Studying Mathematics - 12 Months Until the HSC

- The Important Qualities of a Memory
- The Importance of Forgetting and Relearning
- Before they Start Studying
- Maths Study
- In Conclusion
- Extra - Tips for Memorising Formula (if we get time)

Studying Mathematics - 12 Months Until the HSC

Welcome to everyone who is here live or watching a recording some time in the future.

For those watching a recording of this webinar, it is being held the afternoon before most of the 2022 Mathematics HSCs, with the exception of the Extension 1 paper which is held next week.

Studying Mathematics - 12 Months Until the HSC

About me:

- Maths teacher at Cowra HS in country NSW for 29 years.
- Maths Study Days in the Central West
- Online professional development for Advanced, Extension 1 and Extension 2 through TTA.
- Online courses for Extension 2 students.
- Extension 2 textbook writer
- Extension 2 HSC marker

Studying Mathematics - 12 Months Until the HSC

This webinar is largely based on the first session of a free Study Day that Helen Vere from Parkes HS and I used to run for students around the Central West.

It has been on hold for the last few years because of COVID, but we are looking at getting it up and running again next year. More information will be emailed out when we sort out details, but we may also run an online version.

Studying Mathematics - 12 Months Until the HSC

The aim of this webinar is to:

- Create a framework of understanding you can use to teach your students how to study maths
- Provide a wide range of ideas about the brain, memories and study - take 10 or 20 of them and add them to what already works for you.

Every teacher and every class are different, so you will need to adapt the ideas presented here to suit your needs.

Studying Mathematics - 12 Months Until the HSC

Before we start, it helps to focus on how **studying maths can be different** to studying other subjects.

- There is **more content** in Maths courses that has to be remembered.
  - Think of how thick Maths textbooks are compared to textbooks in other subjects.
- This content is **a mix of facts and skills** in how to use those facts.

Studying Mathematics - 12 Months Until the HSC

- Studying Maths is all about **creating high quality memories** for each of the many facts and skills they need to know. This is the main focus of this webinar.
- **Exam technique** is more important in maths and also needs to be practised during their study. It is another set of high quality memories to create. This will be the main focus of the next webinar.

I've just been fired from the clock making factory after all those extra hours I put in.

The Important Qualities of a Memory

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Bjork Learning and Forgetting Lab at UCLA

https://bjorklab.psych.ucla.edu/research/

The Important Qualities of a Memory

Our brains are much better at ignoring or ‘forgetting’ information than they are at retaining it – this avoids us being overwhelmed by memories at every waking hour.

Studying is the art of tricking our brains

into remembering the information we want to retain,

and into remembering how to use it

The Important Qualities of a Memory

When we ‘forget’ a memory what happens for most of us is that the **brain cannot retrieve** it - the memory is still in our subconscious but our conscious mind cannot access it.

This is actually a good thing overall - people who cannot ‘forget’ their memories are often overwhelmed in everyday life as they cannot shut the memories off.

We study to try and choose the memories to access freely.

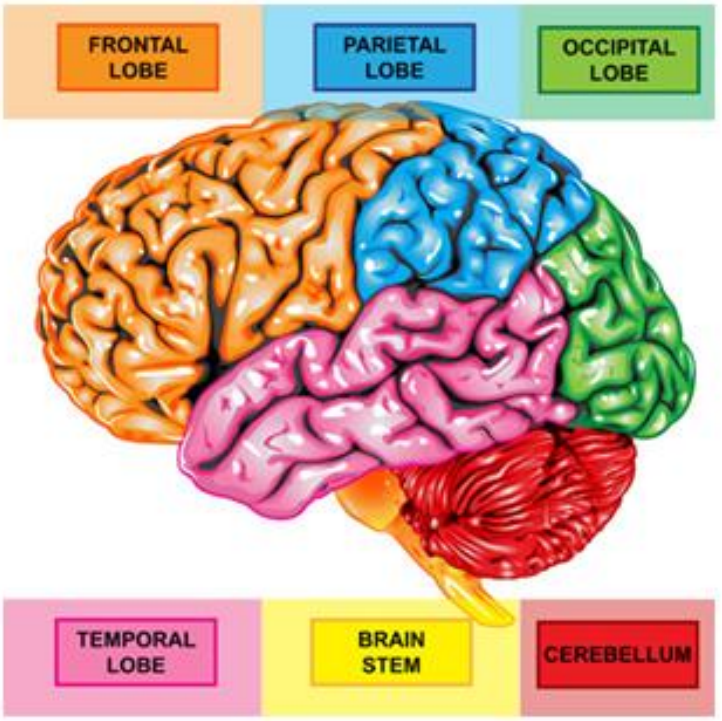
The Important Qualities of a Memory

Think about the **next new concept** you will teach Year 11, tomorrow or later in the week. Twelve months from tomorrow they need to use it in their HSC.

- What has to happen **in their brains** for them to be able to answer a question on the concept next year?
- What **sort of memories** do they need to create?

The Important Qualities of a Memory

We need to remember facts and remember what to do with those facts.



Frontal Lobe- abstract thinking/sustained attention **(problem solving)**

Parietal Lobe- reading, writing and math calculations **(Visual Spatial)**

Occipital Lobe-Vision, recognition of letters/numbers (tracking)

Temporal Lobe-
Memory/Language/music **(communication)**

Brain Stem -all info to and from brain **(vulnerable to damage)**

Cerebellum-Movement Communication **(speech)**

https://thiskelly.edublogs.org/2016/01/23/how-is-learning-math-different/

The Important Qualities of a Memory

The qualities of the memories that we are interested in are:

1. How easily can the memories be **accessed** during the exam?
2. How **persistent** are the memories?
3. How well **connected** are they to other memories?
4. Have the memories been used so often that they have achieved **automaticity**?

The Important Qualities of a Memory

We often see problems in exams that match those four points:

1. Students **couldn’t recall** what to do during the exam even though they had done it many times.
2. They have relearned a concept but have **forgotten it already**.
3. They were asked to use the memory in an **unusual context** and couldn’t connect to other memories.
4. They had to **think deeply about basic concepts**, which took up time and energy. They didn’t finish the exam, spent the last hour exhausted and made many simple mistakes.

The Important Qualities of a Memory

Some terminology we will use in the webinar:

- The **Retrieval strength** of a memory is how easily it can *currently* be accessed.
- The **Storage strength** of a memory is:
  - How persistent is it (how quickly or slowly is it forgotten)?
  - How easy is it to relearn the concept once it is forgotten?
  - How many other memories is it linked with?
- **Automaticity** occurs when we find an answer without conscious thought.

The Important Qualities of a Memory

What is the difference between retrieval strength and storage strength?

Let’s try an experiment. Look at the number:

513729

Don’t write it down or try any memory tricks.

The Important Qualities of a Memory

We could probably accurately recall it for the next few seconds or minutes as its **retrieval strength** is initially high.

It is a very shallow memory as it doesn’t have any importance, and so it wouldn’t persist very long. Its **storage strength** is low.

The Important Qualities of a Memory

But what does a **low storage strength** actually mean?

1. Your **recall of the number will degrade quickly**. You might be able to remember it fairly well in an hour, maybe with digits incorrect. As time goes on you might only remember that it was in the 500 000's, then later did it have five digits or six?
2. If you have to **relearn it** you will take **slightly less time** than first learning it, but won't be as quick if the storage strength is higher.
3. It is **not linked** to any other memories.

The Important Qualities of a Memory

OK - what was the number again?

If you want write as much of it as you can remember in the **chat pod** if you are live, or on a **scrap of paper** if you are watching the recording, or just **think it through** privately.

I will ask again at the end - hide the number if you wrote it down, as we want to see how the memory degrades.

The Important Qualities of a Memory

Automaticity

A specific type of memory that is very important in studying maths is automaticity.

Students often try to avoid doing the same thing over and over again in their study, but it is crucially important. **Repetition plays a major role for improving the basic skills** in every endeavour in life, and mathematics is no different.

The Important Qualities of a Memory

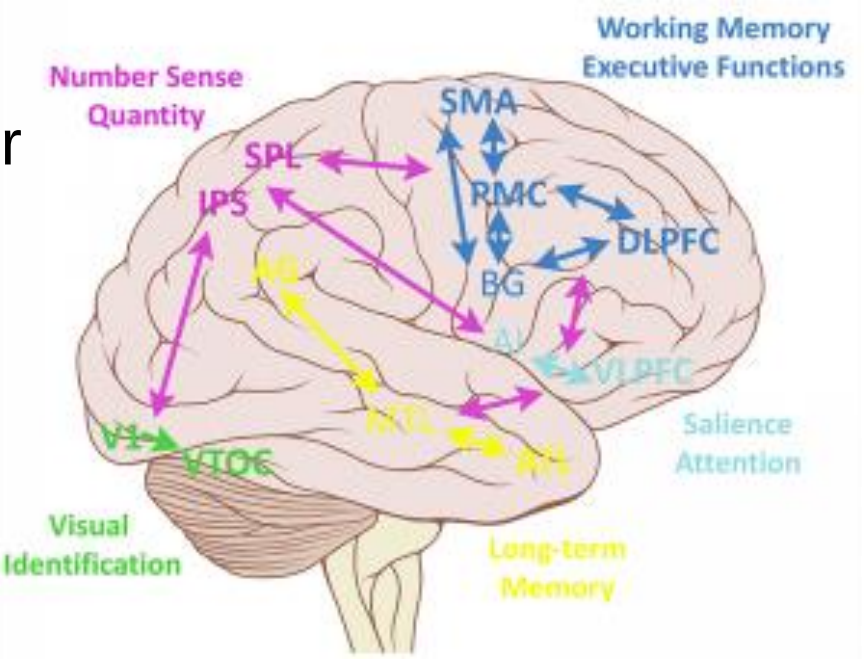
Imagine trying to play the piano well without have played scales repetitively over many years, or playing soccer well without having repetitively bounced a ball on your feet or your head!

Repetition in Mathematics lets our brains achieve **automaticity**.

What is automaticity? It is the rewiring of our brains to create a shortcut for very frequently used information.

The Important Qualities of a Memory

- Without automaticity the brain has to perform a massive number of processes (as shown).



https://dyscalculia-blog.com/2016/09/27/dyscalculia-brain/

- With automaticity we can reduce the number of processes within the brain significantly.

The Important Qualities of a Memory

So once students have achieved automaticity for a fact or skill:

- They find answers much more quickly
- Use less energy (blood sugar)
- Have time to complete the exam
- Make less mistakes, particularly at the end of the exam.

Students should **put aside regular time in their study to focus on achieving automaticity** for as many facts and skills as possible.

The Important Qualities of a Memory

Example Consider the question $2 + 3 = ?$

- Our brains have done this so often that we **know at a glance** that the answer is 5.
- The answer came to us instantly with **no conscious thought or effort** - like a reflex.
- We have achieved **automaticity** for this basic mathematical fact.
- We want students to be able to **extend this** to as much of their mathematics as possible.

The Important Qualities of a Memory

Now consider the similar question $2 + 3 + 4 = ?$

- This time conscious thought and effort are needed, as it is not a fact most of us know automatically.
  - We first work out that we need to find $2 + 3$.
  - Then we find that automatically as 5.
  - Then we work out that we need to add $5 + 4$
  - Then find that automatically as 9.
- The question took far longer and used more energy.
- There were four steps instead of one.

The Important Qualities of a Memory

What happened in our brains for the two different questions?

- When we saw ‘ $2 + 3 + 4 = ?$ ’, our brain didn’t know automatically what to do. Different parts of the brain had to keep talking to other parts of the brain to find information or provided that information. Each request passed through the brain’s CPU, as there is no link direct between the two parts of the brain.
- This is a slow process as there is often a traffic jam at the CPU.
- We used up more blood sugar and at the end of a long exam would feel fatigued.

The Important Qualities of a Memory

- When we saw ‘$2 + 3 = ?$’, our brain knew automatically what to do - there was no delay waiting for the information.
- Over time we have seen this question so often that the brain has been rewired - instead of two or more parts of the brain having to communicate via the brain’s CPU to answer a question, a direct connection is made between those parts of the brain. This avoids the logjam that often occurs at the CPU.
- We also used up much less blood sugar and at the end of a long exam would be feeling less fatigued.

The Important Qualities of a Memory

As part of their study students need to put time aside to achieve automaticity with as many mathematical skills and concepts as possible.

- This will **increase the speed** at which they can answer questions, and **reduce the load on their working memory** so that they can then work with less mental strain and be able to work on more difficult questions.
- They will use up less blood sugar so will be **fresher for the last hour of the exam**.

The Important Qualities of a Memory

Summary

Over the next twelve months current Year 11 students want to develop memories of everything in the course which have:

- High retrieval strength (easily accessed in the exam)
- High storage strength (persistent and interconnected)

They also want to have achieved automaticity for as many concepts and facts as possible.

The Importance of Forgetting and Relearning

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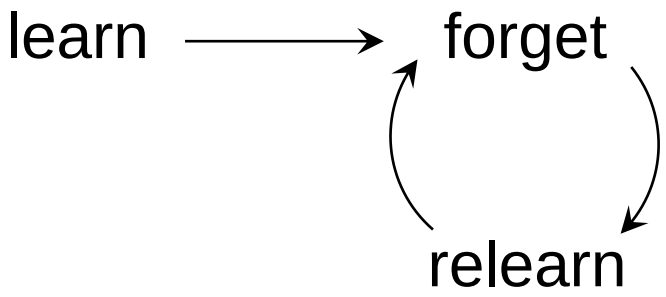
The Importance of Forgetting and Relearning

We now come to a counterintuitive concept:

Forgetting is essential for creating high quality memories

After we first learn a concept we need to go through at least three cycles of forgetting then relearning to make memories that are easily accessible, persistent and well linked.



The Importance of Forgetting and Relearning

We have to largely forget the first memory to trigger the cycle, but then each time the cycle is repeated:

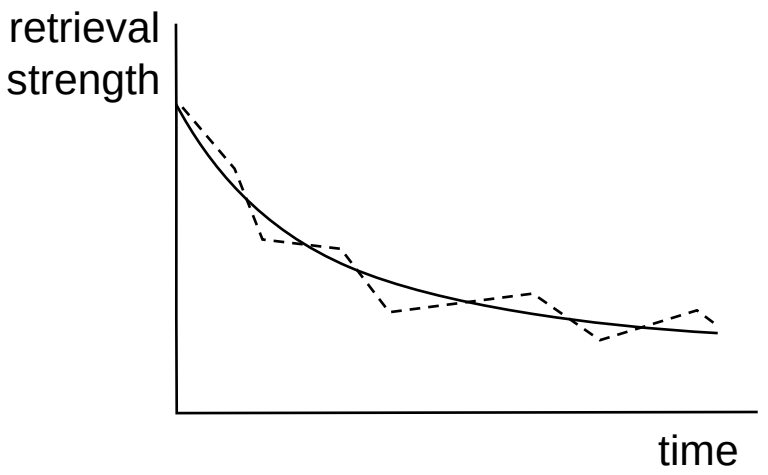
- It takes **less time to relearn** the concept each time.
- We create a **compound memory** that connects with other memories
- It takes **longer to forget** it than it did on the previous cycle - the retrieval strength stays high for longer.

Let’s take a closer look at forgetting.

The Importance of Forgetting and Relearning

The Forgetting Curve

When we first learn something new its **retrieval strength drops quickly** then starts to plateau out, as shown in the forgetting curve. It varies but the overall trend is exponential.



A new memory is generally not persistent and isn't linked to other memories - it has a **low storage strength**.

The Importance of Forgetting and Relearning

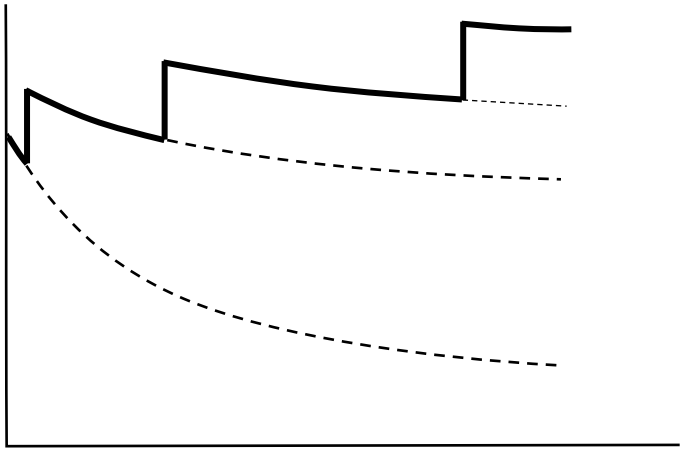
This is what happens in students brains if they don’t revise - the memory is **still in their subconscious in a simple form but they cannot recall it** weeks or months later in an exam.

The exponential shape of this curve is extremely important in setting a study pattern!

The Importance of Forgetting and Relearning

Spaced Repetition

Research since the 1880's has shown that each subsequent time we review information **it is easier to relearn and the start of the forgetting curve is less steep**. The memories are becoming persistent.



Here we see three cycles of forgetting then relearning. See how the memory lasts longer each time.

The Importance of Forgetting and Relearning

The best way to take advantage of the forgetting then relearning cycle is to spread out as a series of revisions over time – this is called **Spaced Repetition**.

Note that the three short bursts of revision in the diagram :

- Make the memory more easily accessible
- Make the memory more persistent
- Link the memory with other memories

The Importance of Forgetting and Relearning

Now the ideal time to revise a topic is **once you cannot recall most of it**, as that helps to create better compound memories. That will obviously vary.

A rough guide for spaced repetition is $\mathbf{2 \times 2 \times 2}$ – revise after 2 days, 2 weeks and 2 months.

Remember if students revise too soon the memories stay shallow and unconnected.

The Importance of Forgetting and Relearning

In each subsequent revision students relearn more quickly so the amount of **time taken decreases each time.**

As a rough guide they should aim for roughly 20% of the original time for the first revision, then 10% and 5%. So for each original hour of work students could revise for 10 minutes in 2 days, 5 minutes in 2 weeks then 2 minutes in 2 months.

The Importance of Forgetting and Relearning

Massed Repetition (Cramming)

But couldn’t students just **cram before the exam and get the same result?** No!

1. The Forgetting Curve shows that students would **start their cramming from a very low knowledge base**, so it is much harder to reach the same level of results.

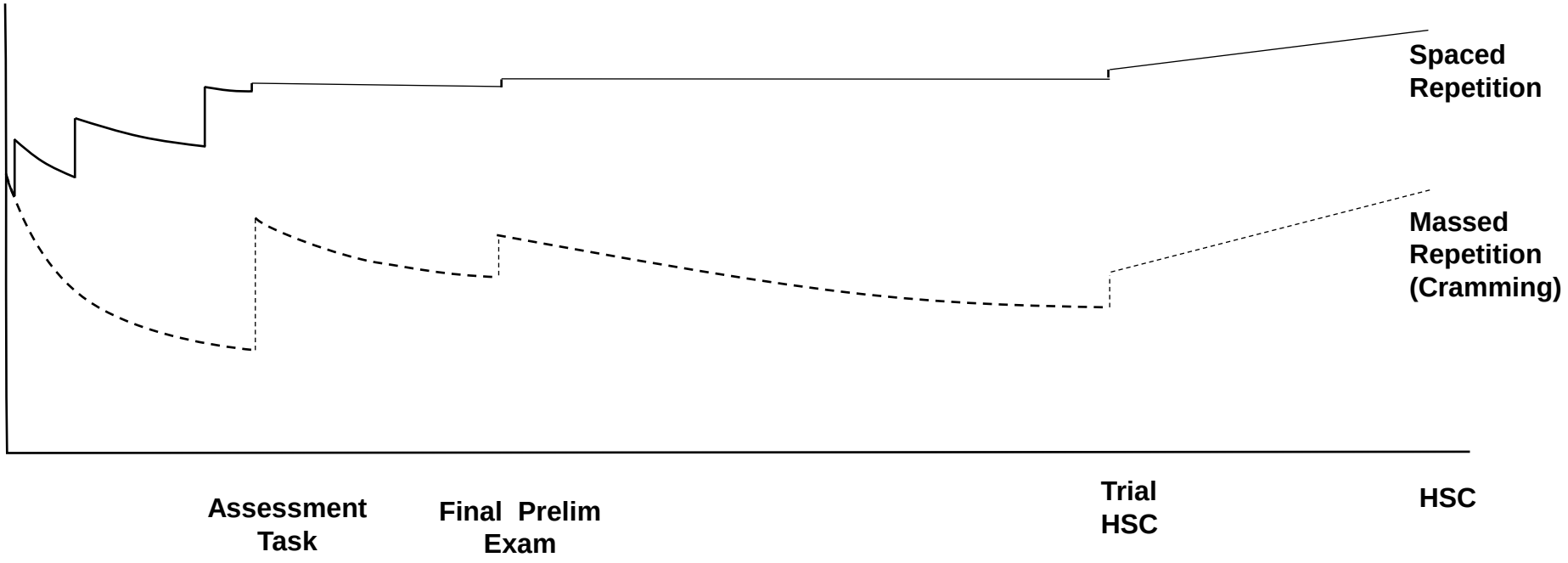
The Importance of Forgetting and Relearning

2. It is only their first ‘relearning’ so it still takes **more time**, the memories will **not be as persistent** and they **won’t have the chance to interconnect** with as many memories.

3. As a result their one big period of **cramming often involves more work** than the three short bursts of revision, and creates memories with lower storage strength.

The Importance of Forgetting and Relearning

Here is what spaced repetition and massed repetition could look like for something first learned at the start of Year 11.



The Importance of Forgetting and Relearning

A practical application of Spaced Repetition is for students to **start going through past HSC & Trial questions** from a topic soon after they finish the topic, and to keep revising that topic every now and then at increasing intervals.

Over time they mix topics up so that you are doing the more recent topics more often than the older ones (which they will have done a few times by then). This will give them an in-built Spaced Repetition using the questions they might meet in the HSC.

The Importance of Forgetting and Relearning

When they come to study just before assessment tasks or the HSC they mainly focus on the last couple of topics, where they haven’t had time for the spaced repetition to take effect, with less time needed on earlier topics.

Their goal is always to go through the **learn - forget - relearn cycle to create high quality memories**.

The Importance of Forgetting and Relearning

The Body - Brain Connection

While we are thinking about their brains, let's look at some other things students can do to help their brains work more efficiently. When their brains are healthy their study is more effective.

- **Eat and drink well** When students eat and drink well, both before and during study, it keeps their blood sugar up and hydrates their brains, so the brain works more efficiently.
- **Breathe deeply** to keep oxygen flowing to the brain.

The Importance of Forgetting and Relearning

- **Get plenty of sleep** Long term memories form during good sleep. It is also when new synapses and brain cells are created, plus our brain ‘resets’. Our brains are actually very active during some parts of our sleep. If students get a poor night’s sleep after productive study they actually forget much of what they have just learned.
- **Exercise** When we exercise blood and fresh oxygen flow through our brains, keeping it in top condition which helps all its functions.

The Importance of Forgetting and Relearning

- **Relax and keep a positive attitude** A lot of our working memory gets used up by stress, leaving less brain power to study (or to remember work during exams).

The Importance of Forgetting and Relearning

Summary

So we have now seen that students need to create memories that have a high retrieval and storage strength, and that this occurs most easily through a continued cycle of forgetting then relearning.

But what else do they need to think about before they actually start studying?

Before they Start Studying

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Self-belief, Motivation and Persistence

Lots of hard work over a long period of time is the ‘secret’ to success in Maths - just like anything in life!

But the hard work won’t happen if they don’t have **self-belief,** if they aren’t **motivated** or if they don’t **persist through difficulties**.

Self-belief, Motivation and Persistence

Always keep in mind that **some students need professional help** that is beyond our ability as Maths teachers to provide.

Tread lightly and be there to assist, but leave the heavy lifting to the school counsellor or similar.

These tips are intended for those who are travelling OK.

Self-belief, Motivation and Persistence

Let’s focus on some human traits that not only help students to study Maths but are also incredibly important life skills.

Students should start by asking themselves these questions:

- **Do I believe that I can be successful** in mathematics at the HSC if I work hard for the next year?
- **Am I motivated** to do the hard work consistently over a long period of time? If not, **how can I motivate myself**?
- **Will I persist** when things don’t go as I want, or will I give up?

Self-belief

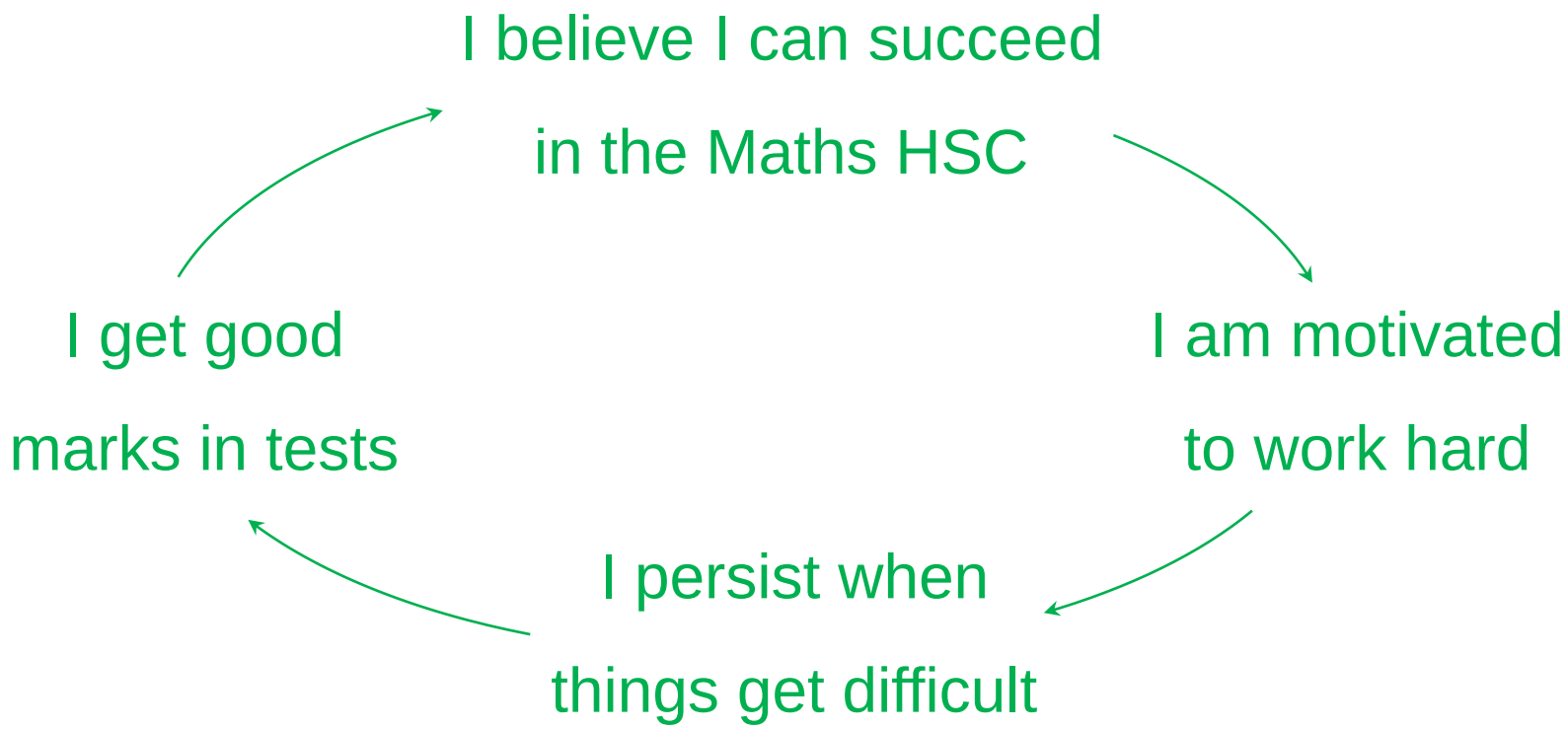
A student's level of success in Mathematics starts with whether they believe they can succeed (or not), and whether they think they can control their success or some external force does.

A student's self-belief about their success is **largely self-fulfilling**.

By the time students reach Year 11 they have had a decade of success or failure at Mathematics, so their self-belief is set firmly and will take lots of effort to change. We can guide them, but only they can change what they believe about themselves.

Self-belief

If students **believe they will be successful** in Mathematics exams then **nothing will stand in their way**.



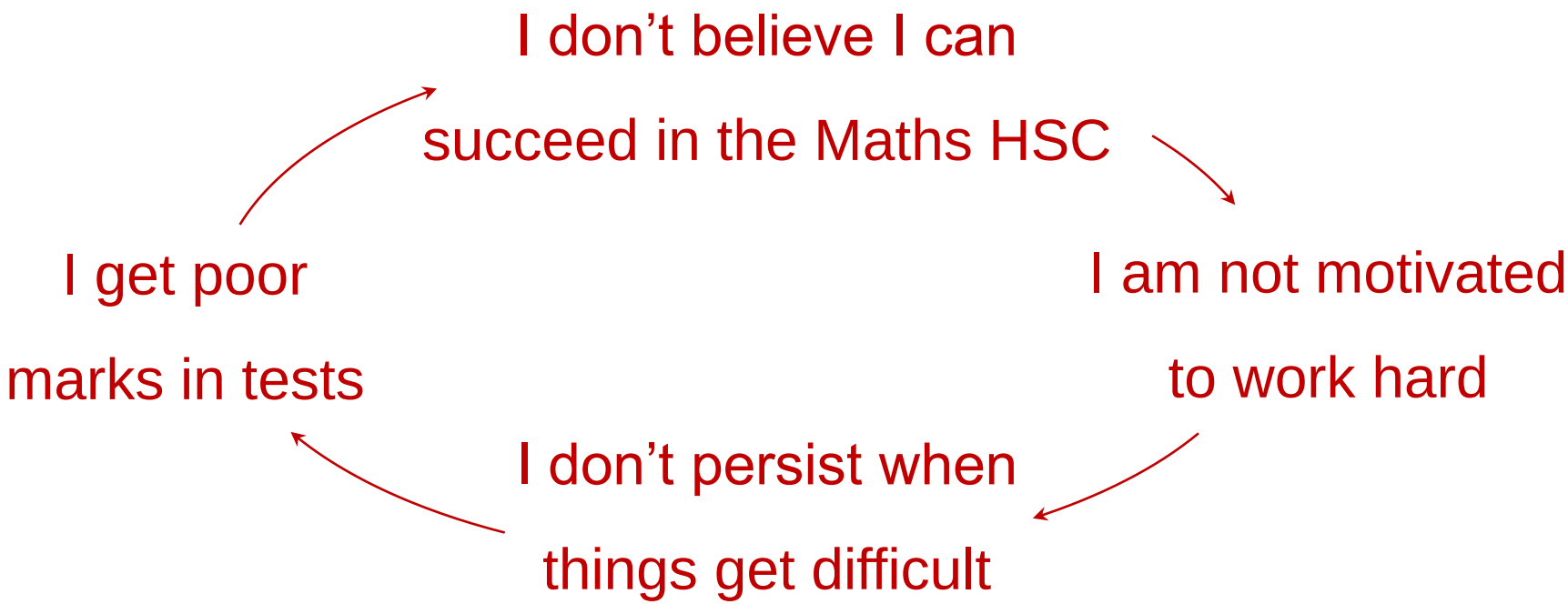
Self-belief

They are in a **loop of positive reinforcement**, so stand aside and cheer them on.

They will lap up the information in this webinar - it is more positive reinforcement for them.

Self-belief

If students **don't believe they can succeed** in Mathematics exams then **nothing will help them (yet).**



Self-belief

They are in a **loop of negative reinforcement**, which often spreads amongst the class.

The information in this webinar is of **little use to them (yet)**, as it is more negative reinforcement.

Self-belief

So if you have a student or a group of students who are stuck in this negative loop, then your **first task is to discuss their self-belief** with them. Get them to think back to how they have gone in Maths since Kindergarten.

They might not be successful in changing their self-belief before the HSC, but we can **at least provide them with the self-knowledge** so that they can address it down the track if they find the urge.

Self-belief

Try and think back to how you went in Maths through school - starting as far back as you can remember.

Since we ended up as Maths teachers probably most of us started off well in Kindergarten and followed a positive loop of self-belief for most of our school life.

Those who had to overcome a negative self-belief are probably the best teachers!

Self-belief

So students with a negative self-belief have probably been stuck in the loop of negative self-reinforcement for a **long time**.

A positive self-belief will probably only develop after they have achieved success in a few exams, but that won't happen until they believe they can succeed. Catch 22!

One way to start them on the journey to a positive self-belief is to **show them that their mathematical intelligence is not fixed**, and is within their power to change - a growth mindset.

Mathematical Intelligence

The brain and the muscles of the body have a lot in common, and the more they are used the stronger they get.

This means that students have the power to make themselves more intelligent if they exercise their brains more over time.

They can beat other students if they put in more work. Most students who achieve very high marks in the HSC do so because they work harder over a longer period of time than others, not because they are inherently smarter.

Get students to compare **changes in their brains to changes in their muscles**. This can remove any stigma.

If we wanted to make any of our **muscles stronger** what would we need to do?

We need to **train regularly over a long period of time** to so that muscle fibres can increase. Muscles cannot increase in size quickly overnight.

Mathematical Intelligence

Similarly, the reason that students need to study hard over at least twelve months is that this **gives their brains time to physically change** - that cannot be done cramming over a couple of months at the end of Year 12.

Parts of their brains become denser with **more neurons**, and **new connections** between parts of the brain are created.

Mathematical Intelligence

If students study hard for the next twelve months **their brains will be physically different** to how they are today.

Knowing that they can physically change their brains **might help those with a negative self-belief**.

Motivation

So hopefully all students now believe that they can succeed, but **are they motivated to put in the consistent hard work**?

This is much **easier of they have a positive self-belief**, so we should **always address self-belief before motivation**.

Motivation

The best form of motivation for students **comes from within** - **intrinsic motivation**.

They do something because they want to do it, and don’t want to stop. We get joy from it.

Intrinsic motivation is often **less stressful** than extrinsic motivation, and **stays with them for life**.

Motivation

Some examples of intrinsic motivation are:

- A **passion** and **curiosity** for maths
- A desire to **understand more deeply**
- A desire to **outperform** others
- A desire to **thank** others

The first two are the best as they are purely positive and don't cause stress. Maths isn't work then, it is enjoyment!

Students with a positive self-belief often have intrinsic motivation.

Do you recognise any of these from your school days?

Motivation

Extrinsic motivation comes from outside, and involves gaining something good or avoiding something bad. Examples include:

- Gaining:
  - **Praise** from teacher/family/friends
  - **Good marks** in assessments or the HSC
  - A **place in the university course** they want
  - A job that makes lots of **money**
  - A **car** if they go well in the HSC

Motivation

- Avoiding:
  - **Detention**/being grounded
  - Being **teased/looked down on** by friends

Extrinsic motivation can work well, but generally only works in the short to medium term. It is generally a **more stressful** way to study and **less successful**.

Students with a **negative self-belief may need some form of extrinsic motivation** to achieve greater success.

Motivation

The best extrinsic motivation?? Students should never forget that being very good at Mathematics will earn them **more money** (if that is what they want) than any other subject at school.

Companies want people who are good at Maths because it makes them money, even when they pay the workers lots and lots.

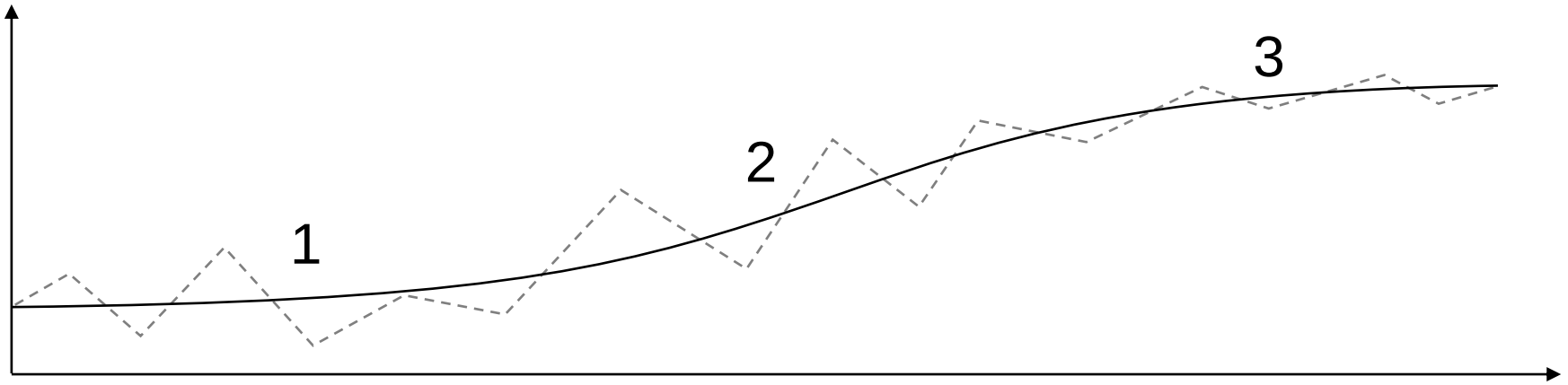
Motivation

Success at Maths can pay their way through uni via scholarships - their parents won’t have to pay a cent. To get the big money though they need to be getting very high marks though.

So Maths might be harder than other subjects, but the rewards are worth the effort.

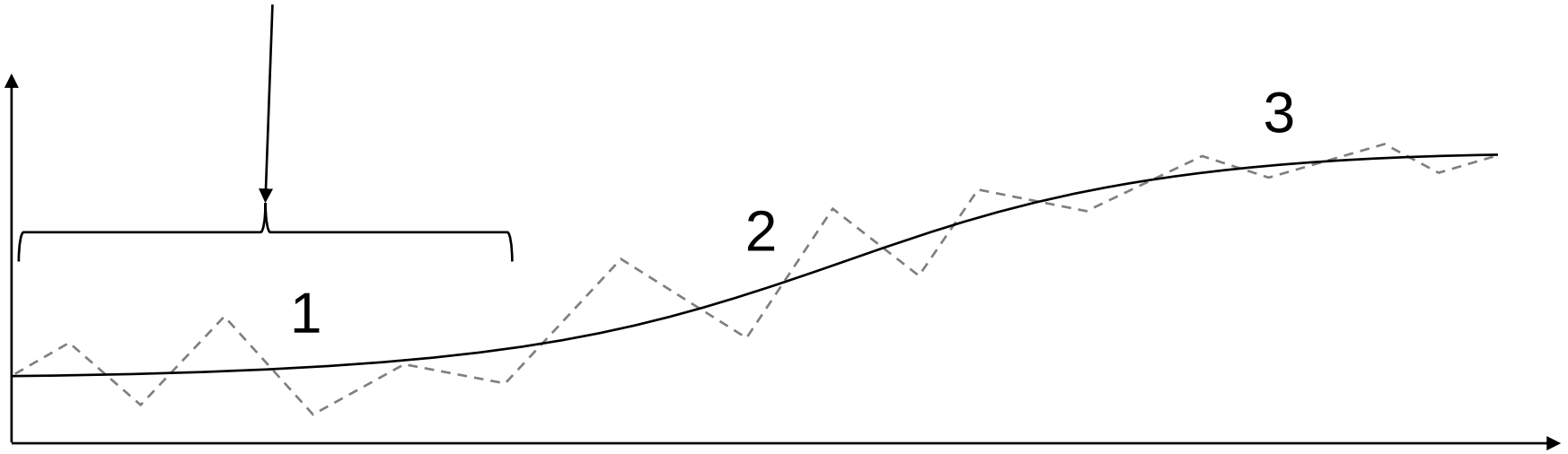
Persistence

So hopefully students start studying with a positive self-belief and motivation, but **will it stay that way**? When studying Maths it is important to keep in mind that progress is generally S shaped, but with lots of ups and downs.



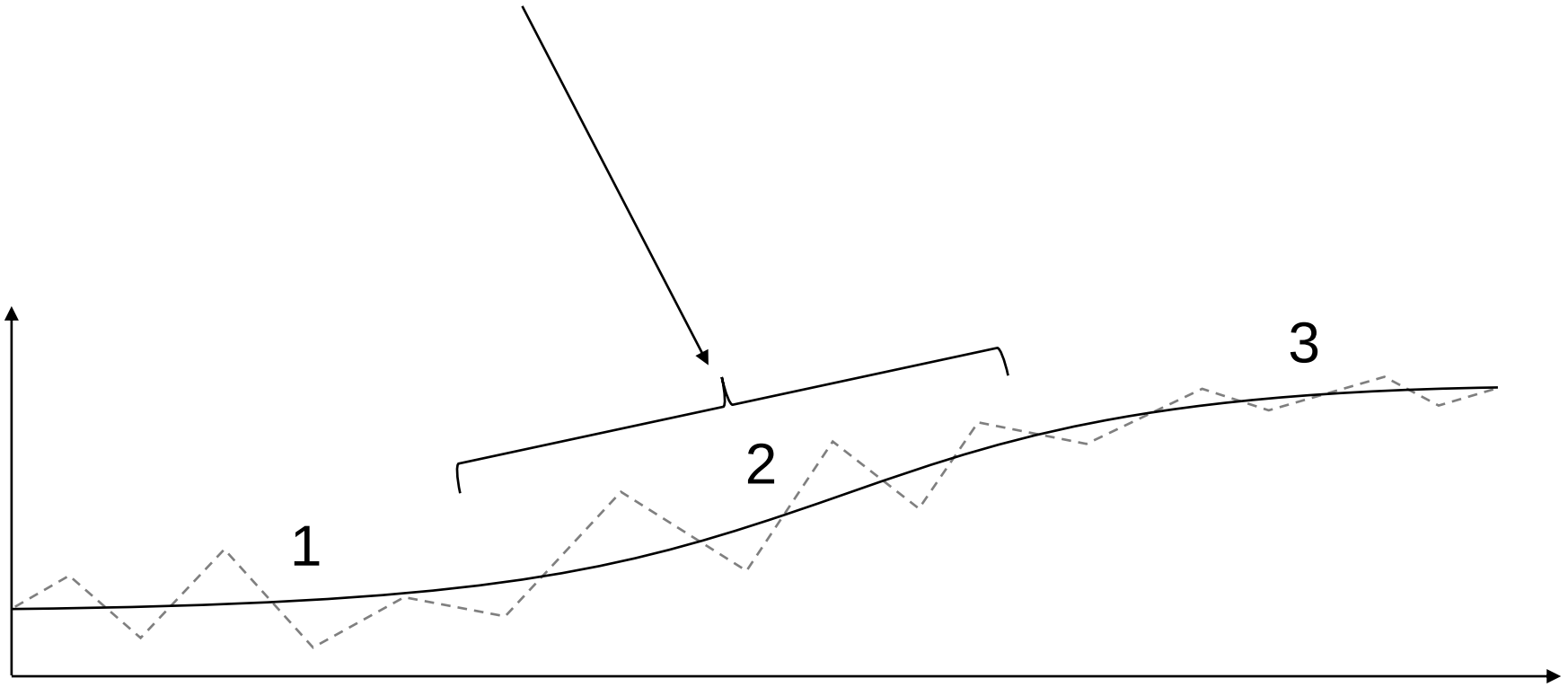
Persistence

Initially students see little improvement from their study, with lots of variation from test to test. We have to encourage them not to give up, but instead do more and more to push through this zone. I call this the **Give Up Zone,** and they **need to persist through it**.



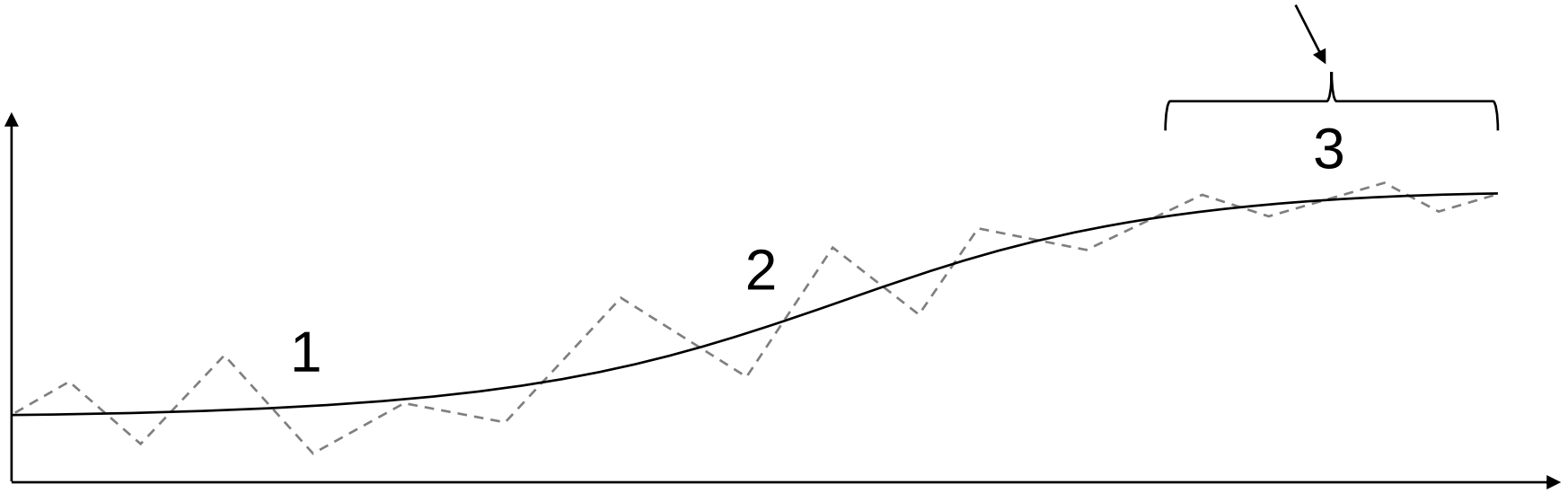
Persistence

After a while **things click** and they often see a rapid increase in results, still with **wide variability**.



Persistence

As they approach their potential their results **plateau out**. The only way for a student to know that they have reached their potential in the HSC is if their marks plateau for a few weeks before - they know that they have got as far as they reasonably can.



Self-belief, Motivation and Persistence

So talk to your students about their self-belief, motivation and persistence.

Even if doesn’t make much difference yet, the self-awareness might click into place sometime down the track.

In the Classroom

We often spend more time talking to students about how best to study, without thinking about **how they can the most out of the classroom**, and so reduce their study load.

Now students could learn a mathematics course straight from a textbook or the internet, without a teacher or fellow students, but what would they miss?

In the Classroom

What students get during lessons at school is:

- **Flexible instruction** that can be adapted to how they learn
- The ability to **ask a question and get it answered straight away** rather than having to search for the answer *.
- They can also get the answer **a second or third way** if the first way doesn’t work.
- Being able to see **what mathematical thinking looks like**

***** Not always a benefit though

In the Classroom

These are all incredibly important to their understanding of the subject.

And yet most students **never stop and think how they can get the most out their Maths lessons**!!

Top tips for getting the most out of Maths lessons

1. **Attend every Maths lesson**. It is harder to catch up in Maths than in any other subject due to its sequential nature – if students miss part of a topic then it is very difficult to do the rest.

> It is like building a brick wall – if they miss some in the bottom row, or lay them poorly, the higher ones will be weak or fall down. So they need to be in class every day and be keeping up with their homework.

Top tips for getting the most out of Maths lessons

2. **Catch up immediately.** If they miss a lesson for any reason (sickness, excursion etc) they need to do work harder than they would have done in class, as when they get the notes for the lesson they will have missed the extra verbal clues which often cannot get written down.

> They need to catch up before their next maths lesson so they are ready for the next concept. If they try to do just enough to keep you off their back it will be an area of weakness.

Top tips for getting the most out of Maths lessons

3. **Give the lesson their full attention**. If there are students around them who are distracting them, or if they are distracting others, then they should sit apart and catch up at lunch.

The **first memory** of a concept they form in class will be the **basis of the memories to follow**. If their focus keeps shifting between Maths and anything else the quality of the first memory suffers, and their study load increases.

Top tips for getting the most out of Maths lessons

4. **Interact more with the teacher** so they can adapt the lesson better to the students' needs. Students should frown, smile, cheer, boo, look bored or excited. They should ask lots of questions, particularly 'why', and bring emotion into maths - curiosity, pride, joy. Students should look happy or nod when they understand something, look confused when they don't, look stressed if the work is too fast, look bored when it is too slow. They will get a lot more out of the lesson.

Top tips for getting the most out of Maths lessons

5. **Make better notes and rework them.** By quickly re-reading notes after class they can add any ideas that they missed, especially anything given verbally. If they rework their notes at a later time (after forgetting), reordering them and adding diagrams, arrows and thought bubbles they will gain a much better understanding of the work and reduce future study. They are linking their memories with other memories, increasing the storage strength.

Top tips for getting the most out of Maths lessons

6. **Present all work neatly and clearly**. If their work in class or during study is scribbled and scruffy, then they should rewrite it. They will not regret time spent on this.

> Clarity of presentation comes from and leads to clarity of mathematical thought

Top tips for getting the most out of Maths lessons

7. **Read ahead in the textbook**, or briefly watch pre-recorded lessons, so they get more from the explanation in class. This should only be skimming the work, not trying to understand it – the understanding will happen in class. Students should only aim to be taking 5 minutes the night before. They will have half an idea of what they are to be taught before the lesson, and will be familiar with the words and symbols.

Top tips for getting the most out of Maths lessons

8. **Listen to other students' questions and answers** to get a different perspective. They should ask and answer questions too, so that other students can get their perspective.

9. **Help create a supportive environment**, especially for the top and bottom students, as their marks in the HSC are what all assessments will be moderated against.

Top tips for getting the most out of Maths lessons

10. **Aim to do fewer questions but persist by themselves until they work it out.** As they try to solve a question again and again, even the unsuccessful attempts are teaching them the subject more deeply than quickly giving up and asking for help or checking answers. Having a teacher on tap doesn't help them long term unless used sparingly, though sometimes that little bit of information that clears up a subject allows them to access much harder work and achieve much greater success.

Top tips for getting the most out of Maths lessons

11. **Students should do the same questions again and again and again** until they have mastered them, concentrating on:
    - Speed and accuracy
    - Clear working out
    - Eliminating silly mistakes
    - Using the most efficient methods

If they do a question poorly and move on they will learn a lot less than if they rewrite a solution clearly and correctly before moving on.

Top tips for getting the most out of Maths lessons

However they choose to work, they should remember that mathematics should not be regarded as a competitive sport. If they want to be competitive then they should compete against themself alone, or against the test.

Unhelpful comparisons with fellow students easily become a source of stress and anxiety - so each student should try not to add to the problem for others.

Maths Study

- The Important Qualities of a Memory
- The Importance of Forgetting and Relearning
- Before they Start Studying
- Maths Study
- In Conclusion
- Extra - Tips for Memorising Formula (if we get time)

Planning Their Maths Study

Students should plan out their study regime first. Studying is primarily about doing lots and lots of questions joyfully, but it is much more effective if they plan it out beforehand, and regularly stop to review how their study is progressing, and whether it is as effective as it can be.

Planning Their Maths Study

Here are some questions students can consider:

- What distractions are they likely to face, and how will they overcome them?
- How soon will they start studying for the HSC?
- How many hours each week will they block out to study?
- Will it be consistent or mainly just before exams?
- Which topics do they need to spend more time on?
- Which basic mathematical skills need to be improved?
- How many practice exams will they do?

Planning Their Maths Study

Allocate study time according to the marks normally available for each topic. Although there is variability from year to year, we can guess which topics should be allocated more marks and spend more time on them. Once students have mastered all or part of a topic, they can then allocate their time to the parts of the course they haven’t yet mastered.

Planning Their Maths Study

Don’t forget to **allocate time to achieve automaticity** in the basic mathematical concepts and skills that are needed in every topic.

Students need to strengthen their Lower Order Thinking (LOT) and Higher Order Thinking (HOT) to succeed in Maths.

Even the hardest questions in any of the HSC Maths exams have **more steps involving LOT than HOT**.

Planning Their Maths Study

At the end of each hour students should write down a few things they know now that they didn't at the start of the hour – it will help them move the memories from their short term memory into longer term memory so that their study is more efficient. It also helps them continually look at how effective their study is.

Planning Their Maths Study

By the end of their preparation they should do harder work in their study than they will need to do in a test. It's a bit like training for sport where you train very hard so that it's easier when you get to the game.

Planning Their Maths Study

Students need to make sure they are in control of **time eaters**: part time jobs, sport & other activities, internet and devices and extracurricular activities at school - SRC, school captain etc.

They need a balance as doing a variety of things in life is good, and helps them get scholarships and jobs etc, but too much starts to affect their school work and costs them in the long term.

Planning Their Maths Study

A lot of students have trouble **politely saying no** when they don't want to do something - an important skill to gain.

Remember that many students will have lots of nice people (including teachers) who will ask them to do nice things, but they can eat up lots of their time when they could be studying.

Planning Their Maths Study

Incorporate Practice Tests A typical study regime involves

study - study - study - study - study - test

In other words there is a long period of study with only one test (the one that counts) at the end.

Planning Their Maths Study

Recent research suggests that there are number of benefits if you change the pattern so that a number of **low stakes practice tests** are included in the study program. This isn't just doing past papers at home - you need to be sitting them under test conditions and getting marked for the full effect.

So the study regime is now

study - study - practice test - study - practice test - study - test

Planning Their Maths Study

The benefits are:

- Memories are more easily retrieved, especially under stress - an important consideration when we are dealing with assessments or the HSC!
- The memories last longer

Top Maths Study Tips

By this time in the webinar it won’t come a surprise that by far the most important study tip for students is to **do lots of questions spread out over a long period of time**.

But what is the most efficient way to approach this work?

Top Maths Study Tips

Students should:

- Aim to do **small amounts of work often** spread out over time.
- **Use past HSC and Trial HSC questions** as the main source of their study as soon as they can.
- **Mix topics up**, spending more time on recent topics and less on ones they have already looked at.
- **Work on Lower Order Thinking skills**, so that their work is fast and accurate.

Top Maths Study Tips

- **Do lots of similar questions** so that their brain achieves automaticity
- **Plan their study realistically** - what will they actually do?
- **Allocate their time according to the marks each topic normally receives** - more time for the important topics.
- Aim to **do much harder questions** in their study than they will have to do in the test.

Top Maths Study Tips

- **At the end of each hour look back at what they have done** and see if they would have been better doing something else.
- Before end of course exams or Trial exams find practice tests or past **tests that cover all of the content** together, rather than each topic separately

Top Maths Study Tips

- **Remove distractions from their study area**. When they need to remember things in an exam, it works most easily if you created the memory under the same conditions. So no noise, no phones, no electronics, no talking, no music and no friends. **Multi-tasking is scientifically proven to be a myth!**

Top Maths Study Tips

- Only work in a **study group** (for part of your study) with others if everyone is increasing their knowledge. They work best if the students involved are close in ability. Working with others can help give you a different point of view, and when you explain things to others it exposes any weaknesses in your understanding.
- **Look at solutions in detail** to see if your answer is as simple and elegant as possible.

Top Maths Study Tips

- **Struggle** to get questions out as you will understand them better than if you look up or ask for the questions straight away. Your brain will forget things that were too easy.
- **Practice writing as neatly as possible and setting your work out clearly**, as clarity of presentation and clarity of thought go together.

In Conclusion

- The Important Qualities of a Memory
- The Importance of Forgetting and Relearning
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- Maths Study
- In Conclusion
- Extra - Tips for Memorising Formula (if we get time)

Studying Mathematics - 3 Months from the HSC

We have focused on longer term study skills in this webinar.

We can spend at least as long looking at exam technique and other skills that apply to students' work closer to and during the HSC - we will do this in another webinar next year.

Here is a brief look at some of the things we will cover then.

Studying Mathematics - 3 Months from the HSC

We start by looking at what they can do over the last few months before the exam:

- Improving their LOT skills - Algebra, writing, presentation
- Physical health
- Increasing their Attention span
- Reducing stress and anxiety
- High Performing Students - how to get extremely high marks
- How can Band Descriptors help focus our skills?
- HSC exam equipment list

Studying Mathematics - 3 Months from the HSC

Then we will look at their final preparation over the last few days and hours before the exam

- Food, drink, rest, exercise and reducing stress
- Last minute practice

Studying Mathematics - 3 Months from the HSC

Lastly we look in detail at how they can improve their performance during the exam

- Timing, presentation and organisation
- Checking work and eliminating errors
- Tips for refocusing the brain during the exam

Keep an eye out for details next year - probably in early to mid Term 2.

And Finally

Remember that you should just try to take ten or twenty things at most from this webinar and incorporate into what you already do.

Thanks for everyone who is watching this live or on the recording, and I hope you get something out of it. Please email me at steve@howardmathematics.com if there are any questions or you would like more details.

What was that number we looked at earlier in the webinar?

Extra - Tips for Memorising Formula (if we get time)

- The Important Qualities of a Memory
- The Importance of Forgetting and Relearning
- Before they Start Studying
- Maths Study
- In Conclusion
- Extra - Tips for Memorising Formula (if we get time)

Memorising Formulae

In Mathematics students **don’t gain marks** for remembering a formula but they **lose marks** if they don’t know it! One of the things that makes Maths much harder than other subjects.

While some formula are on the reference sheets many aren’t, so let’s look at some tricks to help remember the formula quickly.

Memorising Formulae

There are a wide variety of different memorisation techniques mentioned here, but students should **just use a few of them** that work for them.

Students want to achieve **automaticity** with as many of these formulae as they can.

Memorising Formulae

Students should always check the **reference sheet** as a first step. It is amazing how many students will get a formula wrong even though it is provided for them.

Unless a student has major problems remembering formulae then they should reach the HSC and only use the Reference Sheet for **a double check**. If they are continually checking the Reference Sheet they waste a lot of time.

Tips for Memorising Formulae

Here are a host of hints to help them remember formulae.

Understand the formula

- **Understand how and why the formula works**. Students are more likely to choose the correct formula and remember it correctly if they understand it.
- **Create a list of any unusual mathematical symbols** used in the formula, with their name and what they represent. Students will then know what the symbols mean.

Tips for Memorising Formulae

Repetition

- Nothing beats **spaced repetition** for learning. Students should keep going over the formula for months before the exam.
- Students start by going over a new formula every few days, then every week, then every fortnight, then every month – the intervals increase, but they need to keep returning to it for memories to be retained.

Tips for Memorising Formulae

- Students should **use the formula in lots of questions** – if they don’t use it they will forget it.
- Students should **rewrite the formula as part of their working** each time they need it in a question in class or during study. Write the formula on the first line then substitute values into on the second line. They should not rewrite any simple formula during the exam though as it takes up time without benefit. If in doubt though, write it down first!

Tips for Memorising Formulae

In Class:

- Students should **pay attention when the formula is first taught**, and try to understand it. The brain is more interested in something new than something they come back to when they haven’t understood it the first time.

Tips for Memorising Formulae

- Students should **read ahead of the lesson** they are up to – if they have already briefly seen the formula then it will be absorbed better when they see it in class in context. If they have access to pre-recorded lessons then they should watch them the night before they see them live in class.

Tips for Memorising Formulae

Variety:

- Students should use different parts of their brain to learn each formula – look at it, speak it out loud, act it out (if you can), make up songs or silly stories. The greater the variety they use the better will be your recall.

Tips for Memorising Formulae

Memory:

- Students should write the formula over and over using pen and paper – the movement of their hand over the paper (or in the air) stimulates muscle memory.

Tips for Memorising Formulae

Visual Stimulus:

- Students should draw a diagram and a worked example to go with the formula, so they know when to use it. Draw arrows between the parts of the formula and the diagram. Formulae are easier to remember in context.

Tips for Memorising Formulae

- **Flash cards** can help students use small amounts of down time in their lives to study.
  - They should only use them for **the things they are having trouble remembering**, rather than the whole course.
  - Flash cards are more effective if students **make their own** rather than using commercial ones.
  - Have the **name of the formula and a diagram on one side and the answer on the other**.

Tips for Memorising Formulae

- **Memorise a formula by its shape** - associate the shape of a number or symbol with something non-mathematical. ‘2’ looks like a swan swimming, ‘+’ looks like a first aid symbol.
- **Close your eyes and imagine writing the formula by hand**.
- **Make copies of the formula and stick them everywhere** – on the fridge, the bathroom mirror.

Tips for Memorising Formulae

Verbal/Audio Stimulus:

- **Make up a story – the weirder the better** (emotion tricks your brain into thinking it is more important). Humans have been passing information orally for far longer than we have been writing or reading it.
- **Make up a song or rhyme** – the rhythm helps the brain remember. Try singing it to the tune of a nursery rhyme.

Tips for Memorising Formulae

- **Teach the formula to someone else** - this will expose any weaknesses in your understanding, and by speaking you are using other parts of your brain.

Tips for Memorising Formulae

Last minute fall back

- If there are still one or two formula that students are having trouble remembering beyond 15 minutes, then they can have a look at them just before they enter the exam room. Once their writing time starts (but not before then), write it down on something that has clearly just been handed to them say the Reference Sheet.
- Notice that here the student is getting around the low storage strength by using relearning to increase the retrieval strength.