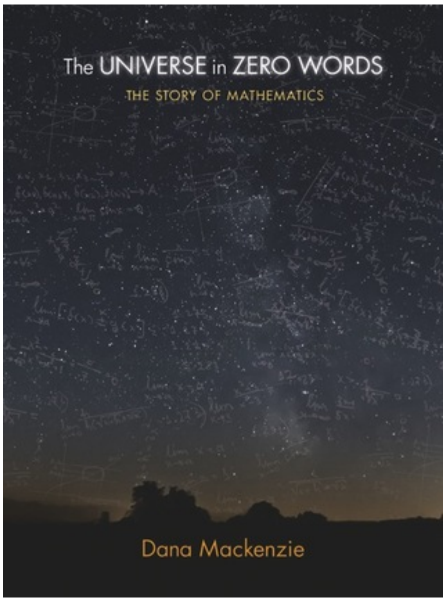

The Universe in Zero Words: The Story of Mathematics as Told Through Equations

Dana Mackenzie

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The Universe in Zero Words: The Story of Mathematics as Told Through Equations Dana Mackenzie Most popular books about science, and even about mathematics, tiptoe around equations as if they were something to be hidden from the reader's tender eyes. Dana Mackenzie starts from the opposite premise: He celebrates equations. No history of art would be complete without pictures. Why, then, should a history of mathematics -- the universal language of science -- keep the masterpieces of the subject hidden behind a veil?

"The Universe in Zero Words" tells the history of twenty-four great and beautiful equations that have shaped mathematics, science, and society -- from the elementary (1+1 = 2) to the sophisticated (the Black-Scholes formula for financial derivatives), and from the famous (E = mc^2) to the arcane (Hamilton's quaternion equations). Mackenzie, who has been called a "popular-science ace" by Booklist magazine, lucidly explains what each equation means, who discovered it (and how), and how it has affected our lives.

(From the jacket copy.)

Note: The Princeton University Press version (black cover) is for sale in the English-speaking world outside Australia. The Newsouth Press version (blue cover) is for sale in Australia. The two versions are identical except for the covers.

The Universe in Zero Words: The Story of Mathematics as Told Through Equations Details

Date	:	Published April 29th 2012 by Princeton University Press (first published January 1st 2012)
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Author	:	Dana Mackenzie
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From Reader Review The Universe in Zero Words: The Story of Mathematics as Told Through Equations for online ebook

Al Bitä says

This handsome publication is a perfect overview of the Story of Mathematics for non-mathematicians! My own level of maths has been more of less limited to basic late-fifties high school learning (algebra up the formula for the solution of quadratics, basic trigonometry; and a smidgin of calculus), but I have always maintained a layman's interest in mathematics in general. In the past, most problems for me came with the later developments in maths, and trying to come to grips with the more abstract areas in particular; but too many "popular" maths books almost always were too simplistic on the one hand, and too abstruse on the other, and mathematical proofs of formulae and applications usually lost me. This is not the case with this book.

Mackenzie writes succinctly and clearly, and his book is a pleasure to read. His experience in the field and in writing about it for ordinary people shines through. The clever conceit is in the title of the book: we can explain the Universe simply through the use of formulae (not words!). Of course, Mackenzie has been selective about which formulae he talks about, but he does cover the field from the beginnings right up to the present time. This he does in four neat sections, each containing six special formulae. What is so pleasurable about this is that each formula is presented as the solution to a particular problem without having to provide the proof of that formula: you simply need to take this on faith; then he discusses a number of real applications stemming from the formula, again without unnecessarily burdening the text with "proofs".

I found this approach clever and ideal. It helped explain, especially when apparently insurmountable problems seemed to loom up in the history of mathematics, why the problems existed; then he is able to describe the kind of leaps and intuitive insights which allowed not only to "circumvent" the problem, but often, also, (ironically) to "solve" it, or at least point to more marvellous and esoteric realms of the mathematical universe. Of course, in reality, this often involved rather abstruse reasoning and calculation on behalf of the mathematicians involced, but the details of this are not necessary in order to understand what is happening, and why. One can only marvel at the brilliance of the solutions and their potential and actual applications as made by some of the greatest minds in history.

One comes away from this work feeling one has somehow *understood* what is going on without necessarily needing to be *au fait* with the actual calculations involved! A wonderful achievement.

John Klumpp says

This book would be good for someone who knew almost no math but wanted to get familiar with some of the most important equations from antiquity through the present day. But I have trouble believing that anyone geeky enough to be interested in these equations (especially from 1900 on) would know as little math as the author supposes.

I think the average reader is probably more like me - literate in math but definitely not a mathematician. For me, the book was so lacking in details that a lot of it felt like a tease. There are too many cases where the author uses vague analogies to describe what an equation is doing when a few simple lines of high school math would have made it perfectly clear.

Having said that, there are a lot of bright spots to the book as well. I really enjoyed the first few chapters where the author talks about the "cult of Pythagoras" and describes how until very recently math was being done with incredibly primitive tools (no words, no equals sign, no plots, not even Arabic numerals - it's amazing anything got done at all!), and it's striking how rapidly mathematics would develop when things we take for granted today were introduced (for instance, calculus was invented less than 200 years after the equals sign was introduced, and less than 100 years after people started plotting equations).

There were also a few bright spots in the latter half of the book. I enjoyed the chapter on set theory/cardinality, which is so elementary that it can be explained in relative detail without any prior knowledge of mathematics, and yet which has some incredibly surprising results. The following chapter talks about the 'completeness' of mathematics and presents the recent but revolutionary proof that no set of axioms can be "complete" (in other words, for any set of axioms, there must be other statements which are at once true and unprovable - in other words, other axioms).

All together, this was a book worth reading, but it could have been so much better...

Dan says

First, a warning: There are actual words in this book. I know, I was disappointed.

What words there are are sometimes but not always used well. By the last section of the book, I was getting lost more often than not, despite a background in math going up to differential equations (albeit some 8 or 9 years ago), wishing for more explanation about things the author takes for granted as givens that sounded interesting.

But I am pleased to say that 'interesting' does fit this book. The concepts discussed are intriguing, if sometimes mind-bending, and especially with the earliest history, it helped me look at math in a new way. This is definitely a text for those already interested in math, rather than those looking to learn, but there is a lot to discover about math and those who've made it.

Note: The reviewer received a copy free from Goodreads First Reads program.

Grrlscientist says

Whilst a child, my male teachers informed me that “girls are terrible at math” and “teaching maths to girls is a waste of time”. Undeterred by their fondness for their own opinions, I’ve always been fascinated by the elegance and the pure artistry of mathematics. Perhaps because this passion had been forbidden, I ended up taking (and excelling in) all the college maths courses that I could find, tutoring maths students and in fact, almost pursuing a university maths degree.

I mention this because you will not find that dismissive attitude in Dana Mackenzie’s book, ***The Universe in Zero Words: The Story of Mathematics as Told through Equations*** [Princeton University Press; 2012]. As he states in the book’s preface, Mackenzie’s purpose is “to lift the veil of mystery and secrecy that surrounds mathematics and equations” so his readers “can see what lies underneath.”

Comprised of short lively vignettes that are part biography, part history and part mathematics, this aesthetically-pleasing book is liberally embellished with period art and engravings, ancient manuscripts, colour photographs, maps and diagrams. Even the dust jacket is designed with the mathematical aesthete in mind: a close look at the stars reveals they are mathematical equations superimposed on the night sky!

To write this book, the author combed through centuries of algebra, geometry, applied mathematics and analysis to identify 24 mathematical theorems or physical laws that fulfilled these criteria:
it is surprising
it is concise
it is consequential
it is universal

In writing about these 24 special mathematical equations, Mackenzie starts with simple practical equations discovered by the ancient Greeks and moves forward to the more sophisticated equations discovered in modern times. As the mathematical complexity of the equations grows, we gain an appreciation for their power and, yes, for their profound beauty. Even though we may not understand all the subtle nuance of these equations, we recognise why they are so intellectually exciting to mathematicians. We also see how these equations can be used to predict and explain natural phenomena and abused to influence economic developments and risk management.

But more than just showing us these equations, Mackenzie goes on to discuss the lives of the people who contributed to mathematical theory, the times they lived in, and how their contributions changed the way that we think about mathematics?—?and about the universe.

In this book, you'll read about prime numbers and the the discovery of π. You will read about the Fourier series, Dirac's equation and about the geometry of whales and ants. I suppose it's probably a foregone conclusion that you will also read about what may be the most recognisable equation the world has ever seen, Einstein's famous E=mc2. You'll be introduced to the group of people behind the Pythagorean Theorem and you'll also meet famous mathematicians such as Archimedes, Kepler, Fermat and Gauss.

I especially enjoyed the chapter on chaos theory/Lorenz equations although I was disappointed to see it only mentions where the idea of the "butterfly effect" comes from without going into much depth. I was surprised that the chapter discussing the discovery of zero neglected to mention that Alex the African grey parrot discovered zero on his own?—?an intellectual achievement that took humans millennia to accomplish.

This book provides a glimpse into the history underpinning some of mathematics' most important equations, a rich and fascinating topic that is rarely mentioned in most classrooms. Further, even though words seldom do justice to the economic beauty of an equation, Mackenzie manages to provide a reasonable idea what these equations communicate.

This attractive 224-page book is a breezy romp through 2500 years of mathematical ideas. It includes four parts that are divided into a total of 24 fairly short chapters, as well as an introduction and conclusion, acknowledgments, bibliography and an index. This well-designed and accessible book will delight and inform the student, mathematician or historian in your life and it may also help you rediscover your forbidden love for mathematics.

NOTE: Originally published at *The Guardian* on 23 October 2012.

David says

The Universe in Zero Words is a beautiful book, in all senses of the word. Dana Mackenzie devotes several pages to each of many equations that made a difference in the spheres of mathematics, science, and economics. The history of each equation is told superbly, as well as the meaning of each equation and its applications in the real world. The explanations are geared toward the layman--you don't have to be a mathematician to understand most of the explanations.

Dana Mackenzie is a mathematician, and his enthusiasm for the subject shines through his writing. He chose equations that have been important in the development of mathematics and science. I found his choice of equations to be quite good, and I learned a lot, even though I was already very familiar with the majority of the equations. A few, however, were quite new to me. The equation of quarternions is brand new for me, and Mackenzie tells why; the concept is rarely mentioned in modern-day physics textbooks. Also, the Black-Scholes equation is entirely new to me, as it is used by financial analysts and "quants".

The book is filled with beautiful illustrations and diagrams. In fact--I strongly urge interested readers to obtain a printed copy of the book, rather than an e-book version. The beauty of the printing, the layout, typography and illustrations add a considerable amount of charm to the reading experience.

Sally says

I was a little disappointed in this book, though it's hard to put my finger on why. It's an intriguing idea to present the history of math through 24 equations, 6 each from ancient times, Europe from 1400-1800, the 19th century, and 1900-present. The author's explanations don't require a knowledge of mathematics. The equations he chose are interesting. Still, I found some of his historical and biographical remarks rather glib and superficial - and once I find a factual error in a book like this, I wonder how many more are slipping past my ignorance. But I made it to the end - luckily, since the last chapters are particularly interesting - which says something in its favor.

Joseph Millo says

The author selected 24 mathematical equations for a more detailed discussion than found in most books written for the non-mathematician reader. He selected the equations based on criteria of is it: (1) surprising, (2) concise, (3) consequential and (4) universal. He introduces each equation by giving its historical and social setting, and a cameo bio of the mathematician. Special attention is given to explaining the equation's function and significance, and the reaction of other mathematicians to its discovery.

I was surprised at how many equations I understood. The equations from antiquity (zero, square of the hypotenuse, pi, etc.) are easy to understand because they are so basic and even intuitive. My ancient education in calculus and geometry enabled me to understand the fundamental theorem of calculus and non-Euclidean geometries (except for varying curvature geometry, which I still fail to grasp). And my experience in geophysics allowed me to understand the beauty and utility of Fourier transforms. Which leaves most of the other 24 equations that I do not have the math skill to really understand. But because of the author's skill as a communicator, my not being able to "do the math" did not interfere with my ability to appreciate the importance and poetry of the equation.

Highly recommended!

Sylvain Bérubé says

Une belle idée bien exécutée !

Brett Thomasson says

Despite what many of us may have thought when we were taking math class, the equations we were required to learn did not spring fully-formed from the sadistic minds of our instructors. Though some are ancient and some are recent, all of them "came into being," so to speak, when someone happened upon a principle and expressed it in terms that developed into the formulas we are used to (or maybe not so used to) today.

According to mathematician Dana Mackenzie in *The Universe in Zero Words*, the history of humanity's understanding of the world around us can be found in looking at some of the very same equations we may have cursed in the classroom. Mackenzie selected 24 equations, starting with antiquity, and with brief vignettes, sketches the role each played in the development of human thinking and understanding the universe.

And he does start with the basics -- the very first equation he considers is ye olde 1 + 1 = 2. Perhaps self-evident in the modern world, but as Mackenzie notes, until you have the relationship between objects thus coded in some way, you don't have a system for manipulating numbers and you don't even have basic arithmetic. Take one apple and add another and you have two apples, but what about pears? Are they the same? Or what about groups of different objects? Do they behave the same way as the apples? Without the expression 1 + 1 = 2, you are left with having to count them all of the time. But with that expression, you can state a general rule that frees you from counting everything in order to see how many you have. We have no idea when this basic arithmetic was first used or where it came from, but there was a time before it, and without someone figuring it out we are pretty much stuck with stone knives and bearskins.

Mackenzie goes through the history of mathematics this way, touching on famous equations like the Pythagorean Theorem (probably not discovered by Pythagoras) or Albert Einstein's E = mc2. He also explores lesser-known formulas that the blogger interface can't reproduce properly, but which have proven vital to understanding the universe as well as the infinitesimally small world of quantum mechanics. First by outlining the basic arithmetic and geometry that let people begin to think in abstract as well as concrete terms, then through the times of Newton and Liebniz, Gauss and Galois and into the 20th century with Gödel and Dirac and Einstein himself, Mackenzie offers the story of humanity's ability to know the world around us -- or at least parts of it -- through the development of the equations that describe the planets, the atoms, the particles of which they are all made and the way they behave.

Mackenzie doesn't load the book with a lot of formulas and mathematical arcanum -- it takes algorithm-phobes such as myself some time to puzzle out the different symbols and their meaning, but it can be done. And doing so is worth the trip for a fascinating view of how human beings have sought to find -- and in some cases impose -- order on the world in which we live and move and have our being.

Original available here.

Maria says

As I just recently started a bachelor degree in physics and therefore have a lot of math, and I was glad to come across this book so I could get to know more about the history behind some of the more famous equations and understand more about what they mean. I always look at awe on my math books when thinking about all the brain power and all the centuries that had to happen for me to have this knowledge so easily available. "The Universe in Zero Words" made me even more impressed with the mathematical genius of mankind, though I should say I don't think I would have enjoyed it as much if I hadn't have some calculus, vector calculus and physics. It's probably not necessary to have that background at all, but it surely made it more enjoyable and easier to understand. With some of the equations I would like the book to have written more about their usage though, to get an even greater understanding of the importance of math in our society.

Rachel says

I received this book from the GoodReads giveaway. I've now read it twice.

I have to say this book was stunning. I returned to college at 38 years old and discovered I was good at math only after I was diagnosed with ADD. (not very good at it in high school)This book created a space in my head where math made sense. Now that I know I am also dyslexic, after several years back in college I understand how this book worked for me.

I'm not saying read this book if you have a learning disorder but I went through it with my nine year old daughter (who is also ADD and dyslexic) and she loved it. She was fascinated by it. She was already a math phenom so she understood the book much faster than I did. She discusses M-theory with her Dad, while I hope I never have to do Algebra again. I can do it though.

I think that anyone who is exposed to math at all will appreciate this book. Not just a student or a person that works with numbers. Actually now that I think of it, this would be a great gift for an Engineer!

Rama says

Deriving the meaning of mathematical equations in terms of physical reality

Mathematics is a body of language which expresses knowledge about a real or a hypothetical universe. Some equations are not mathematical theorems but physical laws such as energy - mass equation of relativity, energy - wave equation of quantum physics or the Maxwell equations of classical physics that are deduced by the experimental data rather than derivation from a set of axioms. Algebra, geometry, applied mathematics and analysis bind together in expressing the laws of physics and reality so well that one wonders if God is a mathematician. At the frontiers of theoretical physics such as, string theory, brane physics and supersymmetry, math and physics intertwine so strongly that one has to understand and express what those mathematical formulas say about the intricacies of laws of nature.

The title of the book is misleading, because I first thought that this book is a new kind in that explains what the mathematical equations of physics and cosmology tell us about reality or what the physical constants mean for the universe. It is disappointing in that the author discusses a brief history of laws of levers, Newton's laws, Fermat's last theorem, Euler's theorem, group theory, Fourier series, and theory of chaos and none of them go into any level of detail. There are many books that discuss the historical development and this book serves no real purpose in that regard. Despite this weakness, the chapters on Kepler's law that describes the planetary motion around sun, the chapters on quantum physics and relativity are interesting but still lacks depth.

In the early part of 20 century when principles of quantum physics were proposed, mathematics became the only guide. The entire world quantum physics was not comprehensible. It sounded absurd to talk about wave-particle duality, and the ability of photons to decide that it should behave like wave or particle is dependent on what experiment the observer chooses to perform. Paul Dirac's attempt to reconcile spin angular momentum of an electron with special relativity lead to far reaching consequences that predicted the existence of antiparticles and the existence of bosons and fermions. An empty space contains particles and their antiparticles that pop into existence and pop-out of existence. In quantum physics, particles are treated like quantum fields, which are like electric fields, that pervade all of spacetime and particles are their local manifestations. In other words, a particle may be a fluctuation in the quantum field that may be just temporary or long lasting. The fact that the two fermions cannot have the same quantum state, a consequence of Paul Dirac's equation, which makes an atom to have atomic orbitals that build electron around the nucleus to form various atoms that underlies all of chemistry. There is a very interesting discussion as how Dirac's equation revolutionized modern physics and chemistry.

There are many websites which discusses mathematical equations of physics elegantly, and I recommend NASA's website for educators. For example: [...]

Equations have evolved as powerful tools that enable us to grasp ideas that can be put into words. Historically this has served very well in physics and chemistry, but it is expected to find useful applications in this century in biology, medicine, agriculture, pharmaceuticals and social sciences.

Kam Yung Soh says

A fascinating book on mathematics and equations and how they impact on us. The equations featured in the first half of the book will probably be familiar to most of us but those in the second half may mystify some. But all of them will amaze you with the depth of meaning that can be found hiding behind a line of mathematical symbols.

With so many equations known, the author decided to include that met the following criteria:

1. It is surprising
2. It is concise
3. It is consequential
4. It is universal

The first section covers those known since ancient times and starts with, surprise, surprise, "1 + 1 = 2". Yet even this simple equation is not without its interesting notes.

The second section covers those discovered as man began to explore the world. At this time, mathematical discoveries were mostly kept secret and guarded like treasures; not a really good time for disseminating information.

Next, the use of mathematics and the discovery of equations really explodes as institutes and centres of science began to share discoveries, leading mathematicians to question basic axioms and founding new areas of mathematics like non-Euclidean geometry and Maxwell's equations (of electro-magnetism).

The final part catches up to the present and covers the more 'esoteric' areas of mathematics like quantum theory, chaos and ends with the notorious Black-Sholes equation ("the formula that killed Wall Street").

The book, of course, will never be finished. New equations and new mathematics will be discovered in the future. For those who have an interest in mathematics and willing to do some thinking about what the equations represent, this is a book to read.

Brian Clegg says

In awarding this book five stars I am rather reminded of the infamous Samuel Johnson quote on women preachers: ‘A woman’s preaching is like a dog’s walking on his hind legs. It is not done well, but you are surprised to find it done at all.’ Leaving aside that Doctor Johnson might have had to rethink his opinion had he seen Pudsey (on Britain's Got Talent), the reason I say this is because I’m reviewing a book about mathematical equations. Taken purely as a piece of popular science writing it probably only merits four stars, but I am so amazed that anyone can write a book about a series of equations and make it readable and interesting that I have had to award it five.

When I first saw the title I thought I was about to flick through a nice picture book of astronomical photos, but in fact Dana Mackenzie provides us with plenty of words – it’s just that they are describing these ‘no words’ equations. Mackenzie eases us in gently with the work of the ancient Greeks, then brings us forward in time, allowing the maths (and the equations) to grow in complexity as we go.

What makes the book work so well is that there is plenty of context – we learn about the individuals behind these equations (not always the obvious ones when it comes to, say, Pythagoras) and the historical setting of their devising. There are some rather beautiful hand drawn illustrations of the equations themselves and diagrams (I just wish the handwriting was a little more legible) and the amazing, dog-walking-on-hind-legs feat is that we aren’t turned off by the equations, but rather get some feeling for their beauty and power.

I am not saying this book brings me round to a mathematician’s viewpoint. I still think that their view is too abstract, and that much of the maths they get excited about is hugely ‘so what?’ – but this book really does give you a flavour of why they get so worked up.

Strangely, the book tails off towards the end. This is in part because Mackenzie spends more time on physics (which he is less effective at explaining than maths), and partly because there is less focus on equations. Maxwell’s equations, for example, aren’t explored, just mentioned. Yes, remarkably, by then the reader is so drawn in that we want more equations!

I have two specific gripes apart from this. One is about the introduction. We are told how the great Richard Feynman took on someone with an abacus and beat them on the calculation of cube roots because he knew ‘a famous equation from calculus called Taylor's formula' – yet we aren't told what the equation is. In a book that is all about making equations visible, this rankled for the rest of the book.

The other problem I have is with a bizarre mini-rant that Mackenzie has about those who worry about the impact of mobile phones on their brains. He points out that the photons produced by a mobile phone have not got enough energy to ionise atoms, so don't present a danger. But this entirely misses the point. After all, the photons produced by microwave ovens aren't ionising radiation either, but few us would feel comfortable sticking our heads in a functioning microwave. It's not that I agree with the 'danger from phones, phone masts and wifi radiation' lobby – I don't – but Mackenzie merely muddies the water with this strange irrelevancy.

That's a very minor complaint, though. If you've always been puzzled by mathematical formulae, or wondered why mathematicians bother to get out of bed in the morning, this is the book to let you into their secret world. A remarkable achievement.

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Becky Ferreira says

Such an interesting idea, well executed.
