



# STANFORD MATHEMATICS OUTREACH PROJECT

## MISSION

The Stanford Mathematics Outreach Project, in the Stanford Graduate School of Education, seeks to better inform students, teachers, educational administrators, and citizens in general, of the nature, beauty, and utility of mathematics, and raise awareness of the dramatic changes that have taken place in the subject during the past thirty years—in particular the way mathematics is typically done today.

The primary focus of the project is to:

- 1) present the “bigger picture” of mathematics as a rich part of human culture with a long history—a living, growing, human art, full of beauty and pursued by many; and
- 2) describe and explain how mathematics plays an essential, but often hidden, role in modern society (and indeed, throughout history, as the project will describe)

The project’s primary target audience is all of society. In the case of (1), any number of professional mathematicians will admit that an exposure (often by chance) to that view of mathematics was instrumental in persuading them to pursue math as a career, so outreach activities having this focus can have positive impact on the math pipeline.

At the present time, the societal need for the second focus (2) is particularly great. As a result of recent developments in technology, professionals in STEM disciplines, in finance-related fields, and in the social sciences use (and sometimes develop) mathematics in their daily work in a way that is *very* different from the way mathematics is taught in many of the nation’s (and the world’s) schools.

## CONTEXT

A few years ago, GSE Professor of Mathematics Education Jo Boaler successfully launched an initiative to reach classrooms teachers regarding those changes in mathematical praxis, with the creation of youcubed. Youcubed’s main goal is to inspire, educate and empower teachers of mathematics, transforming the latest research on math learning into accessible and practical forms. The youcubed website and Dr. Boaler’s online courses have already reached over a million teachers around the world. Youcubed delivers pedagogic guidance, lesson plans, and examples of mathematics classroom activities.

Youcubed’s focus is on what is often called pedagogic mathematics—carefully chosen mathematical activities and associated teaching methods that years of experience and study have shown to be particularly effective in helping students learn mathematics. The Mathematics Outreach Project has a different, but complementary (and hence supportive) goal.

The extent to which not only our schools, but society as a whole, are unaware of the significant changes that have occurred in how mathematics is done, is indicated by the passionate, and sometimes acrimonious, debates that followed the introduction of the Common Core State Standards for Mathematics in 2009. Yet those standards were drawn up by panels of experts in order to provide guidance for mathematics education to prepare tomorrow’s citizens for life in a world where free, online, computational resources can, quite literally “Do the math.” Not only some of the math; all of it! In the space of just thirty years, the way professionals use mathematics to solve real-world problems changed from spending many hours solving equations and executing procedures, to making effective use of computer systems that do all of that for us—much faster than humans, with many more variables than we can handle, and virtually error free.

In order to use those technological tools, people still have to learn mathematics – and for the most part it is the same math they have always learned. But today’s focus is very different. It is no longer important (or sensible) to teach math in order to learn how to execute procedures; it must be taught for



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understanding. That kind of teaching is what Professor Boaler's youcubed helps teachers learn to provide.

One expected positive outcome of the Mathematics Outreach project is to make people (in particular students, teachers, parents, education administrators, business leaders, and journalists) aware of *why* that new way of teaching is required. This explains the rationale for Stanford's Graduate School of Education taking a lead in this new Mathematics Outreach initiative.

The technologies that have changed the way mathematics is used by professionals in various quantitative domains have also revolutionized the degree to which the beauty of mathematics as a human art can be effectively conveyed to non-mathematicians—taking us back to project focus (1). By greatly reducing, if not eliminating, the need to master a formal, symbolic language and an array of procedural rules in order to lift the curtain and see the beauty that mathematicians do, today's technologies can enable anyone with a high school diploma to add mathematics to the list of human cultural domains that they can experience and appreciate—even if they have no desire to “do it.” Excellent illustrations of this new outreach capacity are provided by the computer-generated animated math videos produced by Stanford mathematics graduate Grant Sanderson and distributed through his *3blue1brown* YouTube channel (<http://www.3blue1brown.com>) and the popular *Numberphile* videos that have garnered over 2.6M viewers on YouTube (<https://www.youtube.com/channel/UCoxcjq-8xIDTYp3uz647V5A>).

### PROJECT LEADERSHIP

The project is being led initially by Dr. Keith Devlin, a professional research mathematician, formerly a professor in the Stanford Mathematics Department. He is a Fellow of the American Mathematical Society, a Fellow of the American Association for the Advancement of Science, and a World Economic Forum Fellow.

In addition to a strong record in published research in pure mathematics over many years (around 90 published research papers), Devlin has an impressive track record in mathematical outreach stretching back to 1983, when he became the first ever regular mathematics columnist in *The Guardian* newspaper in his native Britain, a position he relinquished two years after moving to Stanford in 1987. He has written 33 books, just over a third of them mathematics outreach books, written for a general audience. He writes a popular, regular monthly online column, “Devlin’s Angle”, for the Mathematical Association of America (<http://devlinsangle.blogspot.com>).

Devlin’s mathematical writing and outreach activities have earned him the Pythagoras Prize, the Peano Prize, the Carl Sagan Award, and the Joint Policy Board for Mathematics Communications Award. In 2003, he was recognized by the California State Assembly for his “innovative work and longtime service in the field of mathematics and its relation to logic and linguistics.”

Since 1994, Devlin has been known to millions of American radio listeners as “the Math Guy” on National Public Radio (<https://web.stanford.edu/~kdevlin/MathGuy.html>). He has consulted for, and appeared in, a number of television science documentaries in the BBC *Horizons* series in the UK and the PBS *Nova* series in the US. He was also a mathematics adviser for the successful TV crime series *NUMB3RS*, that ran on CBS from 2005 to 2010.

In the mathematics education domain, in 2012, Devlin created and launched the world’s first mathematics MOOC (massively open online course) on the Stanford-spinoff course platform Coursera. The focus of the course, called “Introduction to Mathematical Thinking”, is the kind of 21<sup>st</sup> Century way of doing math that the Mathematics Outreach Project seeks to explain and promote. The course is still running, and is regularly one of only two math courses in the most in-demand Top Fifty MOOCs on Coursera.



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In addition, Devlin is a co-founder and the Chief Scientist of an educational technology company that designs and builds mobile games for mathematics learning and assessment. The design of BrainQuake's products draws on many years of research he described in his 2011 book *Mathematics Education for a New Era: Video Games as a Medium for Learning*, now regarded as a seminal text in the field of game-based learning.

Devlin is in constant demand to give presentations on mathematics to different audiences around the world. See <https://web.stanford.edu/~kdevlin/speaking.html> for a listing covering the last fifteen years.

In terms of his research activities, Devlin has spent much of the last thirty years using his mathematical knowledge in a number of different application domains, working on problems for large companies, US Intelligence, the US Navy, and the US Army, providing him with a wealth of hands-on experience in doing math "the new way" that both youcubed and the Mathematics Outreach Project are designed to promote.

Devlin and Boaler have already worked together on a number of mathematics education projects. These include the detailed planning of three research grant applications focusing on the use of new technologies for math learning and assessment, one of which was funded. In addition, Boaler serves as an unpaid academic advisor for Devlin's BrainQuake company, and Devlin was an internal advisor/examiner for one of Boaler's successful Stanford Ph.D. students.

Devlin himself is transitioning to retirement (he now has Emeritus status at Stanford), and sees this project as a way to provide Stanford with a lasting legacy in providing valuable and timely public education of one of humankind's most powerful, but often misunderstood, intellectual tools.)

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