agree completely with Taleb that we are living in both a world of Mediocristan and Extremistan, so we need to understand and be competent in dealing with both. I would also argue that we need to be open to the idea that there may be more “stans” out there that are yet unknown (to “academic” mathematics and science, but likely not to some cultures), and what has been set out as a dichotomy may, in fact, be a much more complex and interesting relationship. I thank Taleb for the invitation of his book into this space of continued exploration and reflection.

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