Learning Mathematics

Mathematics is an abstract subject, but at the same time, one of the most practical subjects taught in schools today. Every student studies mathematics to some level; it is a survival skill, like reading.

If you can't read, you are disempowered in today's society. Also, without a good understanding of basic mathematics you cannot manage or protect your financial interests. These are the two essential skills every student needs to learn during their school career. Unfortunately many students leave school after 11 or more years, sadly lacking in both areas.

For a discussion of the strategies that Master Coaching uses to ensure students success in mathematics studies, see **Mathematics Help**. In this article we look beyond that, to the logic of learning mathematics.

Once the most important part of mathematics was being numerate, able to do simple calculations such as multiplication, division, and having a working knowledge of decimals, fractions and percentages. The introduction of the calculator completely changed this. Now calculators are so common most mobile phones have a simple scientific calculator.

The problem with reliance on calculators is many people today have little or no number concept. They can be over-charged massively without even realising it. Prior to calculators most people had a feel for numbers and were more easily able to recognise when numbers quoted were inflated or wrong.

The shift in mathematics has been away from a thorough understanding of, and skill level in calculation to other branches of the subject.

After calculation, the next feature of mathematics is the expounding of logic, ie looking at logic of a formula or equation such as $A + B = C$ or using logic to show that: **If $A = B$ and $B = C$ then $A = C$.**

This is called transitive logic. Genuine mathematicians enjoy the challenge of finding such relationships and the really gifted mathematicians have the wonderful ability to see relationships where other mortals continue to over look or ignore.

For example, consider the following that I have many times used with gifted students. First give the student the following two pieces of information which he/she is very familiar with

$$A + A = 2 \times A \text{ (or just 2A)}$$

$$2^x \times 2^y = 2^{x+y}$$

Then ask the students to simplify

$$2^x + 2^x$$

Very few students see the connection, which leads to the answer as set out in full here

$$\begin{aligned} 2^x + 2^x &= 2 \times 2^x \\ &= 2^1 \times 2^x \\ &= 2^{x+1} \end{aligned}$$

Still, even fewer students can recognise the reversal of this logic

$$2^{x+1} - 2^x = 2^x$$

These three examples encapsulate the true meaning of mathematics, the ability to apply logic and to find relationships. Learning mathematics requires the patience to test relationships, to write possibilities and to look at the results.

The best way to learn mathematics is to be continually writing. The same applies in a mathematics examination: let your pen do your thinking, don't just stare at the question.

At Master Coaching we coach the students to think and explore in their problem solving. As well, we have a number of unique ways to solve questions that eradicate some of the mathematical language that stands between the student and understanding.

Consider Pythagoras' Theorem. Most students know that

$$a^2 + b^2 = c^2$$

but very few students know that ab is divisible by 12 and that abc is divisible by 60 (only IF a, b, and c are integers).

You can check by considering some of the more well known Pythagorean

Triads such as 3,4,5, 5,12,13, 8,15,17, 7 24, 25, 20,21,29,33,56,65 etc. The proof of this is fairly difficult in our base ten number system, but if we use a base three number system, then every square number ends in a 0 or 1.

Consider the table of all four outcomes for a,b,c. The possible last digit in base 3 for each number is given in the following table:-

Outcome Number	a^2	b^2	$c^2 = a^2 + b^2$	Result
i	1	0	1	Means that b is divisible by 3
ii	0	1	1	Means that a is divisible by 3
iii	1	1	2	Impossible outcome, c^2 cannot end in 2
iv	0	0	0	Means all sides divisible by 3

To prove that ab is divisible by four you just have to use the same table because, in base 4, every square number also ends in a 1 or 0.

The preceding pages have shown some of the relationships that mathematicians have discovered over time. The exciting thing is that there are still an unlimited number of discoveries in mathematics just waiting for that spark of genius to reveal.

Students who study mathematics are well advised to make a short study of the history of some of the most famous mathematicians as it makes fascinating reading, and can only inspire you to greater results.

You can find information on famous mathematicians at **http://www-history.mcs.st-andrews.ac.uk/~history/BiogIndex.html**