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Cover Page Footnote

I want to thank E for her support and the surviving family of R for their openness and desire for good to come from their loss.

Comforting with Mathematics: A Case Study

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Synopsis

Death by suicide often leaves behind grieving family members with unanswered questions. Of these concerns, fear that their loved one suffered or felt regret is common. When the method of suicide was jumping from height, that answer can easily be determined using basic kinematics. Despite the perception that mathematics is a cold, calculating field, it can provide a clear, definitive answer and comfort those left behind.

Keywords: *humanistic mathematics, kinematics, bereavement*

1. Introduction

Math is hard. It's hard, and no one uses it in real life except for engineers and scientists. And even when they use it, it's a necessary evil to get to the really important stuff. Math has no place outside of a computer or a classroom. Right?

This mindset is pervasive throughout schools in the United States, from primary school through university [8, 12]. Teachers providing concrete, real world examples of mathematics being used in conjunction with active learning techniques are slowly changing this [4, 11], but it will be many years before the current school-age generation brings a new attitude toward mathematics into the real world. Given the current attitude, it should not come as a surprise that the intersection between mathematics and the human experience seems but a strange fiction to most.

However, mathematics has many humanistic applications in many fields. One of these is medicine where mathematicians apply mathematical modeling techniques and game theory to diseases such as heart disease [5] and cancer [7]. While these areas of research have a slightly more human feel, the humanistic potential of mathematics goes deeper. One of the issues holding this back is that the current use of mathematics in medicine is largely statistical in nature.

Relative risk and odds ratios are often used in discussing with patients and family members complications and outcomes of various diagnoses and treatments. Unfortunately, most humans tend to think they know far more than they actually do, including about fields they know little about such as statistics and medicine [3, 10]. This leads many to simply ignore mathematical truths laid out before them, engaging in whatever mental gymnastics are required to find even the smallest evidence for their line of thinking. In the absence of straight denial, it seems that many who fall into this cognitive bias trap utilize any ambiguity or admitted uncertainty in the statistics presented, maximizing the small probability of confirmation while minimizing the large probability of being incorrect [6].

This sort of injection of math into human moments is not where the true potential of math in medicine lies. Rather, it is in using mathematics to describe extremely human experiences and to answer questions that are charged with emotion. This leads us to the subject of this case study: comfort through mathematics.

Jumping from height as a method of suicide accounts for approximately 2.0% of all suicides in the United States [1]. For surviving family members, the thought of these victims falling to their deaths while regretting their decision is often devastating. The average person has little to no understanding of kinematics. Coupled with images of suicides in news media and film or television, this lack of knowledge leads the imagination to the worst scenarios.

In this case study, we discuss the comfort provided from mathematics to the surviving family members of a victim of suicide. After a brief introduction, a description of the mathematics used and the level of comfort achieved will be given.

2. Background Information

R was an 18-year-old male with several diagnosed but poorly-controlled mental health issues. Among these were bipolar disorder and a history of suicidal ideation, including two previous suicide attempts. Compounding these diagnoses was a history of marijuana and alcohol use. R completed multiple rehab stints and had successfully completed rehab in the months prior to his death. Despite this accomplishment, while on vacation with his family, R jumped seven stories to his death from the roof of his hotel while his family waited for him inside.

He left behind several grieving family members, but his mother and grandmother took his death particularly hard. Their grief brought the expected questions about whether they could have done something to prevent it and whether they should have seen it coming. However, both his grandmother and his mother reported insomnia due to recurring nightmares of R falling for thirty seconds to a minute, regretting his decision and being terrified until his death.

As a mathematician, this concern was brought to me by his grandmother. It was through this interaction that at least one of their loose ends was brought to a close.

3. Motion in One Dimension

Kinematics have been studied for centuries, with many scientists and mathematicians contributing to the field. Galileo's experiments with gravitational acceleration, Kepler's laws of planetary motion, and Issac Barrow's, Liebniz's, and Newton's contributions to mathematics through calculus ultimately led to the mathematical description of an object in one dimensional motion that we still use today, and which are taught in every introductory physics course [2]. The following derivation and calculation was done on a piece of scrap paper in the presence of R's grandmother, the result of which was later presented to his mother.

One dimensional motion was explained as the result of an object falling from rest under nothing but the acceleration due to the Earth's gravity, a force governed by Newton's formulation of the second law of motion:

$$F = \frac{mdv}{dt} = m\,\frac{dv}{dt} = ma = mg$$

where $g = 9.80\frac{m}{s^2}$ is the acceleration due to gravity. The masses cancel out, and we have:

$$a = g$$

Note that g is positive because we've chosen the downward direction as positive. Now, using a bit of calculus, we get to the equation of interest:

$$y = y_0 + v_0\Delta t + g\frac{\Delta t^2}{2}$$

which is our familiar equation of motion for an object in free fall. Since the object in this case began at rest, we can eliminate the v_0 term and express the displacement in terms of Δy and use a little algebra to solve for Δt:

$$\sqrt{\frac{2\Delta y}{g}} = \Delta t$$

We assume 3.00 meters for the height of each story, giving us a $\Delta y = 21m$ (the value is positive because we choose toward the ground as the $+y$ direction). Substituting in our values, we have:

$$\Delta t = \sqrt{\frac{2\Delta y}{g}} = \sqrt{\frac{2(21m)}{9.80m/s^2}} = 2.1s$$

So the total falling time is slightly more than two seconds. Using a stopwatch, I demonstrated just how fast this is, making it very unlikely that R had any time to even process what was happening to him before reaching the ground. Combined with the knowledge that he died on impact, this calculation shows that R likely did not suffer physically or mentally during his suicide.

4. Results

The effect of the above presentation was immediate and lasting. Prior to our interaction, both demonstrated having trouble progressing through their grief. After learning that the fall lasted less than three seconds, R's mother and grandmother expressed relief at the knowledge that he did not suffer. This removed a major source of concern that could not be answered by other counseling means, allowing them to focus on grieving. Additionally, they both reported resolution of their insomnia. Following up two years later, both women continue to find solace in the above and have moved normally through the stages of grief.

5. Conclusion

What makes R's case a perfect platform for extending mathematics beyond the blackboard is the very human nature of it. R is not simply another statistic. He was a son and a grandson. A brother. He left behind human beings who feel human emotions. The two family members who were the subject of this case study experienced arguably the deepest hurt a mother and grandmother can experience. It came with its own fears and grief, one of which was allayed with mathematics.

Through flipped classrooms and active learning, mathematics is slowly moving out of esoterica and into relevance [4, 11]. However, mathematics is more humanistic than simply a way to describe how objects move. As demonstrated by this case report, the language of mathematics can be one of comfort and compassion.

When discussing traumatic events with patients or surviving family members, the initial intuition is that throwing a bunch of numbers at them takes the humanity out of the picture, reducing them to a number or an equation. As we've seen here, that is not always the case. There is a fine line to walk between drowning a patient in statistics and using a bit of math to make the abstract more concrete.

This is not limited to victims of blunt or penetrating trauma. Radiation oncology patients are commonly concerned with how the treatment works, if they will become radioactive, and for how long [9]. The total dose and half-life of the radiation can be explained plainly using some simplified math and visual aids. The potential for mathematics to comfort family members and put at ease the minds of patients is expansive. It's time to step away from the blackboard.

Acknowledments. I want to thank E for her support and the surviving family of R for their openness and desire for good to come from their loss.

References

[1] Centers for Disease Control and Prevention, *10 leading causes of death, United States: 1999-2007, all races, both sexes* (2007); available through `https://webappa.cdc.gov/sasweb/ncipc/leadcause.html`, last accessed on January 29, 2019.

[2] Rene Dugas, *A History of Mechanics*, Dover Publications, Inc., New York, 1988.

[3] Matthew Fisher, Mariel K. Goddu, and Frank C. Keil, "Searching for explanations: How the Internet inflates estimates of internal knowledge", *Journal of Experimental Psychology*, Volume **144** Issue 3 (2015), pages 674-687.

[4] Scott Freeman, Sarah L. Eddy, Miles McDonough, Michelle K. Smith, Nnadozie Okoroafor, Hannah Jordt, and Mary Pat Wederoth, "Active learning increases student performance in science, engineering, and mathematics", *Proceedings of the National Academy of Science of the United States*, Volume **111** Issue 23 (2014), pages 8410-8415.

[5] Huaming Yan, Monica Romero-López, Lesli Benitez, Kaijun Di, Hermann Frieboes, Christopher Hughes, Daniela Annenelie Bota, and John Lowengrub, "3D mathematical modeling of glioblastoma suggests that transdifferentiated vascular endothelial cells promote resistance to current standard-of-care therapy", *Cancer Research*, Volume **35** Issue 15 (2017), pages 4171-4184.

[6] David M. Marsh and Teresa J. Hanlon, "Seeing what we want to see: Confirmation bias in animal behavior research", *Ethology*, Volume **113** Issue 11 (2007), pages 1089-1098.

[7] Padma Murali1, P. R. Deepa, Raghavan Subramanyan, Farida Farzana A. J., Nithya Lakshmi M., and Murali Raman, "Mathematical modeling of coronary artery disease (CAD): Analysis reveals HbA1c and total cholesterol to be significant risk predictors", *Applied Mathematics*, Volume **7** Issue 1 (2017), pages 1-4.

[8] William H. Schmidt, "At the precipice: The story of mathematics education in the United States", *Peabody Journal of Education*, Volume **87** (2012), pages 133-156.

[9] Lena Schnitzler, Sian K. Smith, Heather L. Shepherd, Joanne Shaw, Skye Dong, Delesha M. Carpenter, Frances Nguyen, Haryana M. Dhillon, "Communication during radiation therapy education sessions: The role of medical jargon and emotional support in clarifying patient confusion", *Patient Education and Counseling*, Volume **100** (2017), pages 112-120.

[10] Steven Sloman and Philip Fernbach, *The Knowledge Illusion*, Riverhead Books, New York, 2017.

[11] Mark Stuckey, Avi Hofstein, Rachel Mamlok-Naaman, and Ingo Eilks, "The meaning of 'ĂŸrelevance' in science education and its implications for the science curriculum", *Studies in Science Education*, Volume **49** Issue 1 (2013), pages 1-34.

[12] Kuo-Hung Tseng, Chi-Cheng Chang, Shi-Jer Lou, and Wen-Ping Chen, 'Attitudes towards science, technology, engineering and mathematics (STEM) in a project-based learning (PjBL) environment", *International Journal of Technology and Design Education*, Volume **23** Issue 1 (2013), pages 87-102.