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As a high school student, it can be difficult to get an accurate picture of a degree program by reading brochures and websites. Can you describe briefly what the area of mathematics is all about?

There are many answers to what mathematics is all about. Some famous mathematicians have said mathematics is the queen of the sciences, or it is the study of patterns, or it is the one true universal language, or it is what mathematicians do, or it is the enabling science. There is truth in all these answers, but for me mathematics is about everything. I really mean this. I'm an Applied Mathematician. I respect that not everything is about mathematics. Suppose you think of something far removed from mathematics, like abstract art. OK, this is not about mathematics. On the other hand, if you think of the famous abstract art piece "Blue Poles" by Jackson Pollack then you can look at it in a new light using mathematics. You can measure multi-fractal textures in it and then maybe you can speculate if there is an optimal multi-fractal measurement that relates to the aesthetic quality of the art. Maybe not. But maybe the multi-fractal measurements that you develop can be applied to skin cancers and then it becomes a diagnostic tool. Maybe the multi-fractal textures can be related to other mathematics like wavelets, and maybe wavelets can be applied to abstract art.

What subjects should a high school student enjoy or excel in if they are considering studying mathematics?

They should enjoy mathematics and they should do well in it. But they should enjoy learning too. They should enjoy solving problems. They should enjoy the thought of developing super powers. There are many mathematical problems that cannot be solved at present without new super powers.

Can you briefly outline the structure of the Bachelor of Advanced Mathematics and what students experience as they progress?

Students start out in first year doing calculus and algebra, much like high school but much more intensively and at a much more rapid pace. In second year students start to learn about the core things in a university mathematics education, like vector analysis, complex analysis, stochastic processes, multivariable analysis and differential equations. In third year students start to take specialist courses like biomathematics or dynamical systems or optimization or functional analysis or topology or experimental design. At this stage, students are choosing their path to specialise in Applied Mathematics, Pure Mathematics or Statistics. In their honours year students take very specialised courses and they also work on a research program. This is where their true discovery really begins. Research is the frontier.

What are the key skills students can expect to graduate with when they complete the program and why are they so important/relevant?

Our graduates will have exceptional problem-solving skills. They will have the quantitative tools that are needed to provide reliable forecasts or to improve system behaviours or to deal with uncertainties. They will be able to use their mathematical skills to solve real world problems or to advance the knowledge of mathematics.

What types of career paths do graduates of mathematics take on when they graduate, and who might they work for?

There are not many positions that use "mathematician" as a position descriptor, but there are large numbers of positions advertised for mathematicians. If you visit the website of the Australian Mathematical Society you will see some of the positions currently available for mathematicians. So there are the obvious things like mathematics teachers, or lecturer in Applied Mathematics, lecturer in Pure Mathematics, and lecturer in Statistics. Then there are Postdoctoral Research Fellows in mathematics and Computational Scientists. But then there's also Calibration Technologist, Strategic Data Analyst, Quantitative Analyst or Credit Risk Analyst, Operations Modelling Analyst, Modelling and Simulation Analyst, Graduate Meteorologist, or Biostatistician...

What interests and excites you about mathematics and teaching mathematics?

Mathematics has a very special place in our universe. It is the unique self-consistent and logical formalism that we have to understand our universe. It is a God given gift in this sense. This is something that struck a chord with Galileo when he commented that philosophy is written in the book that is the universe, and we cannot understand it unless we understand the language that it is written in, which is mathematics. In a similar vein Einstein wondered how it could be that mathematics, being a product of human thought, could be so appropriate to describe reality. Put simply, how can it be possible that you can write down some equations and then solve the equations, and then use this to predict or improve behaviours in the universe? The equations are an abstraction. The solution is an abstraction of an abstraction. That this reveals truths about the universe is magical, miraculous. Moreover the truths hold true all over the world, all over the universe in fact. It's why all of us should be excited about mathematics.

Mathematics is a very old discipline. Is it possible to discover anything new in mathematics?

It is true that mathematics is a very old discipline. Thousand of years old in fact, dating back to the Egyptians using it for finance and building, and then the Ancient Greeks a little over two thousand years ago with their developments of geometry and their remarkable discovery of irrational numbers. But then we have the calculus from Newton and Leibniz which is only a little over three hundred years old, and less than fifty years old we have fractal geometry. In fact new mathematics is being discovered, or invented every day. There are classic problems that have not yet been solved, problems like Golbach's conjecture, posed in 1742, that every even integer greater than two can be expressed as the sum of two primes. And there are problems that have not yet even been posed. It is likely that some of these as yet unposed problems will have to be solved before Goldbach's conjecture can be solved. One of the great solved problems in my lifetime is Fermat's Last Theorem that $x^n+y^n=z^n$ has no positive integer solutions x,y,z if n is a positive integer greater than two. This problem was posed in 1637 but it was only solved in 1995. The mathematics that was used in the solution did not exist when the problem was posed. There are many Applied Mathematics problems too that will drive the invention or discovery of new mathematics. One of the problems that I am interested in is the electro-diffusion of ions in nerve cells in the brain. Nerve cells have little spines along them that trap the ions and release them, and this affects the diffusion so that the standard equations of electro-diffusion don't apply. We have derived new equations that use fractional derivatives. There is a lot of new mathematics to be developed before we will be able to determine how the spines affect the cognitive functioning of the nerve cells.

What is special about the Advanced Mathematics program at UNSW?

The Advanced Mathematics degree is our premier offering. It is for elite students who are really capable of developing new mathematics or using mathematics to solve important real world problems. We aim to provide students in this degree with the best possible training in modern mathematics. Students in this program will do higher level courses than students in standard programs. They will receive mentoring, teaching and supervision from our leading researchers in the School.