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Woo-Hoo! The Mathematics and Education of the D'oh-Nut
A Review of Simon Singh's *The Simpsons and Their Mathematical Secrets*

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How to Review a Book Twice. D'Oh!

I am a mathematics educator working in a Faculty of Education, at a mid-sized university. I have degrees in mathematics, teaching, and education related to the teaching and learning of mathematics. I also have twenty years of experience with school boards as a secondary school mathematics teacher and department head. It is from these experiences, knowledge, and professional practice that I approached this book review—from a place of how I see the world around me and work to understand it. I love thinking about and working to understand teachers' beliefs, problem solving, and professional learning in problem solving contexts, and thus my secondary school teacher 'self', or identity, is quite interconnected to my mathematics education researcher 'self, or identity.

First, I read the book, then after a little break to read other books, I read the book a second time. The first reading pass was enjoyable but resulted in what I felt was not enough insight worthy of a book review except for an obvious appreciation that I could use this book and the television shows it talked about in my classroom mathematics teaching. So, thinking like a mathematics teacher, I looked for the teaching support for this book—the details that could help me incorporate this book into my classroom mathematics lessons. I Googled the title of the book. And I found: https://www.simonsingh.net/Simpsons_Mathematics/ !

This website looks like it was initially a blog post space for Simon Singh, and which appears to have developed into a webspace for this book. And, it has a section for teachers! (This is 'gold' for teacher googling efforts.) There is a PowerPoint presentation he created for teacher use, and a Book Project Template (created by Nathalie Cameron) for classroom use too. I downloaded both items, read through them, and then, as I would do

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for any task I give my students, I completed the Book Project Template worksheets to make a sample solutions set. The template consists of a chapter tracker for the reader of the book, pages for details about the author and the book, and chapter highlights pages. At the very end of the template is a page asking for a final book report, and, there is a "summary notes" work page to help organize my thoughts. Figure 1 is an example of a completed chapter highlight page; I used chapter 13 for this example. Figure 2 shows the summary notes I completed before writing my book report.

Figure 1. Chapter 13 Notes

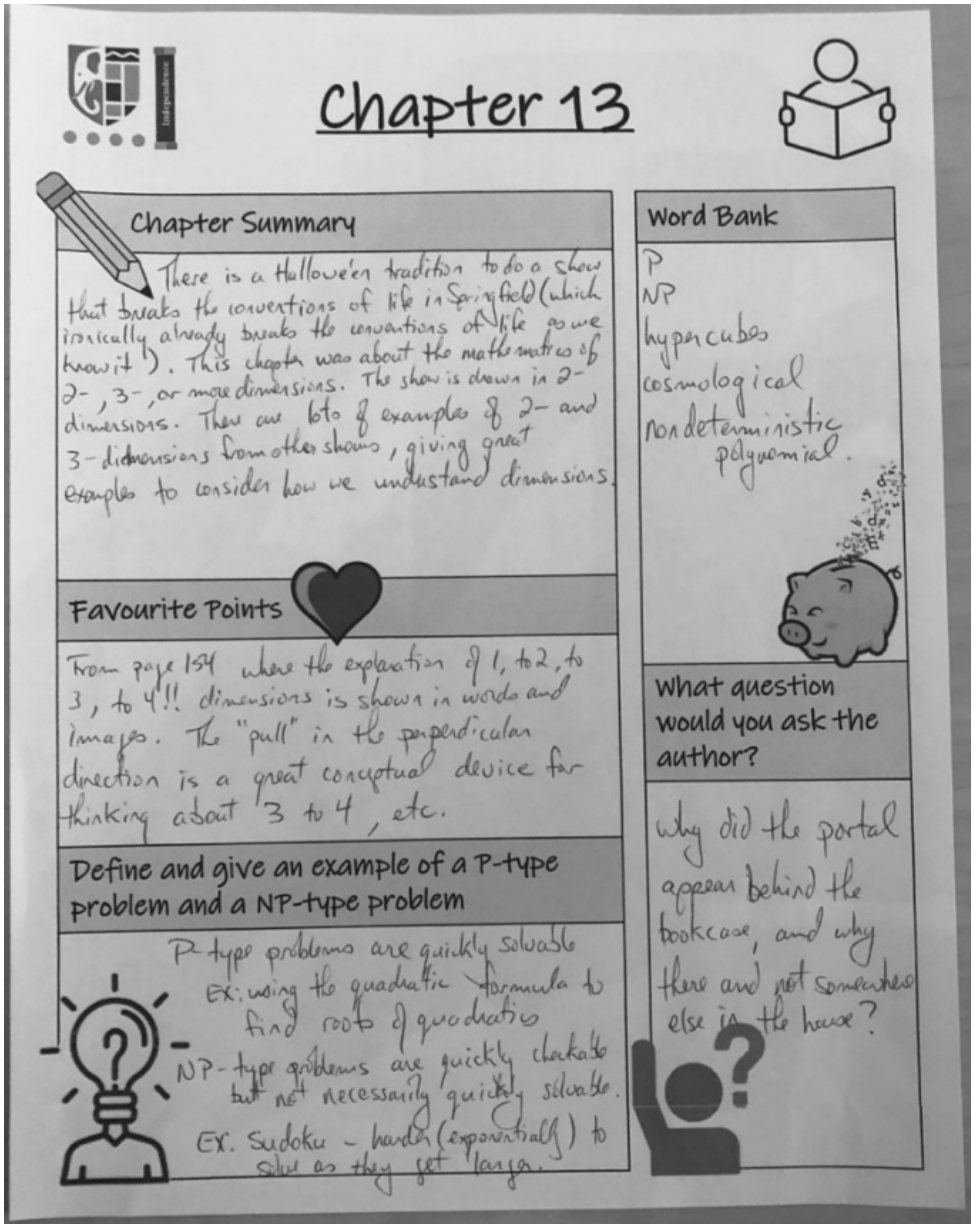
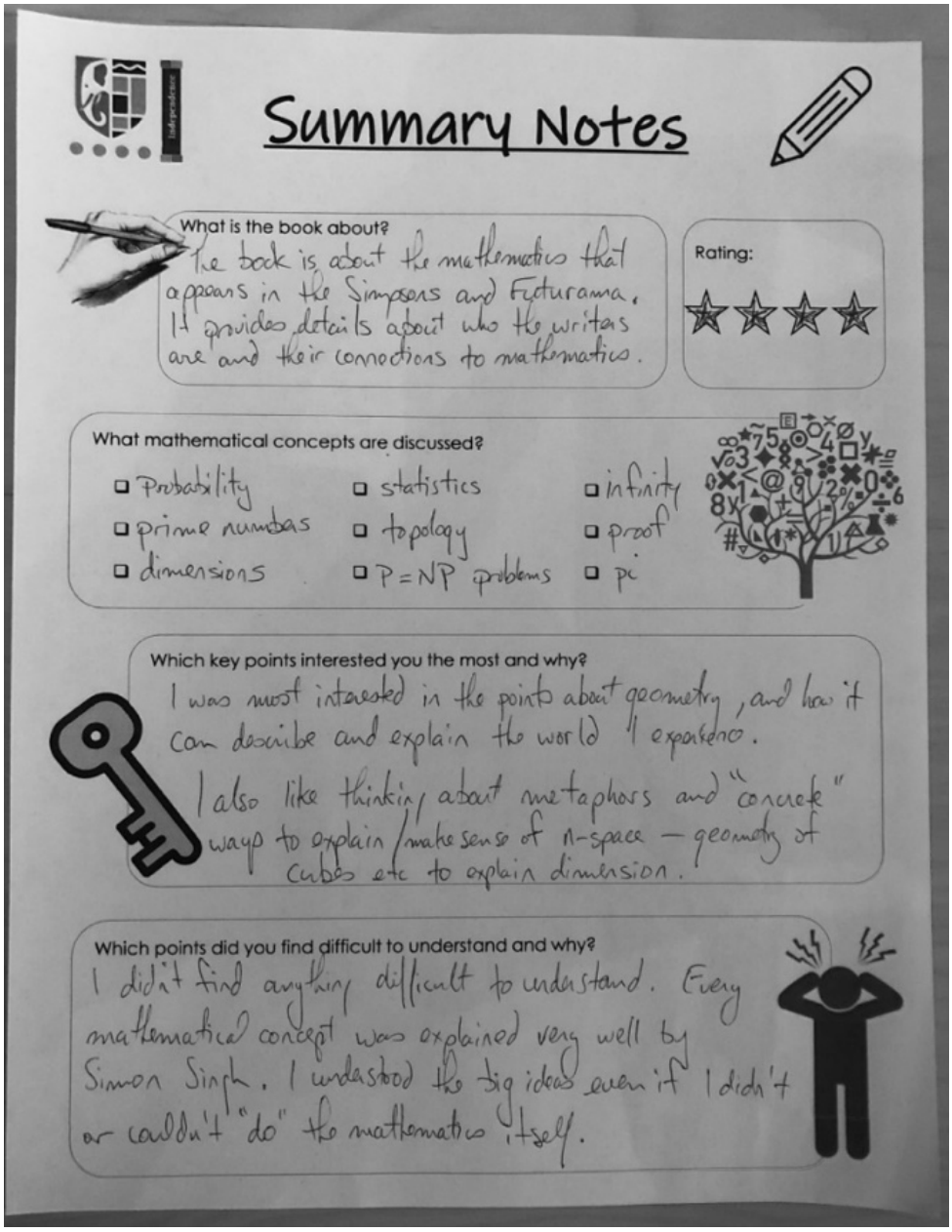
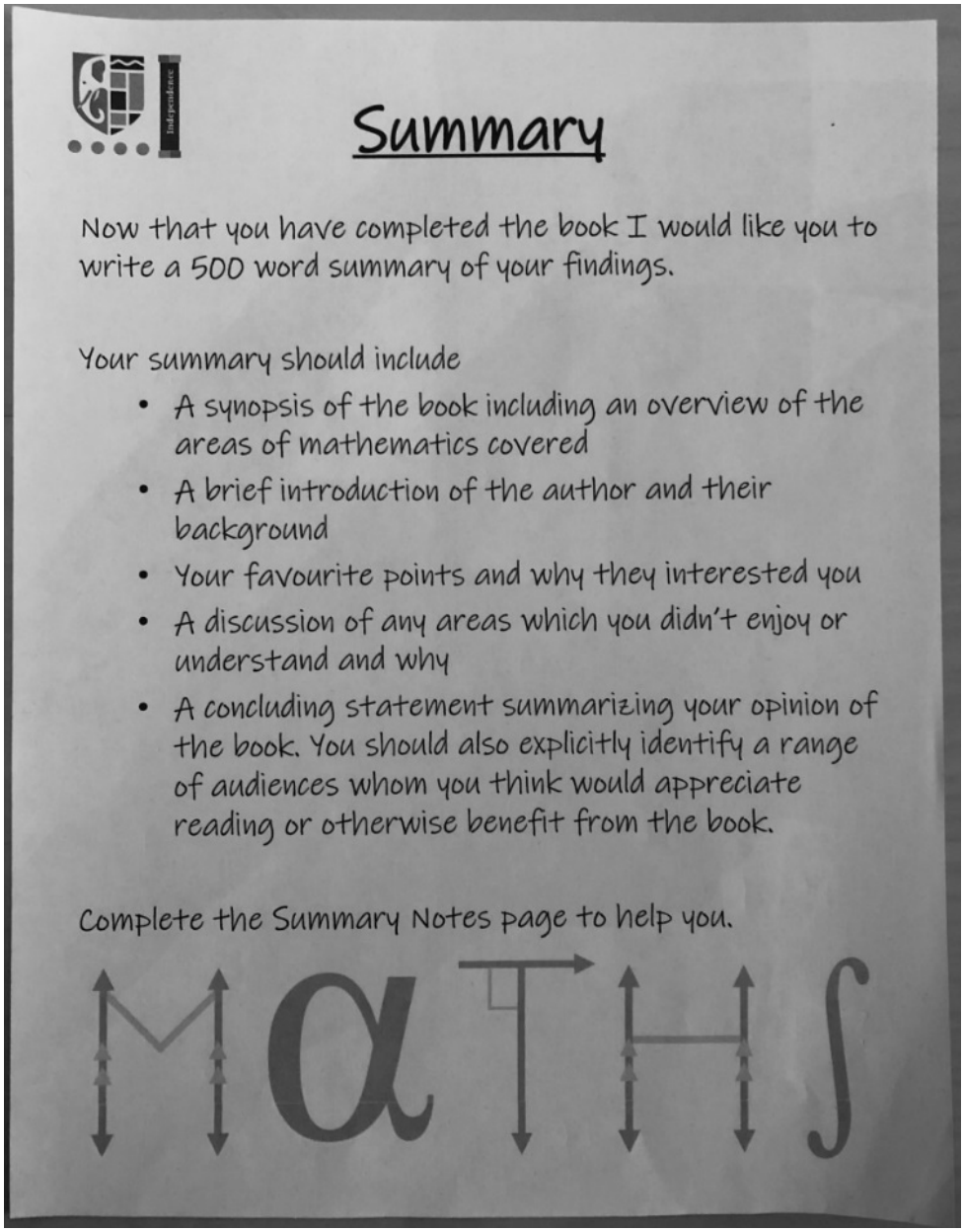


Figure 2. A completed Summary Notes page for my book report.



As a teacher expecting a book report from my students, I wanted to have a sample report from which I could plan for potential student problems with the task and identify assessment foci and assessment opportunities. The following is my book report using the book summary instructions (see Figure 3).

Figure 3. Summary instructions for the book report.



Book Report/Review of *The Simpsons and Their Mathematical Secrets* by Simon Singh, Written by Jamie Pyper

The book, *The Simpsons and their Mathematical Secrets*, by Simon Singh, is an exploration of all (if not most) of the mathematics that appears in the television animated series, *The Simpsons,* and *Futurama*. Most of Singh's book was about *The Simpsons*, so

most of this report will focus on *The Simpsons* too. While the television series was not written to be about mathematics, and many of the scripts are written without mathematics, much of the mathematics have been added in the editing and refining phases of each episode's development. Many of the writers for the show have mathematics degrees and have worked in jobs that require mathematics. In fact, while writing for the show *Futurama*, one of the writers, Dr. Keeler, developed a new theorem (Keeler's Theorem, or the Futurama Theorem), and the two shows have inspired many other people to explore and develop mathematical theories.

The book describes the life of the two shows from their beginnings to the current time, from the perspective of the writers who joined the writing team, and a bit from the time trajectory of the development of the shows. There are all kinds of mathematics presented in the book, from cryptography, to statistics, number theory, geometry, applied mathematics in financial applications, discrete and continuous mathematics, and the mathematics found in coding and physics. All the mathematics are described using examples from the shows, and the book author uses examples from other shows and events in our lives.

Simon Singh is an author who has written several mathematics-based books, for example, *Fermat's' Last Theorem*, and *The Code Book*. Dr. Singh has a Ph.D. in particle physics from the University of Cambridge. He lives in London, UK, with his wife, Anita, and his son, Hari to whom the book is dedicated.

One of my favourite points of the book is the dedication. Simon uses Greek letters to state: $\eta + \psi = \varepsilon$. I figured this was another way to state a dedication to his family; it took me a bit of time to figure out what the epsilon meant! (I will leave that for you to find on your own too!) Another favourite point is the 'examinations' that appear five times in the book. They are mathematics joke examinations, and they are very funny. My last favourite point of the book was how the writers of the shows, and Simon too with his explanations, found real-life examples and situations for all the mathematics. Those were very helpful to understand and appreciate the mathematics that is all around us, and how much

mathematics is a real part of our lives whether we think we are 'doing' mathematics or not.

There was only one part of the book that I enjoyed less than the rest, when the discussion became more about the mathematics than the relevance of the mathematics to the world around us, or the connections of the mathematics to the ways we live and experience the world around us. I am not as interested in reading the mathematics itself, as I am appreciating and experiencing how mathematics is ubiquitous in our lives. (But that is probably why I am in mathematics education and study the teaching and learning of mathematics more than the mathematics itself!)

In my opinion, mathematics is not just a language to explain the world in which we live, it is not just a way to describe the phenomena of the world around us, or just a service to the other sciences that define the interactions of objects and forms of the earth and our environments… it is a way of seeing the beauty of the world around us, and appreciating and understanding the complexity of how things and people work together; it is the art and science of life all together. As the writers of these shows hoped, "to drip-feed morsels of mathematics into the subconscious minds of viewers" so that the viewers have been "tricked into watching an animated introduction to everything from calculus to geometry, from pi to game theory, and from infinitesimals to infinity" (p. 2). Simon Singh says, "mathematical jokes test your mathematical knowledge" (p. 48) which makes me think, therefore, everyone who loves the shows, HAS mathematical knowledge! We are all mathematical thinkers whether we are aware of it or not, whether we think we have the school curriculum mathematics ability or not. I like this conclusion. It means to me that these shows are for *everyone*, just like this book is for everyone. And we can all experience and enjoy mathematics however we see it in the world. Thank you. The end.

The End of the Book Report

This is the end of the book report. But the beginning of the next phase of my review of this book is for you, the reader of this article. The following is what happened with the second reading and its subsequent analysis thinking like a mathematics education researcher.

Since I was performing a book review, my purpose was identified as: to identify what it was about the book that I noticed, that was interesting to me, that was important. This easily translated into a research question of "What is it about this book that I noticed and what am I going to likely be remembering after I have read the book?"

Research Analysis of the Book

Methodology and Methods

My methodology was a form of document analysis (such as Bowen, 2009), since this was a document, a book, but I was also comfortable considering this a narrative since it was written in narrative form by Simon Singh. Thus, I felt the document analysis and the narrative inquiry methods could coincide, especially since I was not using any other data for the purpose of this book review analysis. My method was a qualitative inductive analytic approach (such as Thomas, 2006), that I could employ from document analysis, which aligned with a qualitative inductive approach I would employ with a transcript from an interview that was rather narrative in form. While I was reading, I identified words and phrases that seem noteworthy for any reason, these became my 'open codes'.

Analysis

I then took all those 188 open codes and examined them for connections between and amongst them, grouping them into common idea spaces, spaces where the open codes seemed to fit together. I wrote memo notes alongside some of the open codes; I considered these memo notes part of the data set for the next analysis phases. For example, the open code of 'writing process' came from the sentence "These incomplete jokes are the bounced around the writers' room until they have been resolved" (p. 43) and included the memo "[about mathematical thinking]". This was my axial coding phase to create categories, and there were 14 of these categories (see Table 1 for the categories from Axial Coding, and the Appendix for the code book showing open codes grouped by category). My next action was to examine the categories for connections between and amongst them, grouping them into, what I hoped would be, two or three (perhaps four) big ideas or themes. This phase is called thematic coding.

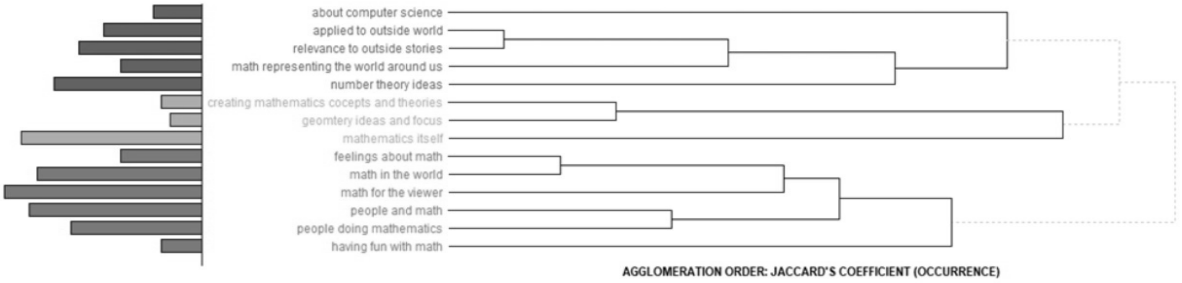
I performed an analytic process using some software designed to analyse for open code frequencies and co-occurrences of categories. (This software is QDA Miner 6 from Provalis Research). The co-occurrence algorithm looked for a separation between categories of no larger than three successive instances where the associated open code presents itself in the data set. Table 1 indicates the numbers of times an associated open code appeared in the book.

Table 1. Categories listed and the number of times an open code presented in the data for each category.

math for the viewer	24
mathematics itself	22
people and math	21
math in the world	20
number theory ideas	18
people doing mathematics	16
relevance to outside stories	15
applied to outside world	12
math representing the world around us	10
feelings about math	10
about computer science	6
having fun with math	5
creating mathematics concepts and theories	5
geometry ideas and focus	4

Figure 4 shows the result of the co-occurrence analysis of the categories. This co-occurrence analysis resulted in three themes: computer science and applications in the world around us (the top cluster of categories), mathematical concepts (the middle cluster), and the personal connection to mathematics (the bottom cluster).

Figure 4. The Co-occurrences diagram from the algorithm in the analytic software.



Findings

The theme of *computer science and applications in the world around us* is suggesting to us that the writers of the two shows, The Simpsons, and Futurama, see mathematics as an integral aspect of the world around us—mathematics explains and defines the world and our interaction within that world. This theme is also rather relevant because the lead writer, Cohen, had been a graduate student in computer science. A great number of the mathematics evident in The Simpsons and Futurama are found in the field of computer science. For example, there is a wonderful description of the P = NP question and about P-type problems (those that are quickly solvable) and NP-type problems (those that are quickly checked for correctness but not necessarily quickly solvable). Incidentally, Cohen had also explored P-type and NP-type problems during his masters' degree in computer science.

Myself, I particularly enjoy finding unexpected spaces of intersection between the world around me and mathematics, and often this comes from carefully crafted wordplay. For example, the name of the beer in a "7^{11}" convenience store in Futurama, is St. Pauli's Exclusion Principle Girl Beer, "which combines the name of an existing beer (St. Pauli Girl) with one of the foundations of quantum physics (the Pauli exclusion principle)" (Singh, 2014, p. 198).

The *mathematical concepts'* theme is an obvious theme for me:

> the writers of The Simpsons are deeply in love with numbers, and their ultimate desire is to drip-feed morsels of mathematics into the subconscious minds of viewers. …we have been tricked into watching an animated introduction to everything from calculus to geometry, from pi to game theory, and from infinitesimals to infinity. (Singh, 2014, p. 2)

Even though some of the episodes were initially written without the involvement of any mathematics, and mathematics was added in later script sessions, the writers were so fascinated and engaged with mathematics that some script sessions became mathematics exploration and discussion sessions, and mathematics became the focus of work that day rather than script writing. For example – the development of the Futurama Theorem (or Keeler's Theorem, describing how to re-set everyone's minds back into their own bodies with a certain number of mind-body exchanges – an identity switching story line called "Prisoner of Benda"), spending time exploring the cross-sections of a cube for the episode involving the Frinkahedron, and the concept of higher dimensions (for example, Homer moving from the two-dimensional Simpsons animation space through a portal into a three-dimensional space where he has become "so bulgy. My stomach sticks way out in front" (Singh, p. 151).

The writers also provided what Singh calls "niche knowledge" (p. 128), with obscure references to mathematics that would likely require the viewer to have the ability to stop the show at a particular spot and freeze the motion so all that was presented on the screen could be read at leisure. Singh calls this "freeze-frame mathematics" (p. 128) and a whole chapter is devoted to this subtle way to increase the number of mathematics concepts that would be more 'gags' for the humour of the show. A classic example appears in the "MoneyBART" episode, and the frame to freeze consists of Lisa studying to become a baseball coach, the gag is the titles of the books on her desk.

The personal connection to mathematics is a theme that illustrates and illuminates the way the writers see the beauty of mathematics. The writers promote mathematics through playful interpretations of mathematical concepts that can be more easily experienced in a make-believe world of an animated story-life of fictitious characters. Everyone is able to

do mathematics; even Homer, who usually bumbles along in his life, is given chances to become mathematically adept as in the episode "НОМЯ" when he removes a crayon that has been stuck in his brain and can suddenly use calculus to solve life's (tongue in cheek) little problems, such as proving that God does not exist.

The writers are serious about gender equity too, as they position Lisa to be a progressive intellectual force in the show and provide her with wonderful mathematical pursuits with 'galgebra', and 'femistry'. There is also a mirroring of the lives of mathematical women such as Sophie Germain in the episode "Girls just want to have sums". Singh suggests that "when Dolph Starbeam shouts out, "We've been Yentled!" it would have been more germane had he exclaimed, "We've been Germained!" (p. 85) …and I really appreciate Singh's wordplay there with 'germane'!

Writing a television comedy series script is likened to doing mathematics:

> There's this creative common thread, which is that you're trying to solve problems. In one case, it's a mathematical theorem that's a problem. In the other case, it's a story issue. We want to break the story down and analyse it. (as stated by the writer J. Stewart Burns on p. 43)

Conclusions

These three themes label and highlight what I noticed as I read the book. As an analytic process to understand what I noticed, inductive qualitative analysis provided three themes, or perhaps perspectives of insight. When I consider all three themes simultaneously, I think of the structure and substance of mathematics, and the opportunities to learn mathematics and when this learning takes place. Schwab (1961/1978) detailed the difference between the syntactic and the structure of mathematics, and that these two aspects of knowledge are vitally important to the ability to understand, and to teach, mathematics. There is a close parallel to the writing process, and I feel this is most evident in the way the writers collaborated in their writing as they would have problem solving a mathematics problem: both mathematical problem solving and writing scripts require people to be "confident and comfortable exploring the

unknown with only their intuition" (p. 43), and how an episode could be initially written without any mathematics and then have mathematics appear as a seamless thread in the final script. I interpret this as a natural relationship between writing television scripts and problem solving in mathematics. Mathematics has an inherent beauty, and the people who work with mathematics demonstrate an inherent artistry in their work with mathematics. And comedy clearly can be expressed with mathematics. Perhaps the most enjoyable aspect of human life is finding the humour in the world around us (don't you think so too?) and mathematics can provide that opportunity to laugh…and learn.

I realized that this analysis of what I had noticed when I read the book, primarily identified details about the two television shows, and less about Singh as an author and what he wrote. I felt a little perplexed, because my overarching purpose was to write a book review, not a television show review. However, I do appreciate that Singh was writing about the contents of the shows, and so I would naturally have noticed the mathematics being presented in the book that was coming from the television shows. Taking some time to reflect upon this apparent quandary, a thought of understanding began to crystalize for me. I felt comfortable with this emerging new sense of understanding because this is also what I do as a researcher—pause, reflect, think, and let sometimes what appear to be disparate pieces of data and results show me how they are related.

Final Thoughts on These Two Lenses to a Book Review

Ultimately, what my 'mathematics teacher'-self considered, and what the 'mathematics education researcher'-self found, came together in the way I see the teaching and learning of mathematics: as a sense of space between us and the mathematics. Vygotsky (for example, see Daniels, 2016) coined this space the Zone of Proximal Development (ZPD), which is the conceptual and intellectual space, or difference between, where the learner is thinking and where the teacher is thinking. The more finely tuned, purposeful, and attentive we are within this space/zone, the better the learning opportunities and outcomes. The writers of *The Simpsons* and *Futurama* clearly understand this zone, not only mathematically but also socially with their viewers. They purposefully, and often

blatantly, included the viewer into the art and science of mathematics, and dared the viewer not to laugh, and enjoy that which they often dismiss—their own inherent and natural ability to think mathematically and appreciate mathematics in the world around them.

However, it is not only the show and its writers that are brilliant in opening the doors of the world and the wonders of mathematics to us, but Simon Singh himself. He writes as though he is talking to a friend and colleague, and if we get a little lost in the complexities of the mathematics or its applications, he seems to know and shifts his explanation just a bit to accommodate us and carry us along farther into the space of characters, mathematics, real-world coincidences and applications, to which we sit back again, and enjoy the ride. (And one feature of the book that I have briefly mentioned, but needs mentioning again because it is so integral to the humour and enjoyment of the book as a whole, are the "Arithmetickle and Geometeeheehee Examinations" that are sprinkled throughout the book. "A five-part test of humor and mathematics" which are "puns, gags, and shaggy-dog stories [that] have been handed down from one generation of geeks to the next" (p. 51). Oh…I laughed!)

As I believe the writers of the two shows intended, those who find the shows funny will also be appreciating if not understanding the mathematics, thus everyone is actually mathematically minded. As well, I believe Simon Singh intended, for those who enjoy the intricacies and complexities of mathematics (whether we can 'do' the mathematics itself or not), there is a lot to this mathematical world of ours we can learn more about, enjoy, and have fun with.

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Appendix – Code Book