

Premier’s University of Sydney Mathematics Scholarship

Developing growth mindsets in mathematics and engaging all students in their learning journey

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# Introduction

As a teacher I regularly reflect on what I can improve on to benefit my students. At times I try to put myself in my students shoes and think what does mathematics look like to them?

One conclusion of mine is that there is too much of an element of performance in mathematics. Students are defined by their next performance. Students are told what they can’t do from a period of silent, closed performance rather than being given multiple opportunities to show where they are now, understanding where they need to be and supporting them in getting there.

One of the recommendations from the Review to Achieve Educational Excellence in Australian Schools:

**Priority one: Deliver at least one year's growth in learning for every student every year**

Student growth is a measure of the individual progress a student makes over time along a defined learning progression. Focusing on student growth matters because it enables every student to progress regardless of starting point or capabilities.

(Gonski D, 2018)

I like the idea of placing a focus on the growth of a student over a period of time and engaging the students in recognising this growth. It is essentially the job of a teacher. Looking at the concept of a growth mindset versus a fixed mindset led me to recalling a few quotes from students I have taught:

“Mr Lawson you taught my brother, he is good at maths I am not”

 “Ahhhhhhhhhhhhhhhhhhh, why was I told that I was not good at maths as I was not working quickly enough?”

 “My parents were never any good at maths either, so it is OK that I am not”

 (Parent giving their child an ‘out’ – an excuse to not take on challenge)

At this point I began doing more reading and research and a combination of factors led me to being motivated to apply for this scholarship.

# Focus of Study

The study can be split into two parts which can overlap and are defined below.

1. Developing a growth mindset in mathematics

I have specifically stated in mathematics. I think that mathematics specific growth mindset needs to be clearly defined as the way in which we teach. It is not a few lessons on brain science and ensuring we praise students for effort and the rest will look after itself. To give potential for students to be developing a growth mindset the messages around brain science need to be accompanied by well-designed tasks which are open, creative and engaging. Such as low-floor, high-ceiling tasks where differences in the needs of a group of students are catered for and challenge is provided. Within these tasks students will need explicit teaching of new concepts and will need to practice the application of these.

1. Engaging all students in their learning journey

For me this is students progressing through school being able to connect new ideas to those they already understand and being aware of the progress they are making from one point to another. The time between these points could be a few lessons, a whole topic or a semester. Being aware of the gaps they have in their understanding and the impact of these on future learning.

For one or each of the parts described above my aims are to:

* provide a practical guide to enable mathematics teachers to implement changes in their practice
* understand the importance of educating parents
* develop a success criterion to measure the impact of change
* provide a range of resources for teachers
* develop a model for assessment and reporting on mathematics using a growth mindset approach
* provide a practical guide to how evidence from other subject areas can contribute to a student’s learning journey in mathematics

# Significant Learning

I have detailed below key features of experiences from my study tour.

## Nanyang Girls High School, Singapore

Nanyang Girls High School caters for girls from the Australian equivalent of Years 7 to 10. They have 1600 students, lessons are 55 minutes, average class size 35, one mathematics lesson per day.

### **Key observations**

* In classrooms Our 2019 mindset messages were displayed.
* The teacher and students were very comfortable discussing mistakes, no students were reluctant to have a go in fear of getting something incorrect.
* With regards to engaging students in their learning, exit cards were used to get an understanding of progress. These were then used in planning for future lessons or for students to be quickly aware of gaps in their understanding. This then prompts them to seek extra assistance and target these gaps.
* At the start of a recap lesson students completed ten questions and marked them in class. Depending on which questions they got correct or incorrect they were then directed to different starting points for the next task.

## Association of Teachers of Mathematics Annual Conference, UK

### **Key observations**

* Colin Foster presented on the topic of ‘Listening to the learners, learn from them’. Consideration to be given to setting up lessons to allow this to happen.
* Developing collaborative talk about the critical features of multiple representations was discussed. Connecting ideas through visualising the same thing in different ways. Examples can include multiplication or fractions:
	+ How many ways can $\frac{4}{7}$ be represented?
	+ Present different representations of 18 x 13.
* Craig Barton presented on the use of questions in the classroom. His key message was that we do not want students on autopilot repeating the same questions and tricking themselves into thinking they can do it, subtle variation is required.
* A video shown in a presentation about teaching number to younger students showed a girl counting, getting very excited at 30, 40, 50 etc. She got to 99 and paused, she was asked “Do you know what comes next?”, her response was “Not yet”. Can we harness this mindset in young people as they get older?

## Didcot Girls’ School, UK

Didcot Girls School is a comprehensive school in the UK. They have had a focus on developing students with a growth mindset for around five years and the mathematics department have been key contributors to this. Their reports refer to wanting students to become outstanding learners and adopt a growth mindset. By spelling out what this means in their reporting system they hope it will help to achieve this.

Feedback to parents is split into learning in class and learning out of class and the categories in each of these are aspiring, committed, developing and more effort required. Within each of these there are five strands and a definition is given for each. An example of the developing category is given below:

|  |  |  |
| --- | --- | --- |
|  | **Strand** | **A student in this category is likely to demonstrate some or all of these traits:** |
| Developing | Resilience and commitment | She works well on simple tasks, but does not yet show high levels of resilience when working on challenging tasks. |
| Independence and concentration | She can complete straightforward tasks independently, without over-reliance on others. |
| Approach to feedback | She accepts feedback, acts on it and can describe her strengths and weaknesses. |
| Quality of work produced | Work is usually well presented, and every effort has been made to complete tasks. |
| Behaviour and conduct | She cooperates with instructions and follows all classroom rules. |

The overall effectiveness in their most recent Ofsted inspection in November 2015 was Outstanding. The school’s 2018 Key Stage 4 results from GCSE Examinations were excellent in a cohort of 190 students, they are summarised below.

|  |  |  |
| --- | --- | --- |
| **Summary of results** | **School 2018** | **National average** |
| Basics – English & Maths at 4+ | 80% | 64% |
| 4+ in English | 90% | 68% |
| 4+ in Maths | 80% | 59% |

Class size average is 32 students. Classes are streamed into three tiers (streams) which leads to the level of GCSE examination the students will sit.

Observations from discussions with students:

* Maths lessons often had a starter activity, possibly four questions, throwback to last term, throwback to Term 2, throwback to Term 1 and last topic. Lessons could involve individual work, group work, projects, investigations or class discussions.
* Students felt teachers were very aware of their progress.

Key observations

* The school were kicking off a growth mindset reboot. Five years after commencing they felt the need to give more focus to this again and to refresh students, teacher and parents about what it is about and why they were doing it.
* Year 7 start Term 1 with a number project, lots of low floor, high ceiling type tasks.
* Students have access to Hegarty Maths, an online resource. Department collection of data from skills tests and problem solving tests was well organised and used effectively.
* Head of department thought that the biggest challenge to getting all teachers on board with developing a growth mindset in students was changing the language that is used by teachers.
* Teachers can send postcards home to parents to recognise where students have gone above and beyond.

## St Marylebone School, UK

St Marylebone School is an inner city girls school. Year 7 to 9 are mixed attainment classes and they have their take on a mastery approach to teaching. In essence this is all students doing the same concepts at the same time. Procedural fluency and conceptual understanding are developed in tandem, significant time is spent developing deep knowledge of key ideas to underpin future learning.

Key observations

* Teachers of each of Years 7 to 9 meet once a week for a period as part of a Teacher Research Group. This comes from non-teaching time.
* In discussion with teachers they were sceptical about adopting the mixed attainment classes and mastery approach, but they were now onboard and thought it had been an excellent change for their students.
* Teachers commented that students were far more willing to try something challenging or new.
* Head of department noted that being an inner city school they generally had a high turnover of staff but in recent years since adopting this approach there had been far less movement of staff.
* I asked about observing lessons and what they would be looking for in a teacher?
	+ Questioning – always asking why?
	+ Teacher not giving away the answer
	+ Mathematical notation and language being accurate, correcting students where appropriate
	+ Confidence using different representations and celebrating these
	+ Facilitating good discussion in the classroom
	+ Drawing out common misconceptions

## Parkview School, UK

Parkview is comprehensive co-educational school. Overall effectiveness in an Ofsted inspection in November 2017 was good, with a continuing trend of improvement in GCSE results. In 2018 they changed from having students streamed to mixed attainment classes.

Their approach to mixed attainment is a pre topic task which allows students to assess their prior knowledge and it guides them as to what tasks they will work on in the new topic. At the point of student self-assessment it is emphasised it is not about how many outcomes are highlighted at this stage; it is about progress from now to the end of the unit.

### Key observations

* In a Year 8 lesson a Do Now task used as a starter activity. Then students had three levels of task to choose from. After 10 minutes students were asked to swap books and comment on What Went Well (WWW) and Even Better If (EBI), some were shared with the class.
* Teacher feedback was that they were very concerned about the change to mixed attainment and that it was difficult at first but six months down the line it had been a great change for them.
* Students have access to Hegarty Maths, an online resource.
* Student feedback
	+ They liked not having to repeat work that they were confident with and could choose a starting point rather than reviewing everything as not everyone knows it.
	+ But on the flip side students at times still did need to listen to the teacher talking about things they already knew.
* Classrooms were set up with prompts on the walls relating to growth mindset, see examples below.



Figure 1 - Mindset Posters in Classroom at Parkview School (photo by Stephen Lawson)



Figure 2 - How to Learn Maths flow chart in Classroom at Parkview School (photo by Stephen Lawson)

# Conclusion

I believe the fundamentals of a growth mindset approach need to be embedded into a mathematics classroom on a day to day basis. If a teacher wants to encourage a growth mindset, it is what the students are being asked to do in the classroom which will make the difference.

From my study tour seeing schools choosing to stream students or to place students in mixed attainment classes was not the key factor in developing a growth mindset in students. If a student in a lower stream believes they have potential and there are pathways for this potential to be realised it can work. The message is not everyone can learn concept z by Year 8.

I think in mathematics we have an advantage thanks to Jo Boaler and her youcubed team at Stanford University who have and are producing a wide range of excellent resources specifically for mathematics. This gives access to well-prepared material which should give teachers confidence to begin dipping their toes into low-floor, high-ceiling type tasks.

Observations during my study tour were encouraging. Didcot Girls School are achieving well above average results, particularly the mathematics department. Staff in schools who have relatively recently made changes to their approach were very positive about the impact on their classroom and student outcomes.

I will work through each of my aims and then summarise in my conclusion.

**Provide a practical guide to enable mathematics teachers to implement changes in their practice.**

* Educating yourself about the brain science and what is meant by a growth mindset and specifically in mathematics, reflecting on the way that you teach, the language that you use and what you are asking the students to do in your class. Are tasks open or closed? Are tasks easily accessible with sufficient challenge? Do they encourage slow deep thinking rather than a race to memorise things?
* I recommend Jo Boaler’s book, Mathematical Mindsets. There is an online course through Stanford University which is excellent too. The website https://www.youcubed.org/ has a wide range of articles and resources, including a free online student course. These resources are useful for both introducing the thinking and for lots of ideas for classroom activities and tasks which are designed with a low-floor and high-ceiling for engagement and deep understanding.
* Plan well. Review scope and sequence and lesson sequencing.
* Educating your students.
	+ Go through the brain science, how making mistakes, taking on struggle and challenge will grow our brains, highlighting that speed is unimportant. Students come up with their own growth mindset slogan based on what they have learnt to that point. Students glue it in the front of their book as a reference point to go back to during the year. I have included an example below:
	+ 

Figure 3 – Example of brain synapse activity with slogan from classroom activity (photo by Stephen Lawson)

* + It is then backing up the talk with action in the form of the tasks students are being asked to do. Consider whether students need to be guided through how to approach group discussion or how to attempt open tasks.
	+ As a teacher dedicating time to reflect on lessons should be an everyday event.
	+ Talk to students about learning in mathematics not being about a whole lot of memorisation. Identify the importance of deep thinking about conceptual ideas and not rushing to memorise methods.
	+ Being careful not to contradict the growth mindset messages with language you use in the classroom. Reinforce key messages, possibly using slogans generated by the students.
* Educating your parents (see next aim).
* Sharing ideas with your colleagues, have conversations with them, show them tasks which work well for you and the work students produced.

**The importance of educating parents**

Messages from home can be negative with regards to mathematics and can give the students an excuse with comments such as “I was never any good at maths, it’s ok not to get it”. Use newsletters, parent teacher evenings, stage or year group information sessions, websites to provide information about growth mindset they can read or watch. Let the students and parents know what you value highly.

**Develop a success criterion to measure the impact of change**

I started out thinking of many different things here. I think that if the students in the classroom are engaged and they know that you know them it is a good start.

Teachers should step back and analyse what feedback students are receiving. Then what became more apparent for me was in the growth mindset focus, how do students respond to this feedback? Initially is the teacher giving students the opportunity to reflect and act on feedback. Is the teacher aware that the student has used the feedback, modified their approach and applied it to a new piece of work. Are they making progress by using feedback effectively?

A student at Didcot commented that “My teachers are very aware of my progress”. It stuck in my mind as something which would be great for a student to know.

I think student surveys, which can be anonymous or not, getting an insight into these things from your students and monitoring this over time could be a source of data to measure the students’ perception of the above and over time give an indication of the impact of change.

The feedback from students does not need to be an extensive survey, ideas such as WWW and EBI feedback for the teacher on a topic they have taught or a specific lesson could be worthwhile.

**Provide a range of resources for teachers**

Recommended resources are listed in my References

**Develop a model for assessment and reporting on mathematics using a growth mindset approach**

I have taken ideas seen at the different schools I visited and the priority of delivering at least one year’s growth in learning for every student every year and have translated the NSW Stage 4 and 5 syllabuses into a continuum of learning.

The plan being if we have four weeks in Term 1 allocated to algebraic concepts and three weeks in Term 2. When we start the three weeks in Term 2 the student picks up where they left off in Term 1 or the teacher and student are aware of the gaps which need to be filled before certain concepts are to be taught. Note that some concepts will have prerequisites, and some will not.

Hopefully the continuum idea improves the retainment and use of knowledge about a student’s progress from year to year as well as during a school year.

The idea of growth I see moves in two directions, within concepts previously experienced students can make progress in their understanding, not necessarily moving along the continuum but having more depth than previously. The second direction is new experiences moving along a continuum, whether the student’s understanding is minimal or extensive they have grown and know something they did not previously.

This is an ongoing project to finalise a model that is user friendly for teachers, students and parents. A part of this reconsidering the more traditional school report and if we started with a clean slate what would it look like. I am happy to share work on this as it progresses.

If a growth mindset approach is adopted school wide, then the wording of a report could take a similar style to that of Didcot Girls’

**Provide a practical guide to how evidence from other subject areas can contribute to a student’s learning journey in mathematics**

During my study tour and in further reading I have found minimal evidence of this occurring. At Parkview School a pre topic test would allow a student who has studied graphs in science for example to demonstrate an understanding which would impact their starting point within that topic.

My ideas would be that if a student is looking for an entry level to a topic, they can use evidence to support this from previous work, regardless of the subject. My analogy on this would be with the high jump in athletics. You can pass on heights before attempting a jump. On a continuum of learning a student could pass on concepts that they are confident with and have accompanying evidence.

In conclusion a growth mindset approach is not a fast track way to success and if a teacher scratches the surface then very little impact will be seen. But if teachers are willing to explore the essence of a growth mindset approach in mathematics and what this looks like on a day to day basis then I believe it can improve student outcomes. As importantly we can enhance students engagement with mathematics and their belief in their ability to learn mathematics.

Maybe in the future we will have less parents giving their child an out!

# References

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