

How to learn maths

The big picture

Learning to drive

No one would claim to know how to drive just by watching other people drive. Likewise, you cannot learn maths just by watching others. Get some instruction and then get your hands dirty!

Most of the time you spent learning to drive you were behind the wheel, yet often students feel more comfortable letting the lecturer or tutor do the maths. You need to take the wheel and rack up the hours!

You cannot learn to drive overnight, so do not try to learn maths in one night either. Learning to do anything new will take time and regular effort.

Working out

If you join a gym, they should show you around the place and show you how to do some basic exercises. You would not expect them to do your workout for you while you watch each week! You get some instruction and then you get into it. This is what you need to do with maths. Too often students spend less time actually doing maths than watching maths. If you want to learn, maths you need to **do the work yourself**.

Be proud of yourself

"If it were easy, everyone would be doing it"

Feel good about learning something new.

Talk to people

You do not have to embark on this journey alone! Despite what you might think, many of your peers are similar to you. You will be at university for a considerable time, you may as well make friends while you are here. Friends who you can study with? Even better.

SURROUND YOURSELF WITH



THOSE ON THE SAME MISSION AS YOU

During lectures or while reading notes

Reading examples

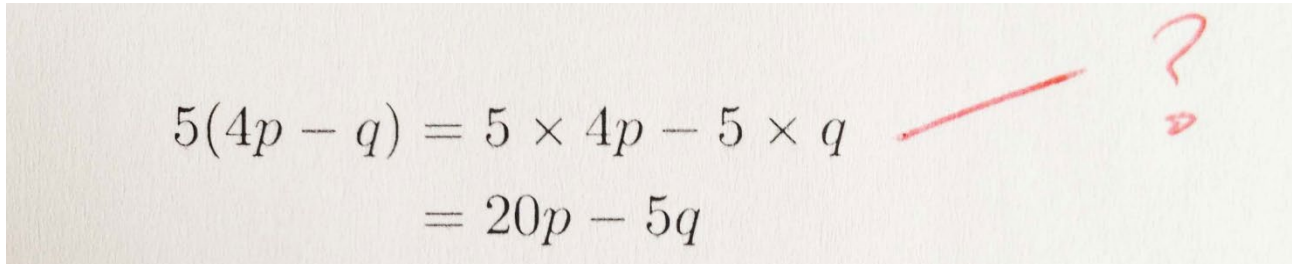
It is really easy to skim maths, fall asleep and learn nothing. Do not do that. When you are looking at an example, you need to actively determine what has been done at every step. You should also be asking yourself things like, 'why did they do that?' or 'what just happened?' The answer to these questions might not be clear until you get to the end of the example so at this point, go back to the beginning and follow what they did again, this time with more insight into what is happening and why.

Reading what is written alone will not help you learn what is happening. You should be thinking things like 'ok, so that does that and then this happens and that is what we get ...' even thinking things like 'what the hell is going on?' is more useful than reading the symbols without thinking*.

Now the real test! **Once you understand the example, attempt to do the question without looking at the working provided.** You might not do this for every example, but it is an important stepping stone for those who can follow the examples but cannot seem to do the exercises.

Annotate and act on it

Write notes to yourself in your lecture notes, for example, a simple question mark can signify to your future self that this is something you need to look at again.



A photograph of a piece of paper with handwritten algebraic expansion. The text reads:
$$5(4p - q) = 5 \times 4p - 5 \times q$$
$$= 20p - 5q$$
 To the right of the equations, there is a red horizontal line and a red question mark.

Deal with these question marks before the next lecture. Ask your lecturer, tutor, classmate, Google, anyone! The more question marks you have clouding your understanding the harder it is to make sense of the next lecture or participate in the tutorial.

When I was lecturing I actually enjoyed getting emails from students asking how to do certain questions they could not do. So do not think you will be bothering them; what bothers lecturers is when students cannot be bothered seeking out help.

* Because then you can annotate it and act on it, but also because stressing the brain helps it grow (more on this later).

Doing the exercises

Never miss leg day

Just like working out, you need to do the work yourself, but you need to do it in a balanced way.



Often you will be given more questions than you could imagine doing, so it is important that you do not get left behind while trying to do every question. **Do a selection of every type of question.** Most of the questions are repetitive in order to solidify the skill.

- Write each using a square root sign (i.e. as a surd).
(a) $5^{\frac{1}{2}}$ (b) $10^{\frac{1}{2}}$ (c) $2^{\frac{1}{2}}$ (d) $3 \times 2^{\frac{1}{2}}$
- Use a fractional index to write:
(a) $\sqrt{3}$ (b) $3\sqrt{2}$ (c) $\sqrt[3]{11}$ (d) $\sqrt[3]{4}$
- Find the value of the following.
(a) $4^{\frac{1}{2}}$ (b) $49^{\frac{1}{2}}$ (c) $8^{\frac{1}{3}}$ (d) $16^{\frac{1}{4}}$
(e) $16^{\frac{1}{2}}$ (f) $100^{\frac{1}{2}}$ (g) $144^{\frac{1}{2}}$ (h) $1^{\frac{1}{2}}$
(i) $121^{\frac{1}{2}}$ (j) $32^{\frac{1}{5}}$ (k) $81^{\frac{1}{2}}$ (l) $81^{\frac{1}{4}}$

For example, in question 1 and 2 you might do (a), (b) and (d). Then in question 3 you might do every second question or every third question, or you might do the first two questions, then the middle two questions and then the last two questions. Once you have done this sampling, check if it was a good sample. Did you miss a certain type of question? If so, choose some of them to do.

What to do when you get a question wrong

1. Look over your own working to try and find any mistakes
2. Try the question again without looking at your old working
3. Look back at examples and follow their working through, then compare it to your working
4. Try a different method and see how it differs
5. Try an easier question
6. Work backwards from an answer
7. Make a note of it and act on it by asking for help
8. Remember everyone (even your lecturer) will make mistakes

Pace yourself

Do not try to fit all your maths into one day. Just like most things, spreading it out over many days is much better because you will become more efficient each time you sit down to do some work. Schedule time on your timetable for maths so you get a chance to reinforce everything that you see in the lectures and to do enough exercises to be well practised. Take regular five-minute breaks; it will help you stay focused on the task at hand. Avoid using the internet or TV during these breaks, otherwise, your break will end up being longer than your study time. Remember, **spaced learning commits the material to memory better than cramming.**

Be organised

- Write the week and the day at the top of your lecture notes.
- Label the exercises you are doing so at a later date you can still find where they came from.
- Keep everything collected and organised so you do not have a bunch of loose pieces of paper floating around!
- Buy a stapler and use it when you print notes and hand in assignments (tutors hate plastic sleeves).
- Use a diary or an online calendar and keep track of quiz dates.

After lectures or quizzes

Reflect on what you have learnt

Think about what you have learnt, as this will reinforce it into your memory. While you are doing this, you might actually find you still do not understand something, if so write yourself a note and act on it.

You might find giving a verbal explanation to another person (or yourself) each week will force you to articulate what you have learnt. Some people like to **write a summary each week.**

Doing this will really help at the end of the semester when you are looking for a summary to look over.

Learn from your mistakes

If you get distracted while driving and nearly run up the back of someone, I would hope you would learn from your mistakes and not repeat the same behaviour later on. Quizzes are often in courses so you can learn from your mistakes and not repeat them in the larger exams. If you are not going over your past quizzes you are missing out on learning opportunities. **Review your quizzes** when you get them back, do not just read them, reattempt them, and do this again when preparing for exams.

If your tutor has written a comment on your quiz and you cannot understand it, then you should ask! You cannot learn from a mistake if you do not know what it was.

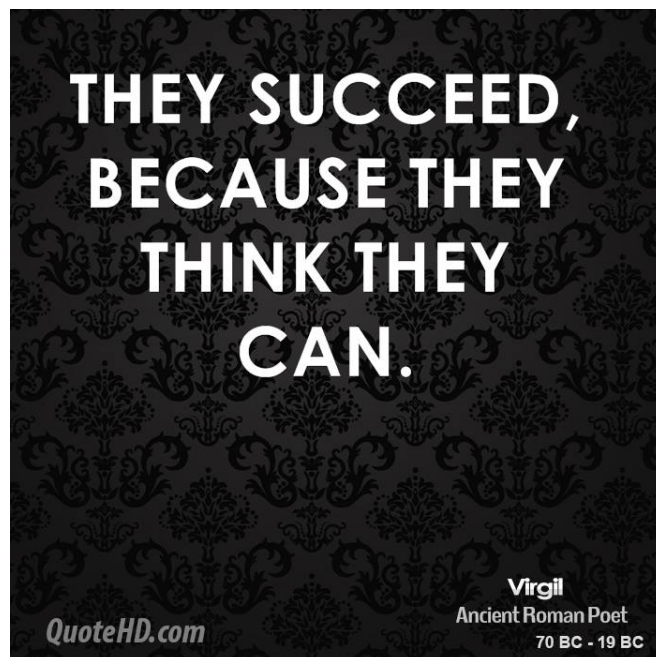
The maths brain/person myth

Who would agree with the statement, 'Maths ability is a genetic thing. Some people have it and some people do not'?

How many times have you heard someone say, 'I do not have a maths brain'?

Maths ability is inbuilt in everyone! Everyone can achieve high levels in maths. The idea that maths is not for everyone is an unfortunate myth that has been spread from teacher to student and parent to child for generations.

The way you think about learning maths has a massive effect on how much maths you learn. There are two mindsets when it comes to learning, the *growth mindset* and the *fixed mindset*. People with a growth mindset believe that the harder you work the smarter you will get, whereas people with a fixed mindset believe that you are either smart or you are not. If you think about it, it is not surprising that people with a growth mindset are less likely to give up and are more likely to achieve in mathematics than their fixed mindset peers.



No matter how good someone is at maths, they still struggle, **the struggle is where the learning happens**. Often when those with a fixed mindset start to struggle, they see evidence

that they are not smart, they quickly decide maths isn't 'for them' and then use this as an excuse to stop. On the other hand, when those with a growth mindset start to struggle, they see a challenge and an opportunity to learn, they are less likely to feel bad about themselves and therefore are more likely to continue trying (and learning).



http://assets.fafmag.com/wp-content/uploads/2014/10/challenge-you-_quote2.jpg

Muscle growth is all about adaptation. Once your muscles can lift a certain weight comfortably, lifting this weight repeatedly will do nothing for your muscle growth. To increase strength you need to stress your muscles and force them to adapt to the heavier load or stress. The same is true in mathematics. People that get every question right are not challenging their brain, they are not actually learning! You have to keep challenging yourself with harder work. Forcing your brain to adapt is how you learn and 'grow your brain'.

If you are interested in further reading here are some places to look:

1. <https://goo.gl/KHJi31>
2. <http://goo.gl/2knBW4>