SUMMARY

IN PURSUIT OF THE UNKNOWN

IAN STEWART

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Summary of "In Pursuit of the Unknown" by Ian Stewart

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Learn how math and physics equations have impacted society.

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Introduction

When you think about things that change the world, what usually springs to mind? Is it a person like a president or a superhero? Is it a written work or a motivational speech that inspires people to take action? Is it an invention like a lightbulb or an automobile? Or is it an equation? Despite the fact that we regularly study famous equations, we rarely consider math or physics as things that can save the world. Instead, we more commonly think about the people who take credit for heroic actions or inventions. But British mathematician Ian Stewart knows that without a few powerful equations, our world would look very different. In fact, without them, many of the geniuses we know today would languish in anonymity. So, over the course of this summary, we'll explore the power of equations and what math and physics bring to our world.

How Math Revolutionized the Field of Sociology

What do math and sociology have in common? You could ponder this question for a long time before coming up with any similarities! One discipline is exclusively concerned with the function and study of numbers. The other studies people and how their lives and cultures are influenced by their relation to other people. But in the nineteenth century, a Belgian academic named Adolphe Quetelet started to ask how other disciplines could be improved by the application of mathematics. Quetelet was both a sociologist and a mathematician, so he had a keen interest in both disciplines. And one day, he decided to see what would happen if you applied mathematical theories to the data collected through sociological studies. Quetelet's idea was especially intriguing because it occurred to him right at the discovery of the bell curve.

If you're not familiar with the bell curve, it might help to know that mathematician Andrew Bloomenthal defines it in the following manner: "a bell curve is a common type of distribution for a variable, also known as the normal distribution. The term "bell curve" originates from the fact that the graph used to depict a normal distribution consists of a symmetrical bell-shaped curve. The highest point on the curve, or the top of the bell, represents the most probable event in a series of data (its mean, mode, and median in this case), while all other possible occurrences are symmetrically distributed around the mean, creating a downward-sloping curve on each side of the peak. The width of the bell curve is described by its standard deviation."

So, how do we use the bell curve to interpret data? Bloomenthal explains that "the term "bell curve" is used to describe a graphical depiction of a normal probability distribution, whose underlying standard deviations from the mean create the curved bell shape. A standard deviation is a measurement used to quantify the variability of data dispersion, in a set of given values around the mean. The mean, in turn, refers to the average of all data points in the data set or sequence and will be found at the highest point on the bell curve." Quetelet decided to apply this type of data analysis to his sociological research because he believed that we can use data to understand people without judging them. This was in direct contrast to the societal perception of his time which applied moral meaning to almost every data point that could be interpreted about the human body.

Phrenology, for example, was a form of scientific racism which used the shape of a person's head to ascertain their moral character and intelligence. Although this might sound completely bizarre and illogical, this was a genuine field of scientific study during the nineteenth century! Historian James Poskett unpacks the concept in his own critical analysis by explaining that, "Phrenology was pioneered by physicians such as Franz Joseph Gall (1758–1828), who believed that the brain is made up numerous organs, each linked to a faculty such as benevolence and destructiveness. As such, a protruding forehead – where the 'perceptive' organs resided – could indicate an impressive intellect, whereas a bump on the crown was the sign of a strong sense of morality. These ideas certainly struck a chord. Phrenological societies sprang up from New York to Calcutta, and audiences were soon flocking to lectures on the science of the skull. These people genuinely believed that phrenology could make the world a better place."

Quetelet believed that the moral theory of sociology was not entirely correct and that social sciences ought to develop a more objective approach. He aimed to create this objective school of thought himself and he called it "social physics." By blending sociology and mathematics, he believed that we could use statistics to understand high crime rates or an increase in suicides. So, after years of studying crime rates, births, deaths, and the height and weight of the population around him, he attempted to test his theory. When he charted the physical proportions of his test subjects (specifically, their height and weight), he found that the data could easily be represented by a bell curve. He summarized his findings by explaining that, "The weights of individuals of different height are nearly like the square of their height."

Put simply, his system measured a person's body mass by comparing their overall weight to their height. Quetelet believed that this test could be used as a measurement of a person's health and wellness. He called it the Quetelet Index. This revolutionary new system caught on and it remained the definitive measurement for height, weight, and health until 1985, when it was adopted by the United States National Institutes of Health and renamed the "body mass index" or BMI. Today, the BMI is the most common method for measuring human body mass! So, from this example, you can see how one equation influenced the world and became a definitive standard!

Einstein’s Theory of Relativity

A book on equations that changed the world would be remiss if it neglected to explore Einstein’s theory of relativity! Just as Quetelet’s body mass index has informed our modern understanding of height and weight measurement, Einstein’s theory of relativity laid the groundwork for our understanding of the universe’s structure. It is most often represented by the formula “E = mc2” and this equation is so widely known that it is commonly incorporated in Halloween costumes, popular jokes, and cartoons. But when he introduced his theory in 1907, it completely rocked the scientific world. That’s because Einstein’s theory made all previously established theories completely obsolete. When Einstein proved what he knew to be true, his colleagues were forced to realize that the scientific truths they clung to were, in fact, totally inaccurate.

For example, Einstein’s theory challenged the perception that the speed of light was relative. Because all previous calculations hinged on the question of relativity, it was believed that you had to know the speed of something else in order to calculate the speed of any other thing. For example, if you were asked to calculate the speed of a thrown baseball, you would first need to ask, “Its speed relative to what?” As a result, scientists assumed that the speed of light could only be calculated in relation to other things. But Einstein proved that the speed of light was a constant; it did not change in relation to other things that passed through it. And last but not least, he also revolutionized the conceptualization of gravity. Rather than representing gravity as an immovable force, Einstein demonstrated that gravity existed on a four-dimensional plane in relation to space and time. His radical new equation formed the basis for our entire understanding of gravity and the way the world works!

Schrodinger’s Cat

Caution: this chapter may or may not contain a live animal. (Just kidding! No kitties have been harmed in the making of this book!) But this joke does serve to illustrate the intentional absurdity of the thought problem posed by the Austrian physicist Erwin Schrödinger. Schrödinger was one of the early founders of the field of quantum mechanics. And the most important thing you should know about quantum mechanics for the purposes of this chapter is that it is a very trippy field of study. Put simply, the principles of quantum mechanics sound like something you would come up with while having a very bad trip on hallucinogenics. Even expert physicists struggle to come to terms with these principles, so the fact that Schrödinger founded this field of study should give you an immediate hint about his intellect.

He also came up with the famous thought experiment that has come to be known as “Schrödinger’s cat,” and he invented this theory in 1935 as a way of making fun of nonsensical explanations of quantum mechanics. Although we could devote the entirety of this book to an attempt at making sense of quantum physics, for practical purposes, it’s best to rely on this summary from physicist Adam Mann. Mann simplifies the early debate about quantum mechanics by explaining that “while developing their new understanding of the subatomic realm, most of Einstein and Schrödinger's colleagues had realized that quantum entities exhibited extremely odd behaviors. The Danish physicist Niels Bohr championed an understanding that particles like electrons did not have well-defined properties until they were measured. Before that, the particles existed in what's known as a superposition of states, with, for example, a 50% chance of being oriented "up" and a 50% chance of being oriented "down."

But Einstein found this explanation to be wishy-washy and nonsensical. He wasn’t content to be told that you can “sort of know” and “sort of not know.” His inquiring mind wanted to understand the exact specifics of how, exactly, the universe knows that someone is measuring something. So, Schrödinger responded by coming up with a thought problem that illustrated the illogical nature of the present explanations. The concept of Schrödinger's cat first appeared in Schrödinger's academic article entitled, "The Current Situation in Quantum Mechanics." Mann unpacks the simple edition of Schrödinger's theory in the following manner:

"Suppose one builds a strange contraption. The apparatus consists of a box with a sealed vial of cyanide, above which is suspended a hammer attached to a Geiger counter aimed at a small lump of mildly radioactive uranium. Inside the box, there's also a kitty (and remember, this is a thought experiment that's never actually been carried out). The box is sealed, and the experiment is left to run for some set amount of time, perhaps an hour. In that hour, the uranium, whose particles obey the laws of quantum mechanics, has some chance of emitting radiation that will then be picked up by the Geiger counter, which will, in turn, release the hammer and smash the vial, killing the cat by cyanide poisoning. According to folks like Bohr, until the box is opened and the cat's status is "measured," it will remain in a superposition of both living and deceased. People like Einstein and Schrödinger balked at such a possibility, which doesn't accord with everything our ordinary experience tells us — cats are either alive or dead, not both at the same time.

As a result, Schrödinger's cat cut to the heart of what was bizarre about Bohr's interpretation of reality: the lack of a clear dividing line between the quantum and everyday realms. While most people think it provides an example in support of particles lacking clearly-defined properties until they are measured, Schrödinger's original intention was the exact opposite—to show that such an idea was nonsensical. Yet, for many decades, physicists largely ignored this problem, moving on to other quandaries." But in the 1970s, researchers started to believe that Schrödinger was on to something, and they attempted to craft theoretical simulations that would test his theory. (Thankfully, all of these simulations were still thought experiments and no real cats were harmed).

Modern scientists took this theory to the next level and crafted computer simulations to finally solve the question once and for all. The computer allowed them to access the state of "superposition" referenced by Schrödinger and they found that his thought experiment was exactly right! Although he crafted it to make fun of nonsensical explanations, he also hit upon an important truth: it is, in fact, possible for objects to exist in quantum states that make absolutely no sense to the human perception of space and gravity! Since the genesis of his thought experiment in 1935, Schrödinger's cat has helped scientists to explore baffling questions about quantum mechanics.

Final Summary

We rarely think of equations as having the power to change the world. But as the author's examples illustrate, math and physics equations can revolutionize our understanding of time, space, and our very existence. The equations represented in this summary are only a fraction of the incredible theories that have shaped modern science and our conceptualization of the world. But as you can see from these examples, these theories are the products of some of the most brilliant scientific minds in history. They exist because scientists are in relentless pursuit of the unknown. And thanks to their continued dedication, we can explore the universe through the power of scientific discovery.