**Tutorial 1**

1. **Exploring ideas in popular science**
2. What point is the author making by referring to the cosmic prime number beat and the prime number twins?

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| **Student Name** | **Group Response** |
| Group 1  Richelle  Saidah  Amos  Xinyuan  Shi Qian | Prime numbers are a part of everyday life and can be used as a form of communication (shows the potential of the application of prime numbers), although it can only be deciphered by people with sufficient knowledge (scientists are still investigating the myths of prime numbers). Primes are a universal language, used both by aliens and humans alike. Also, prime numbers are so unique, that could be easily distinguished from other ways of communication. |
| Group 2  Ryan  Fang Yu  Benedict  Bo Cong  Min Jet | Prime numbers can be used as a form of communication  Prime number sequence may seem utter random, the author is trying to show that this is not really the case. There may be a pattern or order to the way prime numbers are formed. There seems to be a common understanding of prime numbers amongst all beings. |
| Group 4  Francis  Meng Han  Adinda  Kai Lin | Similarity between twins and the aliens with the word “cosmic”   1. Use prime numbers to communicate (no required knowledge of human language/civilisation)   Author’s point : prime numbers are universal; seems to be found in nature and have some form of logic behind them even though at surface level it seems random  Author might want to invoke some sort of deontological appeal in the readers. |
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1. Why do you think the book is titled “The Music of the Primes”?

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| **Student Name** | **Group Response** |
| Group 2  Ryan  Fang Yu  Benedict  Bo Cong  Min Jet | I think the author tried to show that there is a pattern that exist in prime number sequence, though it seems irregular and chaotic, similar to how time signatures exist in music theory.  Prime numbers have the “power to build all other numbers” --> Similar to how individual music notes come together to create a symphony |
| Group 3  Yu Xian  Jia Wei  Tei Kar  Deon | The author tried to draw an analogy between music notes and primes. The entire premise of trying to prove the Riemann Hypothesis is based u pon trying to make sense of the random rhythm that primes have  Primes are the most fundamental building blocks of math, just like how music notes are the building blocks of music.... beats … harmony ...  … evaluate: how effective is the strategy? How suitable is the concept of ‘music’ to understanding ‘prime numbers’? |
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1. “Some philosophers might take issue with such a Platonist view of the world… but to my mind that is what makes them philosophers and not mathematicians “(p.7). Explain the difference in the two world views and why it matters.

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| **Student Name** | **Group Response** |
| Group 4 | Philosophers have abstract truths but mathematicians have immutable truths thus both find their beliefs conflicting. Philosophers might think that prime numbers are just a construct that humans created.  Why it matters:  It is controversial. Mathematicians argue that the nature of prime numbers is irrefutable while many people can argue that this is just something that humans made up and that we cannot be fully certain that it is in fact universal. |
| Group 3 | Philosophers believe that the idea of “prime numbers” is just a creation of human imagination, thus pushing the idea that mathematicians are thinking too much into it: there is no correlations between prime numbers.  However, mathematicians are more flexible with the term “abstract”. |
| Group 1 | Platonism is the view that an abstract object is one that does not exist in space or time, hence disregarding the unknown and treating it as though it does not exist. Philosophers like to leave things as they are and do not look beyond what they are presented. Thus, they treat prime numbers as a human construct, a narrative created by humans.  Non-Platonism is a contingent-on-human knowledge way to understand reality, hence aiming to find logic in everything and seeking answers instead of accepting things as they are. Mathematicians hence view prime numbers as a natural, universal phenomenon that we aim to understand. |
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1. **Exploring science communication**

4. Describe the dominant writing style that is characteristic of this chapter, and discuss the impact of these choices on readers. Make suitable references to your reading to support your answer.

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| **Student Name** | **Group Response** |
| Group 1 | Narrative -> easy to follow along like a trip down a historical timeline/ memory lane with different story characters (historical figures)  >Tells the readers the story about Riemann Hypothesis and the significance of primes not only in the field of mathematics but also in everyday life (e.g., protecting our credit card numbers in e-commerce) >Highlighting the importance of solving Riemann Hypothesis (and then reveal to us that was a prank)  > Inspires more people to get interested in mathematics, especially in Number Theory.  There was a plot twist in the “story” where we realized that Bombieri’s email was just a prank (shift from our initial excitement that the Riemann hypothesis was finally solved -> a sense of disappointment and betrayal)  Sub-Stories  - Mathematicians’ obsession with solving “something” following Fermat’s last theorem  - Mathematical noble prize (or lack thereof, and with an age limit...)  - People are offering money (but mathematicians don’t really want this as much as the next point)  - Wanting their names to be cemented in history  - College de France fresh set of 7 problems  - Highlights the lack of recognition. Eg Fields medal  - Humanizes the mathematicians, their efforts and suffering, makes us care about the theorem, allows us to experience how the mathematicians felt, wanting them to succeed |
| Group 2 | Narrative  Eg:   * “One hot and humid morning in August 1900...” * Third person perspective (use of him, her, they and them) * Dialogues – Excerpt of Hilbert's speech “Who of us....” (para 1); “allegedly asked Hilbert, ‘If you were...’ ” (para 3)   Main story   * Starts with the author mentioning about the news about the Riemann’s hypothesis being proved --> Baits the reader into getting curious about the Riemann’s hypothesis --> Author proceeds to going through the significance of prime numbers in mathematics and in other day-to-day applications --> Revealed that the announcement that the Riemann's hypothesis being proved was a prank (allowed us to experience how the mathematicians felt when they found out when they have been duped?)   Impact on readers:  > Feels like reading a story book instead of a mathematical article   * Brings the reader on a journey, by introducing the problem, introducing the many characters that were involved in the problem and the evolution of the problem, making it relevant to people’s lives through the implication of prime numbers in e-commerce security * Tap into the reader’s curiosity and desire to follow through with the prime number mystery to draw them into finishing the article * Also tries to attract readers to take interest in math and prime numbers to discover the unknown about prime numbers   > Ease the reader into his main topic   * E.g., when the writer mentioned Riemann’s hypothesis, he did not go too in depth or technical about what this hypothesis is. Instead, the development, creation and applications of the hypothesis were the focus. |
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5. Last week you learned how Dawkins used deontological appeal to capture the reader’s attention. Examine page 1 of The Music of the Primes closely and explain how deontological appeal is used to capture the reader’s attention here. What could be a possible impact on the readers?

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| **Student Name** | **Group Response** |
| Group 3 | “... and the audience could hear the nervousness in Hilbert’s voice as he began to lay out his vision for the future of mathematics.’   * This makes the readers also feel nervous about what he is going to say in the next line. (emotional appeal)   “a list of twenty-three problems that he believed should set the course for the mathematical explorers of the twentieth century. … and those who discovered the solutions make up an illustrious band of mathematicians known as “the honors class”.”   * This approach challenges the reader into solving these problems as a chance to be part of this prestigious group. |
| Group 4 | "Lifting the veil”, “**unknown”, “hidden”, “secrets”** invoke a sense of mystery and elusiveness about mathematics and how beneficial it can be in the future if we discover themc   1. Also showed that there were still many things to discover in mathematics 2. Gives the readers the sense of curiosity as to how well humanity did in solving the 23 problems posed by Hilbert, which can lure them in finishing the chapter.   **Evaluative language** to emphasise deontological appeal (review W3T2: areas of evaluation)   1. “CRISPR is not junk” - **unexpectedness -> p. 1 para 1: ‘went against all accepted conventions; daring; unknown’** 2. Discovery that novel findings can transform medicine – **possibility -> p. 1 para 1: challenging the audience with the twenty-three problems that he believed should set the course for future math explorers.** |
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6. Deontological appeal alone may not be able to sustain readers’ interest to finish the chapter or the book. In this chapter, another type of appeal was used to highlight the novelty of the central subjects- both the primes and the Riemann Hypothesis. Examine pages 10 and 11, describe what makes you want to continue reading and what is so novel about the primes and the Riemann Hypothesis? Discuss among your group members whether you think the writer has succeeded in capturing the attention using this strategy.

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| **Student Name** | **Group Response** |
| wGroup 1 | Analogy -> comparing solving Riemann Hypothesis to surmounting Mount Everest -> poses a challenge + solving the hypothesis will open up doors to understanding even more mathematical theories as prime numbers form the foundation of math “the person who proves... will have made it possible to fill the missing gaps...”, “offers the prospect of charting the misty waters of the vast oceans of numbers” -> Just like the attraction of the highest mountain in the world to an ordinary adventurer, Riemann Hypothesis is challenging to ordinary mathematicians but still attracts countless mathematicians to try to solve it. Also, the author pointed out that mount Everest is attractive because it is very challenging to be conquered, however, Riemann Hypothesis on its own is attractive because it lays out the fundamental mathematics rules.   * Readers feel the need to read on to find out how hard it is to solve the hypothesis   “The mathematician who finally scales Mount Riemann will certainly be remembered longer than Edmund Hillary”   * Edmund Hillary is the first person to surmount Mount Everest * Remembered longer = the Riemann hypothesis is a more daunting obstacle than Mount Everest (the highest mountain in the world) * More information could dampen the effect of the original analogy * Not very effective because not everyone knows who Edmund Hillary is * Mount Everest is also more applicable/relatable to readers so its effective   Prime numbers being used to protect our credit cards during e-commerce   * Application to our daily lives * This strategy can actually be counter-effective because most of us non-specialist readers care more about protecting our credit cards than solving the Riemann hypothesis * Hence downsizing the issue of the hypothesis? |
| Group 2 | Teleological appeal -> benefits/consequences/application/effect/real-life impact   1. Impact on mathematicians: “The person who proves the Riemann Hypothesis will have made it possible to fill in the missing gaps in thousands of theorems that have the Hypothesis as their underlying assumption – Proving the hypothesis either true or false can either make or break their worlds, career-wise and for many other theorems. 2. Impact on the greater public: credit card security for online transactions, but also if it is proven and utilised by the wrong people, it can cause great trouble (e.g if someone can generate an infinite number of prime numbers, they can hack anyone's credit card.)   Q: what makes you want to continue reading and what is so novel about the primes and the Riemann Hypothesis?  Ego booster? The potential reward of solving the Riemann hypothesis has severe implications --> the author wrote the paragraph in such a way that makes readers feel that the person solving it would have done an incredible feat and their work would have a lasting impact for generations.  The author leverages on the greed of human beings (see title of the chapter), where one’s attention can be grabbed if the audience has something to benefit/profit from. Eg: how prime numbers are being used extensively in e-commerce, because their inventors (RSA) saw the business opportunity. Likewise, the person who proves the Riemann Hypothesis can potentially generate tons of profit and become rich. When the readers make this link, there is some personal interest involved for the readers to continue reading.  \*\*\* very useful for kiasu people  The author creates tension without resolution. There is constant emphasis on how important it is to solve the Riemann hypothesis, as if putting it on a pedestal  “The dependence of so many results on Riemann’s Challenge is why mathematicians refer to it as a hypothesis rather than a conjecture”  “The person who proves the Riemann Hypothesis will have made it possible to fill in the missing gaps in thousands of theorem  But the author does not give any sort of solution to the problem, which leads the readers to continue reading to try to find some sort of resolution.  (pg 10 para 3 line 10 ) it shows the importance and the effect it can have on the world  (pg11 para 3) it shows the kind of effect prime numbers can have on the world where prime numbers were use to protect your credit cards  It also shows how frequently we interact with prime number in our everyday lives without even knowing. Hence, makes reader wants to continue reading to learn more facts? |
| Group 3 | (pg 11 para 3): “You might legitimately ask: so what?” This is a question that comes through the reader’s mind as they are not sure whether the pursuit for the pattern in prime numbers really has anything to do with them. The author then tried to change the reader’s perspective by explaining how this can be applied to business and security which they should care about since this involves their $$.  -> think about placement as well. Timely? |
| Group 4 | Application --> use of credit cards through prime numbers   1. 3 scientists whose name starts with “RSA” came up with a system called “RSA” to protect credit card information 2. If you multiply 2 prime numbers together, can only break down the product into the 2 prime numbers and 1 – somehow works? Encryption   Comparing past and present --> how prime numbers allowed for online banking compared to in the 1970s when they didn’t find an application for prime numbers “finding hundred digit primes sounds as pointless as counting angels on a pinhead” |
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1. **Group Reflection**

In your groups, you will work on a 100 to 150-word reflection using the template provided. Your group reflection should focus on:

1. whether your group found du Sautoy’s use of the teleological appeal effective and why; and
2. one interesting fact your group learnt about prime numbers which you had not known before.

Type your group reflection in the space below. Your tutor will offer feedback about your group’s reflection.

**Tutor’s feedback:** We learnt about and saw examples of teleological appeal today. As discussed in class/ seen in your previous week’s reflections, we might feel it is more effective or easier to use teleological appeals. However, deontological appeals can be engaging and effective too, as we see below.

You can review and contrast with deontological appeal, e.g. in these news articles: <https://www.smithsonianmag.com/smart-news/doppelgangers-dont-just-look-alike-they-also-share-dna-180980635/>

<https://www.straitstimes.com/world/united-states/your-doppelganger-is-out-there-and-you-probably-share-dna-with-them>

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|  | **Group Reflection** | **Tutor’s feedback** |
| Group 1 | Teleological appeal reaches deep into the innate greed and personal desires of human beings, hence making it effective. By presenting the benefits we could possibly gain, it transforms the “abstract” topic into something tangible. Seeing these potential gains serves as a motivating factor for us to continue reading, and the negative impacts stirs some concern/worry in us that can make the topic more relatable and we are more likely to follow up on it after reading this (like dangling a carrot in front of a donkey to incentivize it to continue walking).  Continuing, the nature of abstraction can also be found within deontological appeal. As mythical as it seems, coherent strategies involving the emphasis of the unexpectedness and possibilities can be employed to strengthen the case for something from a deontological perspective.  Prime numbers could be used as a way of communication and people actually use it, but the myths laying in primes and communication are still unsolved, keeping us stay tuned. Plays an important role in e-commerce. There are several applications of prime numbers (e.g., in credit cards and cryptography), not just in academics. | Or just the practical nature of people too! Yes, this is the strength of the teleological appeal, to highlight how the research is directly relevant to the readers. |
| Group 2 | Effective!   * Beyond academic impacts, author draws real world impacts which are more relevant to us readers * By presenting real impacts that affect our daily lives, it turns the concept into something that is concrete and relatable. * Nobody likes to be average, everybody wants to be a somebody. (The man who solves Riemann hypothesis) * Typically when we invest time into an activity, we want to see some benefits from it, be it investing time into reading or book or trying to learn a new skill. * Provides us with incentive and a duty to get to the bottom of the matter! * Combination of both Deontological appeals and teleological appeal just makes us want to continue read more   Teleological appeal is effective as it allows readers to see the impact it has on the world and how beneficial or harmful it can be.  One interesting fact:   * Prime numbers being used in credit card security * Didn’t know numbers were protecting us * ‘One man’s fortune is another man’s misfortune’ --> Positive discoveries for mathematicians, i.e. solving for Riemann’s Hypothesis, can mean disaster in e-commerce for us normal humans, IF the discovery falls into the wrong hands. * Prime numbers may be a form of communication with aliens   Makes me wonder, what if someone already solved the hypothesis and proved it to be false. Perhaps, they did not want the world to break as hence did not publish it!?!??! (Illuminati confirm!!!!!!) | Good observation on the real-world impact. This is the strength of the teleological appeal. Also consider how specific the example used was: not just generally talking about online security, for instance, but considering how these prime numbers protect credit card numbers during online transactions. In your own writing, consider how your examples can be specific and impactful too. |
| Group 3 | Effective:   * Corresponds to human nature (selfish or resulted-centered by nature): makes the reader interested in how solving the hypothesis could benefit their daily lives * Presents the pros and cons directly without having the reader to infer too much * Doubles up with deontological appeal to provide a sense of duty plus motivation for the readers to find out more about the Reimann’s Hypothesis   I learnt that Hiemann hypothesis is used to find the prime number after 10,000,000. However, it has yet to be solved. | Good point. It is possible to use both strategies within your article, or either one. Consider which would work best for your research article. |
| Group 4 | 1.Effective  When they mentioned the credit card parts and the encryption, helps the reader preserve his attention and continue reading.   * On one hand, helps keep our interest in reading the story * On the other hand, may misdirect the reader on the main point of the story; e.g. credit card and encryption application was more interesting than the mathematical explanation about prime numbers which was what the entire book was about. * Thus, the reader only retains information about credit cards and encryption which are subjects that can be more easily understood, and completely miss the Riemann hypothesis, a significant portion of the story.   2. Prime numbers are used for encryption due to their cool mathematical properties?! Also, it's very interesting that the twins used prime numbers to communicate but no one actually knows how they're doing it or if they understand the significance of prime numbers. | A good reminder for us to keep our priorities in mind. Is the strategy used to engage (colour) or to explain (clarity)? Are the strategies enhancing the research article or veering off tangent? Good to check. |