

# Seeing the bigger picture: my journey to unlock the beauty of maths

by Tristan Pang

I have loved exploring all sort of things from a very young age. Of these, there is one thing that is quite unusual... at least for a young child. That is maths.

Many people think maths is 'unusual' due to the misconceptions surrounding it. I have delivered talks, workshops and also tutoring sessions to many primary and high school students from different schools and organisations. Students are often very honest with me as I am their age, so are not afraid I will tell them off. When I ask them their opinion of maths, the majority of students say they dislike it. They think that maths is boring, confusing, difficult and useless. But when talking about their dream jobs, many of them want to work in the fields of computer science, astronomy or medicine. It seems they are not aware that maths is the study route they need to follow to fulfill their dreams.

This aversion to maths may be one of the reasons why New Zealand has a very disappointing maths ranking in the Programme for International Student Assessment (PISA1). Our maths level is barely above the average of seventy OECD countries.

Why are there negative feelings about maths? Why is it hard for New Zealand students to catch up with the maths curriculum?

## IS MATHS BORING?

Students feel that maths is boring because they do not have anyone to inspire them, whether this is teachers, parents, peers or textbooks.

Most schools teach students how to solve a problem. This can be boring to students as they do not know why they have to do this, what it can lead them to and what they can gain from solving it.

In my opinion, maths is one of the most interesting subjects there is. Unfortunately, many students have been put off before they get to the fun part of maths. Most of the 'maths' that is taught in schools is in fact arithmetic (one of the foundation parts of maths). If students could explore maths naturally, they may be more likely to keep going and finally reach the 'playground' of maths.

## IS MATHS CONFUSING?

Some teachers and parents dislike maths or find it confusing and hard. They pass on this perception to young people which can be

extremely harmful. One example I have encountered involves my year 8 friend. He used to love maths when he was at my former school. After a month at his new school, he asked for my help.

Boy: I find the maths here really confusing. I'm starting to hate it.

Me: Why?

Boy: I'm so muddled. We are learning BEDMAS (order of operations) at school. I thought something was wrong when my teacher said we should go in the order of whatever comes first.

Me: It doesn't really matter which comes first as long as you follow the order of BEDMAS.

Boy: What is the answer of  $36 - 6 + 2 \times 3$  then?

Me: It's 36.

Boy: Yes, my teacher said the model answer is 36 but if we are not doing it from left to right, we will get 24. She said maths is sometimes confusing and asked us just to memorise this rule – to do it from left to right, otherwise we cannot get to the model answer.

Me: OMG!

I spent the next hour correcting the teacher's 'rule' and reminded my friend he could do the calculation in whatever order, but needed first to treat the '+' or '-' signs preceding as part of the number. And to go in the order of BEDMAS where applicable.

There are in fact many different ways to arrive at the same answer. There are also different approaches to explain the same question. I believe that maths is an art and we should let our imagination flow to ensure we can create beautiful pieces of art.

I have never really needed to memorise anything for maths. Once I see the full picture and understand the concept, I can just work problems out and apply them. I am particularly passionate about proofs (which most students hate!) By proving the equations, I can fully understand the problems. It's as if when I am solving these problems, I am the narrator telling a happy story to the audience. I present foolproof and solid content in a logical and appealing way to engage them. It is an enjoyable experience.

Maths should be like this for everyone – fun and logical. Unfortunately, our present system is destroying students' natural curiosity



and love of pattern-making. Students should engage in exploration and not just stick to the textbooks.

Some countries engage in the Math Circle, providing young people with a place to develop their problem-solving skills. It is driven only by the enjoyment of investigation and discovery. I would love to see the Math Circle happen here in New Zealand.

Similar mistakes are not only made by teachers and students... I surveyed 103 adults last year of whom only 10% achieved the correct answer to the question below; 4. Most answered 36 or 1.

The question is  $12 \div 2(6 - 7 + 4) \times 2$ .

Again, they had ignored the  $\div$  sign in front of  $2(6 - 7 + 4)$  and did not treat  $\times 2$  as a separate function.

I explained to this group why they have to see each item as a function:

$$12 \div 2(6 - 7 + 4) \times 2$$

$$\text{let } x = (6 - 7 + 4) = 3, g(x) = 2x,$$

$$h(x) = 12/x, j(x) = 2x,$$

then the original question is

$$= j(h(g(3)))$$

$$= j(h(2(3)))$$

$$= j(h(2(3)))$$

$$= j(h(6))$$

$$= j(12/6)$$

$$= j(2)$$

$$= 2(2)$$

$$= 4$$

### IS MATHS DIFFICULT?

Yes, in a sense it can be difficult.

However, people like me who have a passion for maths find it challenging rather than difficult. There are always solutions to the problems, at least up to the undergraduate level. Of course, there are lots of long-unsolved problems for experts to deal with. But the problems students face are manageable.

Unfortunately, students at junior level find it difficult because they don't see the full picture. They may ask *why* they have to study decimals, or prime numbers, or probability. Senior students may find the topics too abstract. They wonder why they have to learn matrices or the rules of trigonometry, and so on. Even some teachers don't know the reasons for and the application of these topics.

I don't find maths difficult because I didn't learn it at school. I explored maths myself out of curiosity. I could see 'maths' everywhere from a very young age. It probably began with my mother. When I was a baby, she carried me up and down the stairs many times every day before I could walk. She would entertain herself by counting aloud each of her steps '1, 2, 3...13', and did this for months.

She didn't realise the numbers she counted repeatedly were having an effect. I started to understand everything is countable. Counting is actually a pattern.

In fact, everything has a pattern. I was fascinated by the 'imaginative' patterns around me. When I looked at a cloud, I imagined it as an oval. I then imagined a triangle inside the oval, and then a square inside the triangle, then a hexagon... and so on, until I'd run out of ideas.

Another benefit from this counting was that I could count to any number, as I learned that there are only ten digits. I can still remember another mother at playgroup screaming 'Tristan can count! when I counted the pieces of coal that Thomas the Tank Engine was carrying before I was two.

Without knowing what was 'normal' for a toddler, my mother agreed that I could count 'probably to hundreds or thousands? I really don't know his limit.' The woman almost fainted. Luckily my mother didn't add that I was already doing Sudoku and algebra, or we might have had to call an ambulance.

Learning maths is easier if students can explore it for themselves before having a proper lesson. Exploration can also help students to discover their passion. Here's an example... I started learning piano when I was five. Although I received good results in the exams, honestly speaking, I didn't enjoy it.

I had to follow instructions on how to sit, how to position my hands on the piano, and how to follow the music notes exactly. I barely practised as I found it repetitive. I thought music should be creative but it never felt that way. I quit when I was eleven.

Later, I was given an electric keyboard. This time, I had no teacher and no music books. I now play freely, and surprisingly, I'm hooked on it. I play songs my way and I create music. After playing music for six years, I can finally feel the sense of being in the moment when playing an instrument.

This feeling is just like exploring maths or some other topic on my own; I am immersed in inspiration and I forget my own existence. Is this the right way to learn? I suppose so. What motivates people to be persistent in their tasks? I believe it is the passion discovered through natural curiosity or nurtured through early enjoyable experiences.

'Free learning' of maths could be far more effective in unlocking someone's full potential. Removing the academic pressure (fear) can help people become more interested in maths for its own sake. I received a very touching email:

I saw you on television tonight and, being an adult with a fear of maths, was very curious as to how a smart boy like you went about learning and teaching yourself and others how to understand maths.

I went to your website and have just finished Geometry lesson 1, and I so enjoyed it, I thought I would let you know.

I am going to go through every lesson until I understand because, despite my fear of maths, I believe I can do it and with a boy like you helping people like me, I'm sure it will be a breeze!

Once again thank you Tristan for your help and allowing me to think perhaps I could learn the mysteries of mathematics and find there may not be any mystery after all, just hard work. I will keep you posted as to my progress or if I come across any difficulties.

I feel very proud if I'm able to pick up maths from a boy, at my age. Your parents must be very proud of you. :)

### IS MATHS USELESS?

Unlike other languages, the language of maths is universal. There are more than 6,500 languages in the world but there is only one maths. Proficiency in this language can help us make important decisions and perform everyday tasks.

Maths can help us with anything, from shopping wisely to keeping a budget, to predicting events and creating art and design. It is always around us, although we might not notice it.

Plant growth can be mapped using maths, our laptop uses maths to code, and we are even made of maths. The functions of our bodies revolve around many equations which tell them how to operate, when to breathe, when to eat, when to sleep, how we see, how we think and how we feel.

All occupations use maths as well. Neuroscientists map out the brain and its functions with maths; accountants analyse financial records with maths; artists use proportions to make their work pleasing with maths.

Maths is with us. Maths is around us. Maths is in us.

There are many different types of equations. Some are hard and some are easy but they all involve maths. I would like to share with you some of my favourite equations. I am taking a risk here. Stephen Hawking's publishers once told him that every equation he chose to publish would halve the sales of his book. He ignored it. I agree that equations are too important to be hidden away. (I hope it will not affect the readership of *Tall Poppies!*)

At school, we are told that we cannot take the square root of negative numbers. But in reality, we need this group of numbers for calculations. These are called imaginary numbers 'i'.

$$\sqrt{-1} = i \text{ or } i^2 = -1$$

We use this relationship to analyse complex numbers. It is the foundation of quantum mechanics and is one of the key methods to understand electricity, waves, heat and magnetism.

Another of my favourite equations is the famous equation of Albert Einstein:

$$E=MC^2$$

This explains the relationship between E, the energy of a body, and M, the mass of a body. C is the speed of light. It shows that mass and energy are very closely related. This is used for many things, including predicting what happens to a black hole, predicting the reaction of particles when they collide, or how to make nuclear bombs.

Albert Einstein once wondered:

How is it possible that mathematics, a product of human thought that is independent of experience, fits so excellently the objects of physical reality?

Isn't maths amazing? Last but not least...

Maths is one of the most beautiful things in our universe. The relationships and its processes are just like a work of art. Maths is poetry, pictures and stories. Mathematician and philosopher Bertrand Russell described his sense of mathematical beauty as follows:

Mathematics, rightly viewed, possesses not only truth, but supreme beauty – a beauty cold and austere, like that of sculpture, without appeal to any part of our weaker nature, without the gorgeous trappings of painting or music, yet sublimely pure, and capable of a stern perfection such as only the greatest art can show. The true spirit of delight, the exaltation, the sense of being more than Man, which is the touchstone of the highest excellence, is to be found in mathematics as surely as poetry.

I believe maths shouldn't be taught as an empty shell. If it could be explored naturally, and not presented as a bunch of meaningless numbers and symbols, perhaps every student could see the beauty of maths as we do.

When it comes to maths, I am still a beginner. There is so much more to discover. I am grateful to have people who believe in me; mathematician Professor Eamonn O'Brien, scientist Dr Cather Simpson, and NZAGC president Mr Andrew Patterson... they are my inspiration. I will continue to enjoy my quest for knowledge and understanding of maths and science.

Tristan's maths journey started early. His passion led him to self-learn and complete the Cambridge A' level (year 13) maths exams when he was 11 years old, and obtain the highest grade of A\*. At age 12 he went on to study maths at the University of Auckland. There he achieved the top grade of A+ in his papers. Tristan fulfilled all the UE requirements at age 13 and gained full admission as a BSc student, where he is currently studying maths and physics.

For more on Tristan, please visit: [www.quest-is-fun.org.nz/my-interviews-and-speeches](http://www.quest-is-fun.org.nz/my-interviews-and-speeches)