ST BENET BISCOP CATHOLIC ACADEMY
Part of the Bishop Bewick Catholic Education Trust

St Benet Biscop Sixth Form

Personal Development

Mathematics

1. News articles/videos

Phys.Org - https://phys.org/science-news/mathematics/

Science Daily - https://www.sciencedaily.com/news/computers_math/mathematics/

Quanta Magazine - https://www.quantamagazine.org/

The Independent - https://www.independent.co.uk/topic/mathematics

New Scientist - https://www.newscientist.com/subject/mathematics/

Wired - https://www.wired.com/tag/mathematics/

MIT News - https://news.mit.edu/topic/mathematics

Plus - https://plus.maths.org/content/news

2. MOOCs (Massive Open Online Courses)

Autonomous Mobile Robots – ETH Zurich
Robots are rapidly evolving from factory workhorses, which are physically bound to their work-cells, to increasingly complex machines capable of performing challenging tasks in our daily environment. The objective of this course is to provide the basic concepts and algorithms required to develop mobile robots that act autonomously in complex environments. The main emphasis is put on mobile robot locomotion and kinematics, environment perception, probabilistic map-based localization and mapping, and motion planning. The lectures and exercises of this course introduce several types of robots such as wheeled robots, legged robots and drones.

Introduction to Mathematical Thinking – Stanford University
Learn how to think the way mathematicians do – a powerful cognitive process developed over thousands of years. Mathematical thinking is not the same as doing mathematics – at least not as mathematics is typically presented in our school system. School math typically focuses on learning procedures to solve highly stereotyped problems. Professional mathematicians think a certain way to solve real problems, problems that can arise from the everyday world, or from science, or from within mathematics itself. The key to success in school math is to learn to think inside-the-box. In contrast, a key feature of mathematical thinking is thinking outside-the-box – a valuable ability in today's world. This course helps to develop that crucial way of thinking.

Bayesian Statistics – Duke University

This course describes Bayesian statistics, in which one's inferences about parameters or hypotheses are updated as evidence accumulates. You will learn to use Bayes' rule to transform prior probabilities into posterior probabilities, and be introduced to the underlying theory and perspective of the Bayesian paradigm. The course will apply Bayesian methods to several practical problems, to show end-to-end Bayesian analyses that move from framing the question to building models to eliciting prior probabilities to implementing in R (free statistical software) the final posterior distribution. Additionally, the course will introduce credible regions, Bayesian comparisons of means and proportions, Bayesian regression and inference using multiple models, and discussion of Bayesian prediction. We assume learners in this course have background knowledge equivalent to what is covered in the earlier three courses in this specialization: "Introduction to Probability and Data," "Inferential Statistics," and "Linear Regression and Modelling."

Introduction to Actuarial Science – Australian National University

You may have heard of actuarial science, or you might even know an actuary, but do you know what an actuary does? During the course you'll hear from a wide variety of actuaries about their careers. And don't be scared that the course will be "just a whole lot of mathematics". Together, we will go beyond the math to learn how actuaries approach problems relating to risk, using examples from:

- *Finance*
- *Investments*
- *Banking*
- *Insurance*

You will learn how actuarial science applies mathematical and statistical methods to assess risk in these industries and other professions.

You'll experience "hands-on" learning using Excel (or an equivalent spreadsheet tool) to project and investigate the financial condition of a company choosing appropriate strategies for the company through the use of simulations.

Inferential Statistics – Duke University
Inferential statistics are concerned with making inferences based on relations found in the sample, to relations in the population. Inferential statistics help us decide, for example, whether the differences between groups that we see in our data are strong enough to provide support for our hypothesis that group differences exist in general, in the entire population. We will start by considering the basic principles of significance testing: the sampling and test statistic distribution, p-value, significance level, power and type I and type II errors. Then we will consider a large number of statistical tests and techniques. For each individual statistical test we will consider how it works, for what data and design it is appropriate and how results should be interpreted. You will also learn how to perform these tests using freely available software. For those who are already familiar with statistical testing: We will look at z-tests for 1 and 2 proportions, McNemar's test for dependent proportions, t-tests for 1 mean (paired differences) and 2 means, the Chi-square test for independence, Fisher's exact test, simple regression (linear and exponential) and multiple regression (linear and logistic), one way and factorial analysis of variance, and non-parametric tests (Wilcoxon, Kruskal-Wallis, sign test, signed-rank test, runs test).

Visualizing Algebra – San Jose State University
Throughout this course, we will use algebra to quantify and describe the world around us. Have you ever wondered how many songs can fit onto your flash drive? By the end of the course, you'll have stronger skills for modelling problems, analysing patterns, and using algebra to arrive at conclusions.

College Algebra – San Jose State University
Math is everywhere. In this class, you'll gain an in-depth understanding of algebraic principles, many of which you may have seen before, and learn how to use them to solve problems that we encounter in everyday life. The online version of College Algebra will cover all of the topics that you would see in more traditional class formats, but it will present the material in a way that we hope you'll find fresh and interesting. You will learn about functions, polynomials, graphing, complex numbers, exponential and logarithmic equations, and much more, all through exploring real-world scenarios.

Intro to Statistics
Statistics is about extracting meaning from data. In this class, we will introduce techniques for visualizing relationships in data and systematic techniques for understanding the relationships using mathematics.

Intro to Inferential Statistics - Udacity
Inferential statistics allows us to draw conclusions from data that might not be immediately obvious. This course focuses on enhancing your ability to develop hypotheses and use common tests such as t-tests, ANOVA tests, and regression to validate your claims.

Intro to Descriptive Statistics – Udacity
Statistics is an important field of math that is used to analyse, interpret, and predict outcomes from data. Descriptive statistics will teach you the basic concepts used to describe data. This is a great beginner course for those interested in Data Science, Economics, Psychology, Machine Learning, Sports analytics and just about any other field.

3. Books

God created the integers – Stephen Hawking

Stephen Hawking's personal choice of the greatest mathematical works in history. He allows the reader to peer into the mind of genius by providing us with excerpts from original mathematical proofs and results. He also helps us understand the progression of mathematical thought, and the very foundations of our present-day technologies. The book includes landmark discoveries spanning 2500 years and representing the work of mathematicians such as Euclid, Georg Cantor, Kurt Godel, Augustin Cauchy, Bernard Riemann and Alan Turing. Each chapter begins with a biography of the featured mathematician, clearly explaining the significance of the result, followed by the full proof of the work, reproduced from the original publication, many in new translations.

Principia Mathematica – Alfred North Whitehead & Bertrand Russell

Principia Mathematica was first published in 1910-13. The Principia has long been recognised as one of the intellectual landmarks of the century. It was the first book to show clearly the close relationship between mathematics and formal logic. Starting from a minimal number of axioms, Whitehead and Russell display the structure of both kinds of thought. No other book has had such an influence on the subsequent history of mathematical philosophy.

Outliers – William Gladwell

Explore what sets high achievers apart—from Bill Gates to the Beatles—in this seminal work from "a singular talent" (New York Times Book Review) Malcolm Gladwell, bestselling author of Blink and The Bomber Mafia and host of the podcast Revisionist History.

In this stunning book, Malcolm Gladwell takes us on an intellectual journey through the world of "outliers"—the best and the brightest, the most famous and the most successful. He asks the question: what makes high-achievers different?

His answer is that we pay too much attention to what successful people are like, and too little attention to where they are from: that is, their culture, their family, their generation, and the idiosyncratic experiences of their upbringing. Along the way he explains the secrets of software billionaires, what it takes to be a great soccer player, why Asians are good at math, and what made the Beatles the greatest rock band.

The Dot and the Line: A Romance in Lower Mathematics by Norton Juster

Once upon a time there was a sensible straight line who was hopelessly in love with a beautiful dot. But the dot, though perfect in every way, only had eyes for a wild and unkempt squiggle. All of the line's romantic dreams were in vain, until he discovered . . . angles! Now, with newfound self-expression, he can be anything he wants to be--a square, a triangle, a parallelogram. . . . And that's just the beginning! First published in 1963 and made into an Academy Award-winning animated short film, here is a supremely witty love story with a twist that reveals profound truths about relationships--both human and mathematical--sure to tickle lovers of all ages.

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Beyond Infinity: A MatheMATTical Adventure by Charles Ames Fischer
When high school senior Matthew "MatheMatt" Forsythe discovers a weird computer and a secret door at school, a series of events unfolds where he and his friends solve one mathematical puzzle after another. After finding a teleportal, Matt and his friend Kelsie travel to a strange world where numbers are actually alive! There they meet the mad scientist Maglio and the ghostly Fifty-Seven and discover that some of the numbers are mysteriously disappearing.

Humble Pi – A comedy of maths errors – Matt Parker
Exploring and explaining a litany of glitches, near-misses and mishaps involving the internet, big data, elections, street signs, lotteries, the Roman empire and a hapless Olympic shooting team, Matt Parker shows us the bizarre ways maths trips us up, and what this reveals about its essential place in our world.

Fermat's last Theorem – Simon Singh
Fermat's Last Theorem is a popular science book (1997) by Simon Singh. It tells the story of the search for a proof of Fermat's Last Theorem, first conjectured by Pierre de Fermat in 1637, and explores how many mathematicians such as Évariste Galois had tried and failed to provide a proof for the theorem. Despite the efforts of many mathematicians, the proof would remain incomplete until 1995, with the publication of Andrew Wiles' proof of the Theorem.

The code book – The secret history of codes and code breaking – Simon Singh
The Code Book: The Science of Secrecy from Ancient Egypt to Quantum Cryptography is a book by Simon Singh, published in 1999 by Fourth Estate and Doubleday.
The Code Book describes some illustrative highlights in the history of cryptography, drawn from both of its principal branches, codes and ciphers. Thus, the book's title should not be misconstrued as suggesting that the book deals only with codes, and not with ciphers; or that the book is in fact a codebook.

Bad Science – Ben Goldacre
Ben Goldacre's wise and witty bestseller, shortlisted for the Samuel Johnson Prize, lifts the lid on quack doctors, flaky statistics, scaremongering journalists and evil pharmaceutical corporations. Since 2003 Dr Ben Goldacre has been exposing dodgy medical data in his popular Guardian column. In this eye-opening book he takes on the MMR hoax and misleading cosmetics ads, acupuncture and homeopathy, vitamins and mankind's vexed relationship with all manner of 'toxins'. Along the way, the self-confessed 'Johnny Ball cum Witchfinder General' performs a successful detox on a Barbie doll, sees his dead cat become a certified nutritionist and probes the supposed medical qualifications of 'Dr' Gillian McKeith. Full spleen and satire, Ben Goldacre takes us on a hilarious, invigorating and ultimately alarming journey through the bad science we are fed daily by hacks and quacks.

The Black Swan – Nassim Nicholas Taleb

Opinionated, curious and hugely entertaining, The Black Swan: The Impact of the Highly Improbable is a masterful exploration of the way random events shape our lives in remarkable ways. Considering a myriad of examples of our interaction with the natural world, technology and each other, Taleb reveals the loopholes in the human obsession to predict everything. In wild and wonderful ways, The Black Swan shows how embracing ambivalence can sometimes be just what we need.

Nassim Nicholas Taleb's phenomenal international bestseller The Black Swan: The Impact of the Highly Improbable shows us how to stop trying to predict everything - and take advantage of uncertainty.

What have the invention of the wheel, Pompeii, the Wall Street Crash, Harry Potter and the internet got in common? Why are all forecasters con-artists? What can Catherine the Great's lovers tell us about probability? Why should you never run for a train or read a newspaper?

This book is all about Black Swans: the random events that underlie our lives, from bestsellers to world disasters. Their impact is huge; they're impossible to predict; yet after they happen we always try to rationalise them.

4. Films/Documentaries

The History of Mathematics

https://www.youtube.com/watch?v=P-sU9xkmZ5o

The documentary film History of Mathematics embarks on an enthralling journey through the annals of human history, uncovering the profound influence of mathematics on the development of civilizations. Venture into the realms of ancient Egypt, Mesopotamia, Greece, China, and India, as the film explores their unique contributions to the field of mathematics. Discover the origin of decimal systems, the invention of the number zero, the enigmatic concept of infinity, and the birth of algebra, while celebrating the remarkable minds that shaped these ground-breaking ideas.

The Code (17 Episodes)

https://www.youtube.com/watch?v=5RAtFSEkFho&list=PL8CB2A036D0EAED2A

A mysterious code underpins the world. But what does it mean and what can we learn from it? Marcus du Sautoy takes us on an odyssey to uncover the code and reveal its meaning.

Does Maths Reveal Reality?

https://www.youtube.com/watch?v=VN19VOMHxkk

Mathematics has an uncanny ability to describe the physical world. It elegantly explains and predicts features of space, time, matter, energy, and gravity. But is this magnificent scientific articulation an invention of the human mind or is mathematics indelibly imprinted upon the substrate of reality?

The Story of Maths

Episode 1 of 4: https://www.youtube.com/watch?v=mJbChZrXDJE

Marcus du Sautoy uncovers the use of a decimal system based on ten fingers of the hand and looks at the contributions of the great Greek mathematicians.

Episode 2 of 4: https://www.youtube.com/watch?v=_mAZbydFUzg

Marcus du Sautoy looks at the rise of mathematics in the east, discovering how it helped build imperial China and finding out about the invention of algebra.

Episode 3 of 4: https://www.youtube.com/watch?v=OiOIaM_2rvo

Marcus du Sautoy investigates the ways in which Europe replaced the Middle East as the world's powerhouse of mathematical ideas by the 17th century.

Episode 4 of 4: https://www.youtube.com/watch?v=eFNdqZKIaLo

Marcus du Sautoy concludes his look at the history of mathematics by examining the great unsolved problems that confronted mathematicians in the 20th century.

5. Podcasts

The Secrets of Mathematics

A series of talks and lectures from Oxford mathematicians exploring the power and beauty of their subject and how the subject is useful in other fields such as economics and medicine.

A Brief History of Mathematics – Marcus Du Sautoy

10 x 15 minute episodes revealing the personalities behind the calculations and arguing that mathematics is the driving force behind modern science.

The Numberphile Podcast – see also the numberphile series on YouTube.

Interviews with people who love numbers and mathematics, hosted by Brady Haran.

Uncharted with Hannah Fry

10 x 15 minute episodes, statistics focussed. Behind every line on a graph there lies an extraordinary human story…Hannah Fry leads us through 10 captivating mysteries to reveal the power of numbers behind each one.