Using math to make Guinness

July 29 2015, by Atif Kukaswadia

If you ever read public health research, you've probably encountered the term "Student's t-test," or just "t-test." The experimenters will do this magical test, and suddenly conclude that everything is awesome. But even when you're familiar with the t-test and what it does, very little thought goes into where this came from, or who came up with it. Well, today I'm going to tell you the origins of this staple of public health research.

Let me tell you a story about William Sealy Gosset. William was a Chemistry and Math grad from Oxford University in the class of 1899. After graduating, he took a job with the brewery of Arthur Guinness and Son, where he worked as a mathematician, trying to find the best yields of barley.

But this is where he ran into problems.

One of the most important assumptions in (most) statistical tests is that you have a large enough sample size to create inferences about your data. You can't make many comments if you only have 1 data point. 3? Maybe. 5? Possibly. Ideally, we want at least 20-30 observations, if not more. It's why when a goalie in hockey, or a batter in baseball, has a great game, you chalk it up to being a fluke, rather than indicative of their skill. Small sample sizes are much more likely to be affected by chance and thus may not be accurate of the underlying phenomena you're trying to measure. Gosset, on the other hand, couldn't create 30+ batches of Guinness in order to do the statistics on them. He had a much smaller sample size, and thus "normal" statistical methods wouldn't

work.

Gosset wouldn't take this for an answer. He started writing up his thoughts, and examining the error associated with his estimates. However, he ran into problems. His mentor, Karl Pearson, of Pearson Product Moment Correlation Coefficient fame, while supportive, didn't really appreciate how important the findings were. In addition, Guiness had very strict policies on what their employees could publish, as they were worried about their competitors discovering their trade secrets. So Gosset did what any normal mathematician would.

He published under a pseudonym. In a startlingly rebellious gesture, Gosset published his work in Biometrika titled "The Probable Error of a Mean." (See, statisticians can be badasses too). The name he used? Student. His paper for the Guinness company became one of the most important statistical discoveries of the day, and the Student's T-distribution is now an essential part of any introductory statistics course.

So why am I telling you this? Well, I've talked before about the importance of storytelling as a way to frame scientific discovery, and I've also talked about the importance of mathematical literacy in a modern society. This piece forms the next part of that spiritual trilogy. Math is typically taught in a very dry, very didactic format – I recite Latin to you, you remember it, I eventually give you a series of questions to answer, and that dictates your grade in the class. Often, you're only actually in the class because it's a mandatory credit you need for high school or your degree program. There's very little "discovery" occurring in the math classroom.

Capturing interest thus becomes of paramount importance to instructors, especially in math which faces a societal stigma of being "dull," "boring" and "just for nerds." A quick search for "I hate math" on Twitter yields a new tweet almost every minute from someone expressing those

sentiments, sometimes using more "colourful" language (at least they're expanding their vocabulary?).

There are lots of examples of these sorts of interesting anecdotes about math. The "Scottish book" was a book named after the Scottish Café in Lviv, Ukraine, where mathematicians would leave a potentially unsolvable problem for their colleagues to tackle. Successfully completing these problems would result in you receiving a prize ranging from a bottle of brandy to, I kid you not, a live goose. The Chudnovsky brothers built a machine in their apartment that calculated Pi to two billion decimal places.

There's also the story of Amalie Noether, the architect behind Noether's theorem, which basically underpins all modern physics. Dr Noether came to prominence at a time when women were largely excluded from academic positions, yet rose through the ranks to become one of the most influential figures of that time, often considered at the same level of brilliance as Marie Curie. Her mathematical/physics contemporaries included David Hilbert, Felix Klein and Albert Einstein, who took up her cause to help her get a permanent position, and often sought out her opinion and thoughts. Indeed, after Einstein stated his theory of general relativity, it was Noether who then took this to the next level and linked time and energy. But don't take my word for it – Einstein himself said:

In the judgment of the most competent living mathematicians, Fräulein Noether was the most significant creative mathematical genius thus far produced since the higher education of women began.

While stories highlight the importance of these discoveries, they also highlight the diversity that exists within the scientific community. Knowing that the pantheon of science and math heroes includes people who aren't all "math geniuses" can make math much more engaging and interesting. Finally, telling stories of the people behind math can

demystify the science, and engage youth who may not consider math as a career path.

This story is republished courtesy of PLOS Blogs: blogs.plos.org.

Provided by Public Library of Science