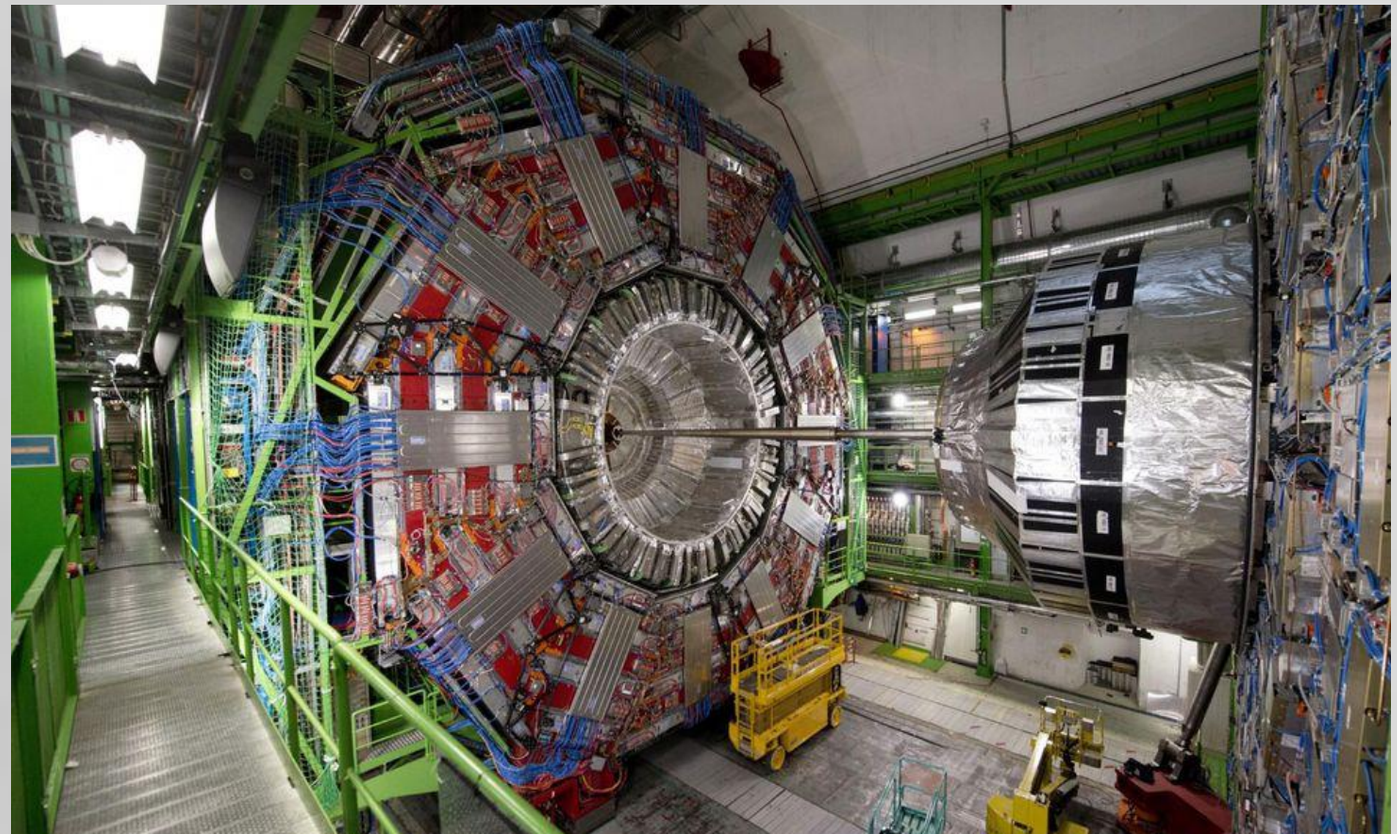
First year mathematics teaching - the experimental approach

Jonathan Shock - UCT department of maths and applied maths



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First year mathematics teaching - the spaghetti approach

Jonathan Shock - UCT department of maths and applied maths

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My personal journey

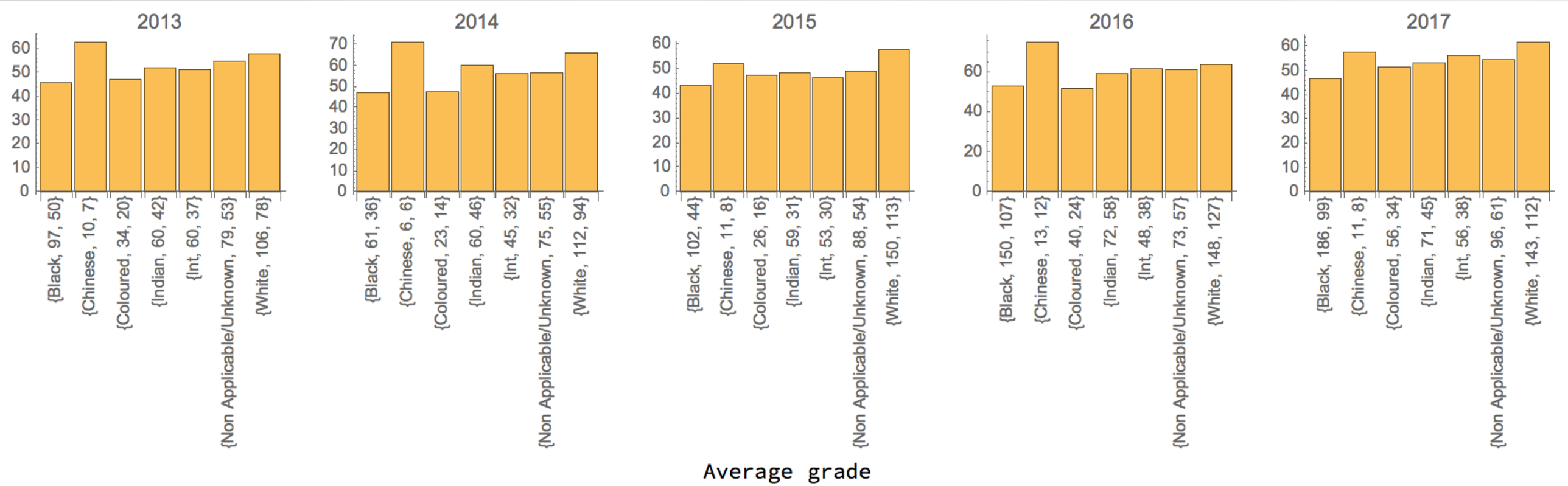
- PhD in theoretical physics in the UK
- Postdoctoral positions in China, Spain and Germany
- Came to UCT in 2013 as a lecturer
- Two weeks after arriving I was stood in front of 300 nervous first years, as a nervous but eager lecturer
- A very steep learning curve for me

Caveat

- This is not a structured approach to teaching a large class
- I have no background in educational research
- Lots of questions/ideas, few answers
- I have a lot of passion for trying to improve the student experience

The landscape of MAM1000W

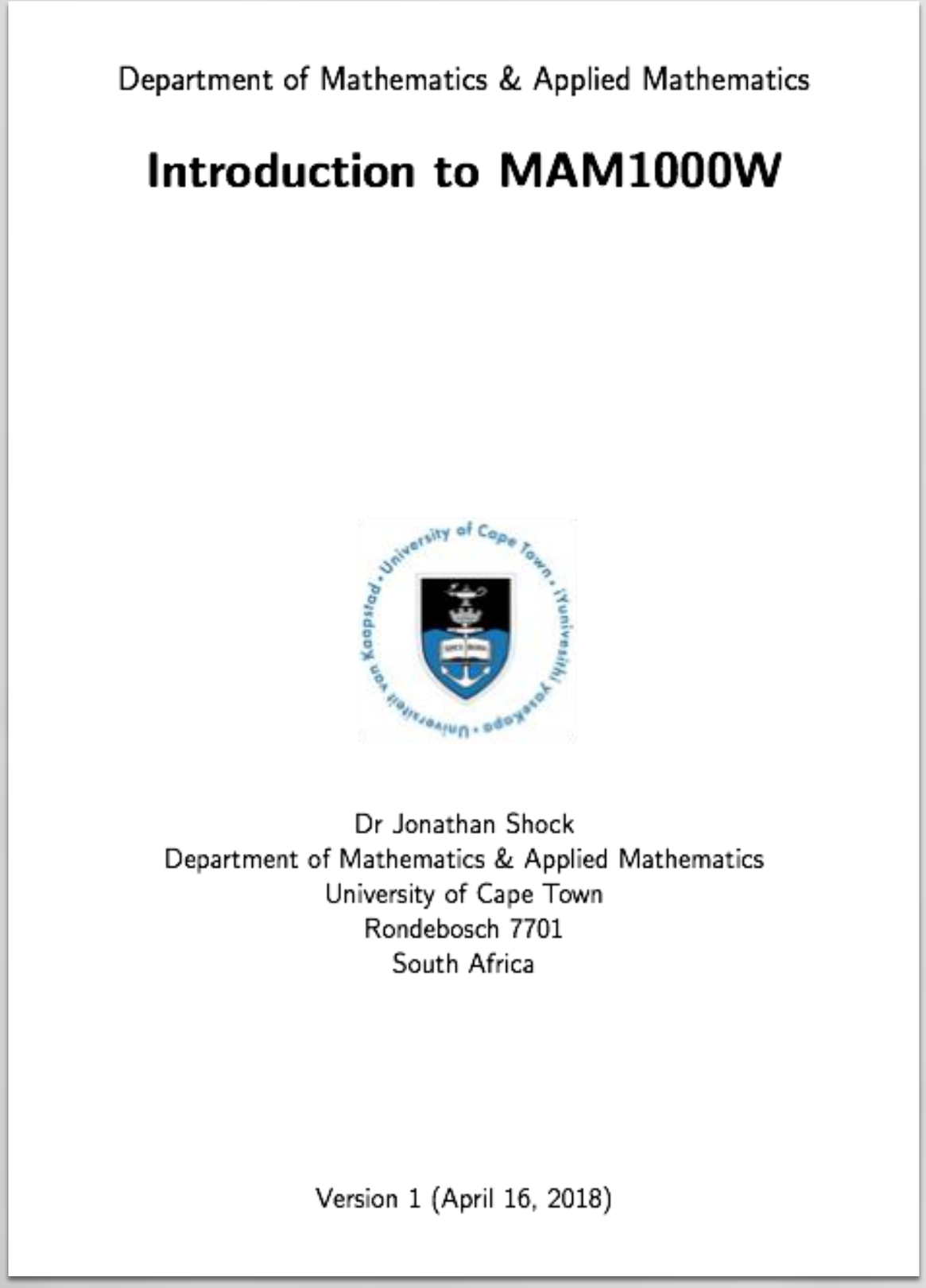
- Huge diversity
- Many students are simply overwhelmed with their courses
- Some with zero computer exposure
- Some who have done a great deal of the course already
- How do we cater to such a diversity?
- We need help, precisely in terms of diagnostics. We have been doing a bad job at enabling success for many students, particularly black students.
- Can the DMISRS help with understanding this and allow us to create a better system?



The major challenge

- Explaining mathematics well is very easy
- Getting students interested in a topic is relatively easy
- Getting students to feel motivated inside the classroom to go out and find out for themselves in pretty easy
- Getting students to actually work on their own outside the classroom is hard

The intro book



Department of Mathematics & Applied Mathematics

Introduction to MAM1000W

Dr Jonathan Shock
Department of Mathematics & Applied Mathematics
University of Cape Town
Rondebosch 7701
South Africa

Version 1 (April 16, 2018)

The intro book

- isiNdebelet.docx
- isiZulu.docx
- MAM1000W resource book 1.pdf
- N sotho.docx
- Sesotho.docx
- Setswana.docx
- Singalakha's guide to plotting rational functions.pdf
- Siswati.docx
- Summary and questions.pdf
- Tshivenda.docx

This is not a highly utilised resource, but the feedback I get is that it shows that we understand from the beginning that not everyone is coming with English as a first language

Attempted: Video versions

Glossary

MAM1000W glossary

File Edit View Insert Format Data Tools Add-ons Help Last edit was made on June 16 by anonymous

Please fill in any words which you might have found confusing when you first came across them in lectures, or in the notes

	A	B	C	D	E	F	G	H
1	Please fill in any words which you might have found confusing when you first came across them in lectures, or in the notes	Either I (Dr Shock), or someone else, will then fill in the rest.	Though please feel free to offer your own definitions if you'd like to.					
2	**Word**	**Dictionary definition**	**Meaning in mathematics**	**Example**	**Links**	**Xhosa translation**	**Zulu translation**	**more translations**
3	suffice	To be enough, or adequate	When we are trying to show that one statement is true, often it is enough to show that a different thing is true, and that the second thing being true means that the first thing will then be true. ie. To prove that statement A is true, if statement B implies statement A, then if statement B is true, then this "suffices" to show that A is true.	To show that a given number is odd, it suffices to show that it can be written in the form 2n+1 where n is an integer.	https://www.khanacademy.org/partner-content/wi-phi/wiphi-critical-thinking/wiphi-fundamentals/v/necessary-sufficient-conditions			
4	Arbitrary	based on random choice or personal whim, rather than any reason or system	Random, any, not yet specified; not assigned a specific value. It is used when trying to make general statement about a class of mathematical objects(e.g. functions, sets, real numbers, etc)	"Let p be an abitrary integer" . Here this means that p is any integer, i.e. any number that satisfies the properties of being an integer. An abitrary integer could be any single element in the set of integers	https://math.stackexchange.com/questions/775333/arbitrarys-meaning			
5								
6								

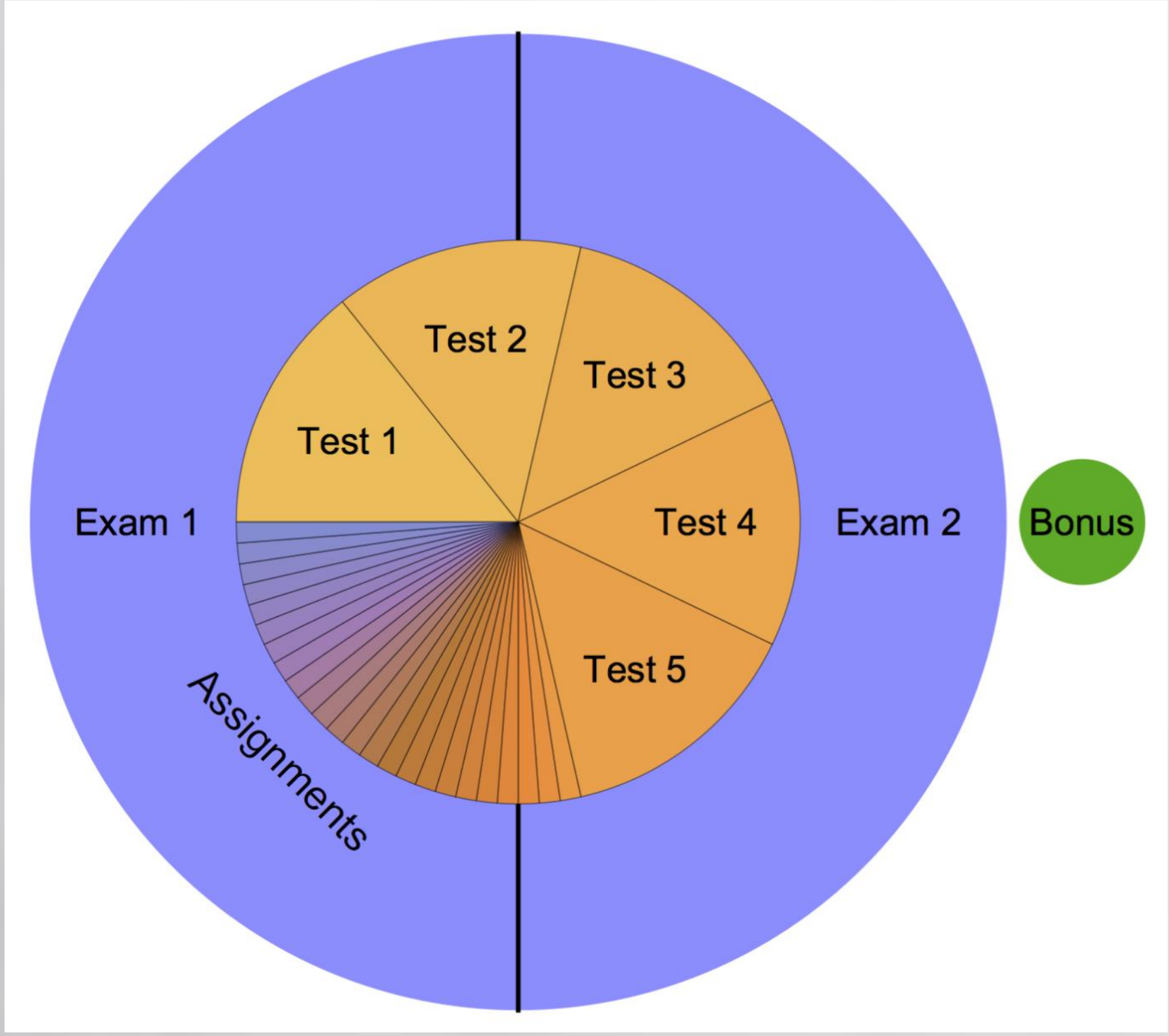
On being comfortable with being uncomfortable

Passive versus active learning

Cultivating the confidence to fail

The problem with emails

Bonus marks - the key to it all!



How do we empower students? Going beyond MAM1000W

Tutorials and tutors

The issue with postgrads, the benefits of undergrads

Sanjiv Ranchod

I'm a 2nd year studying a BSc in Maths and Applied Maths. I like maths (kind of a lot). I hope you do too! Come say hi if you see me around ^.^

question	undergrad	postgrad	experienced
knowledge	$\{\mu=3.17167, \sigma=0.391685\}$	$\{\mu=2.66786, \sigma=0.333765\}$	$\{\mu=3.354, \sigma=0.443512\}$
communication	$\{\mu=2.92984, \sigma=0.524189\}$	$\{\mu=2.65317, \sigma=0.412658\}$	$\{\mu=3.08554, \sigma=0.540372\}$
approachability	$\{\mu=3.11102, \sigma=0.431509\}$	$\{\mu=2.82262, \sigma=0.625365\}$	$\{\mu=3.13456, \sigma=0.527347\}$

Mentors

Yolisa Ncobo

Bio: I'm a third year student. I'd describe myself as friendly, supportive and considerate. I try give 100% in everything I commit to do and have committed to helping you. I hope to help you develop the necessary tools to make tackling math a lot more manageable. Words to first years studying MAM1000W: Breathe. Despite how overwhelming and impossible it may seem now, it can be done. Others before you have managed, so can you. The transition from high school to university can be challenging, but there's hope. Stay present and open to the new experiences and the learning opportunities varsity provide Be open to the process of learning and unlearning. Don't be afraid to admit when you need help

Degree: Applied Statistics

Contact details: ncbyol001@myuct.ac.za, Whatsapp: 0723175631

Singalakha Menziwa

My name is Singalakha, I am originally from KwaZulu Natal. I am a second year Bachelor of Science student majoring in Mathematics and Mathematical Statistics. I love collaborative working, I am excited to

Online textbook use

Property 1 says that the integral of a constant function $f(x) = c$ is the constant times the length of the interval. If $c > 0$ and $a < b$, this is to be expected because $c(b - a)$ is the area of the shaded rectangle in Figure 13.

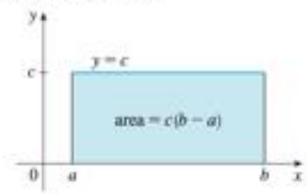


FIGURE 13
$\int_a^b c\,dx = c(b - a)$

Property 2 says that the integral of a sum is the sum of the integrals. For positive functions it says that the area under $f + g$ is the area under f plus the area under g. Figure 14 helps us understand why this is true: in view of how graphical addition works, the corresponding vertical line segments have equal height.

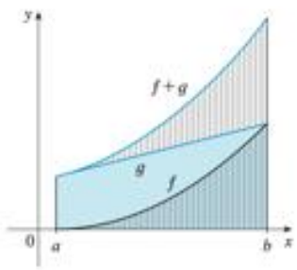


FIGURE 14
$\int_a^b [f(x) + g(x)]\,dx = \int_a^b f(x)\,dx + \int_a^b g(x)\,dx$

In general, Property 2 follows from Theorem 4 and the fact that the limit of a sum is the sum of the limits:

$$\begin{aligned}\int_a^b [f(x) + g(x)]\,dx &= \lim_{n\to\infty} \sum_{i=1}^{n} [f(x_i) + g(x_i)]\,\Delta x \\ &= \lim_{n\to\infty} \left[\sum_{i=1}^{n} f(x_i)\,\Delta x + \sum_{i=1}^{n} g(x_i)\,\Delta x\right] \\ &= \lim_{n\to\infty} \sum_{i=1}^{n} f(x_i)\,\Delta x + \lim_{n\to\infty} \sum_{i=1}^{n} g(x_i)\,\Delta x \\ &= \int_a^b f(x)\,dx + \int_a^b g(x)\,dx\end{aligned}$$

Property 3 seems intuitively reasonable because we know that multiplying a function by a positive number c stretches or shrinks its graph vertically by a factor of c. So it stretches or shrinks each approximating rectangle by a factor c and therefore it has the effect of multiplying the area by c.

Property 3 can be proved in a similar manner and says that the integral of a constant times a function is the constant times the integral of the function. In other words, a constant (but *only* a constant) can be taken in front of an integral sign. Property 4 is proved by writing $f - g = f + (-g)$ and using Properties 2 and 3 with $c = -1$.

EXAMPLE 6 Use the properties of integrals to evaluate $\int_0^1 (4 + 3x^2)\,dx$.

SOLUTION Using Properties 2 and 3 of integrals, we have

$$\int_0^1 (4 + 3x^2)\,dx = \int_0^1 4\,dx + \int_0^1 3x^2\,dx = \int_0^1 4\,dx + 3\int_0^1 x^2\,dx$$

We know from Property 1 that

$$\int_0^1 4\,dx = 4(1 - 0) = 4$$

and we found in Example 4.1.2 that $\int_0^1 x^2\,dx = \frac{1}{3}$. So

$$\begin{aligned}\int_0^1 (4 + 3x^2)\,dx &= \int_0^1 4\,dx + 3\int_0^1 x^2\,dx \\ &= 4 + 3\cdot\tfrac{1}{3} = 5\end{aligned}$$

■

The next property tells us how to combine integrals of the same function over adjacent intervals.

Online assignments

4. **Question Details** SCalc8 12.1.004. [3352355]

Consider the point.

(4, 5, 6)

What is the projection of the point on the *xy*-plane?

$(x, y, z) = (\quad)$

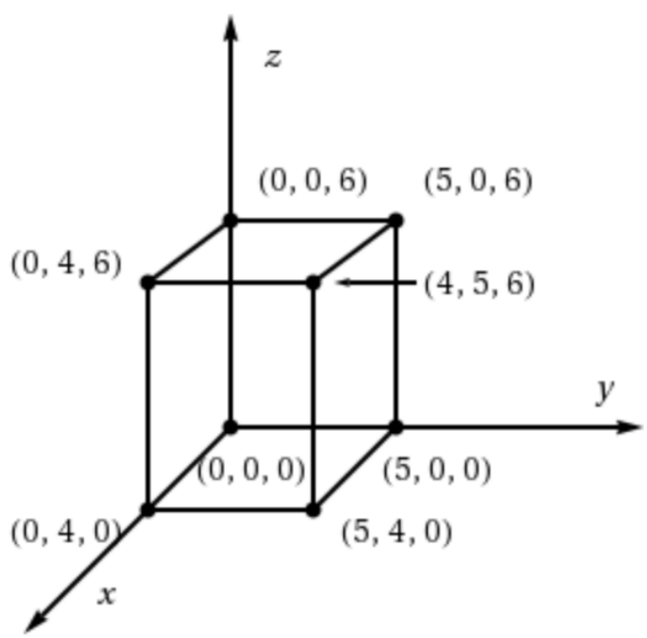
What is the projection of the point on the *yz*-plane?

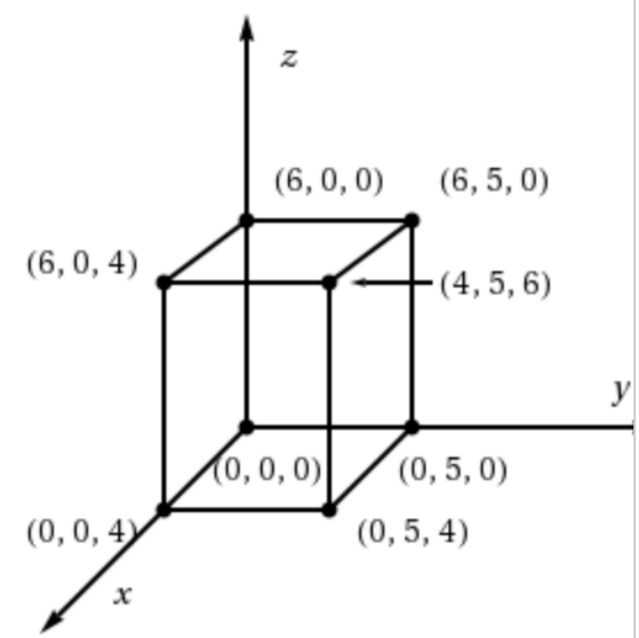
$(x, y, z) = (\quad)$

What is the projection of the point on the *xz*-plane?

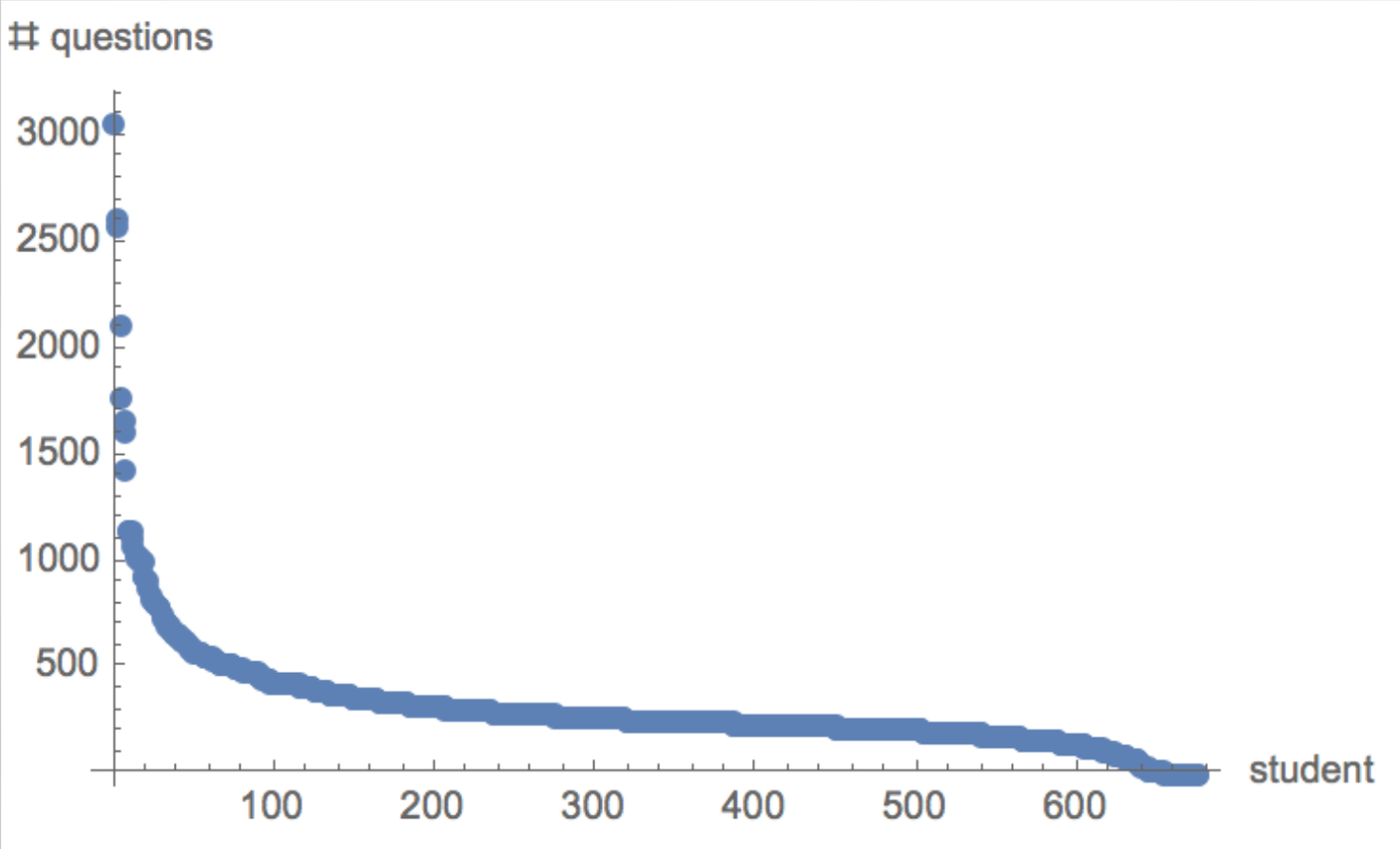
$(x, y, z) = (\quad)$

Draw a rectangular box with the origin and (4, 5, 6) as opposite vertices and with its faces parallel to the coordinate planes. Label all vertices of the box.





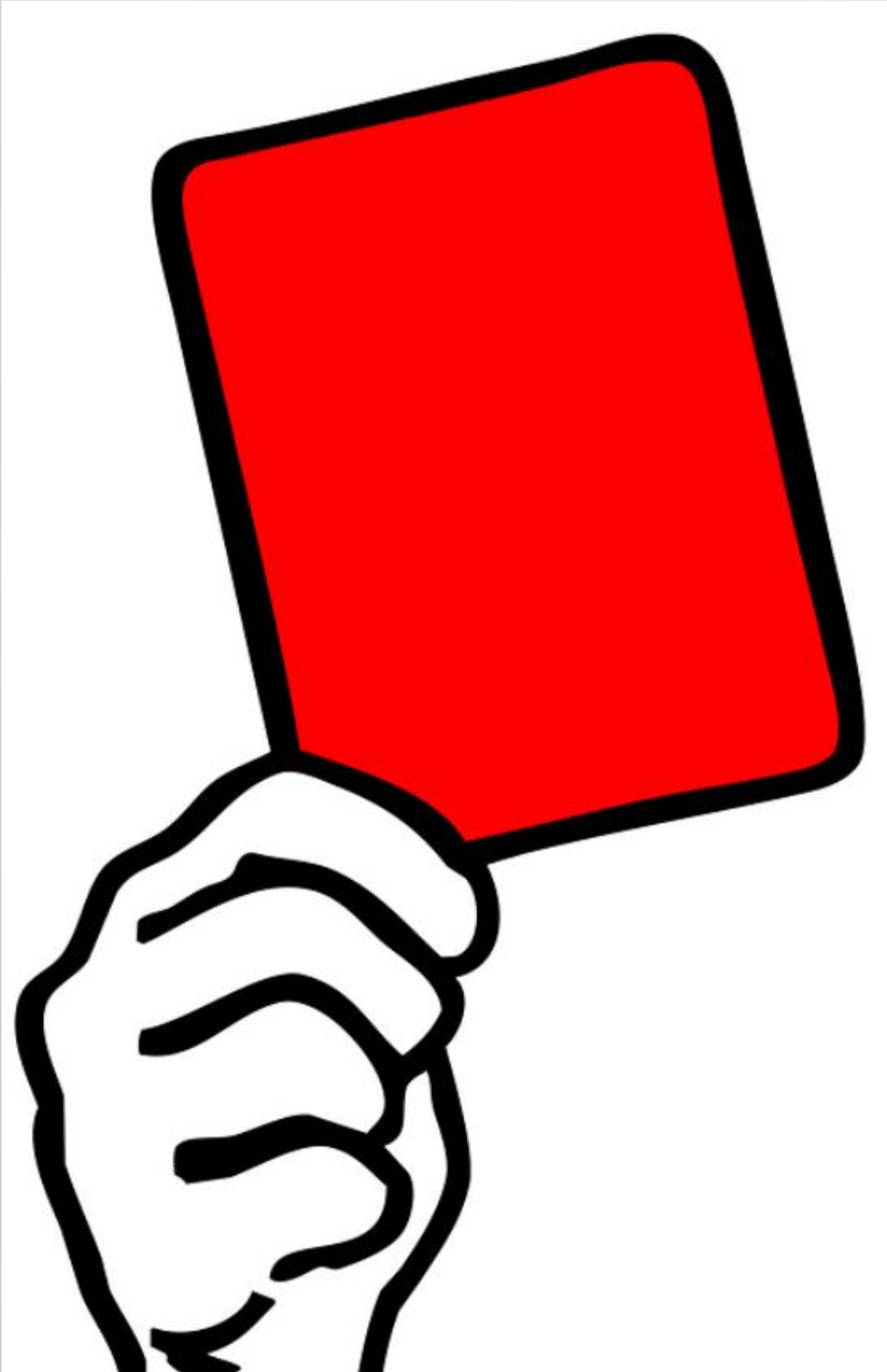
Online assignments



Finding:

- Doing a lot of voluntary assignments correlates well with good final marks
- Doing a very large number starts to become negatively correlated

Empowering the student with the red card



Seeing well-written mathematics

There is a correlation between views of tuts and exam scores.

However, overuse correlates with very low scores

4) a) For every +ve integer n,

$$1+3+5+\ldots(2n-1)=n^2$$

Base case, $n=1$

$2n-1=1$ so the LHS $=1$

RHS $=1^2$ ✓

Inductive hypothesis: Assume it holds true for some $n=k$.

$$1+3+5+\ldots(2k-1)=k^2$$

Now look at $n=k+1$

$$1+3+5+\ldots(2k-1)+(2(k+1)-1)$$

$= k^2+(2(k+1)-1)$ by the inductive hypothesis.

$= k^2+2k+1=(k+1)^2$

$\therefore$ by the inductive step it holds true for $k+1$.

$\therefore$ The statement holds true for all +ve integers.

Regular questionnaires

We have the power to get almost immediate feedback:

- What do you find most confusing in class?
- Which sections have you enjoyed most?
- What did you think of the experiment X in class?

Exam and test time

o we try and test the speed with which students can answer ques

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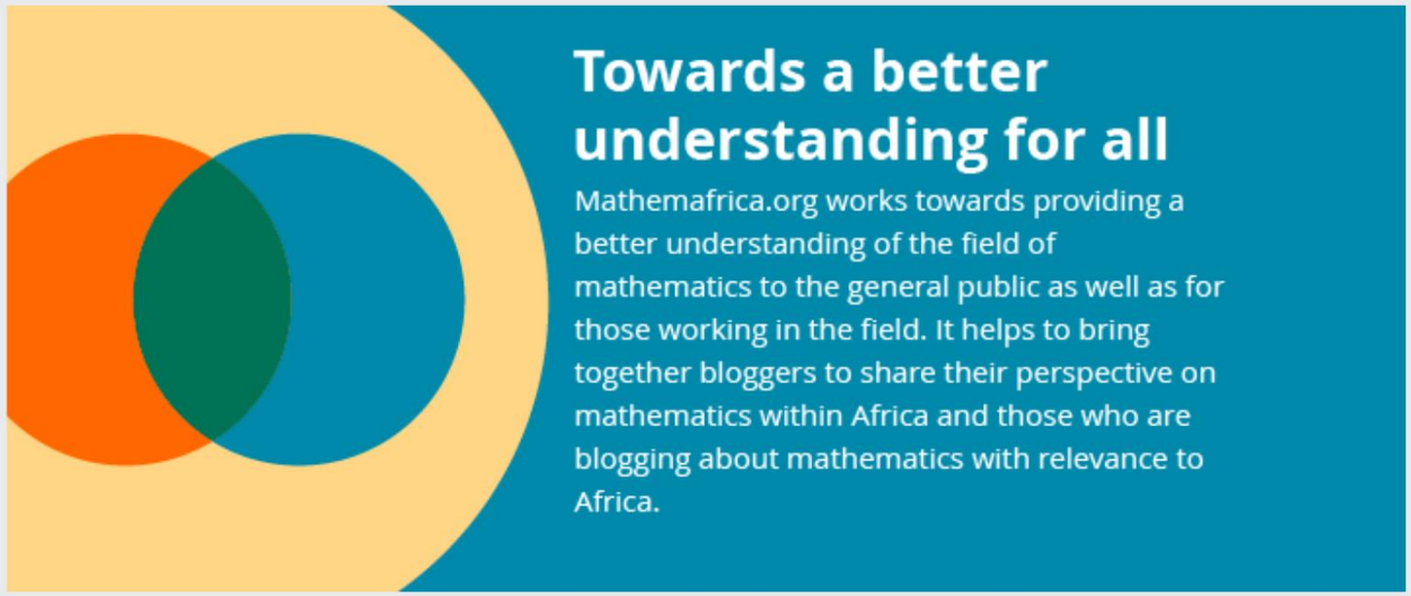

Sticky Post – Read this first. Categories and Links in Mathemafrica

The navigability of Mathemafrica isn't ideal, so I have created this post which might guide you to what you are looking for. Here are a number of different categories of post which you might like to take a look at: First year mathematics notes and resources (particularly for the University [...]

By Jonathan Shock | January 17th, 2018 | 0 Comments Read More >

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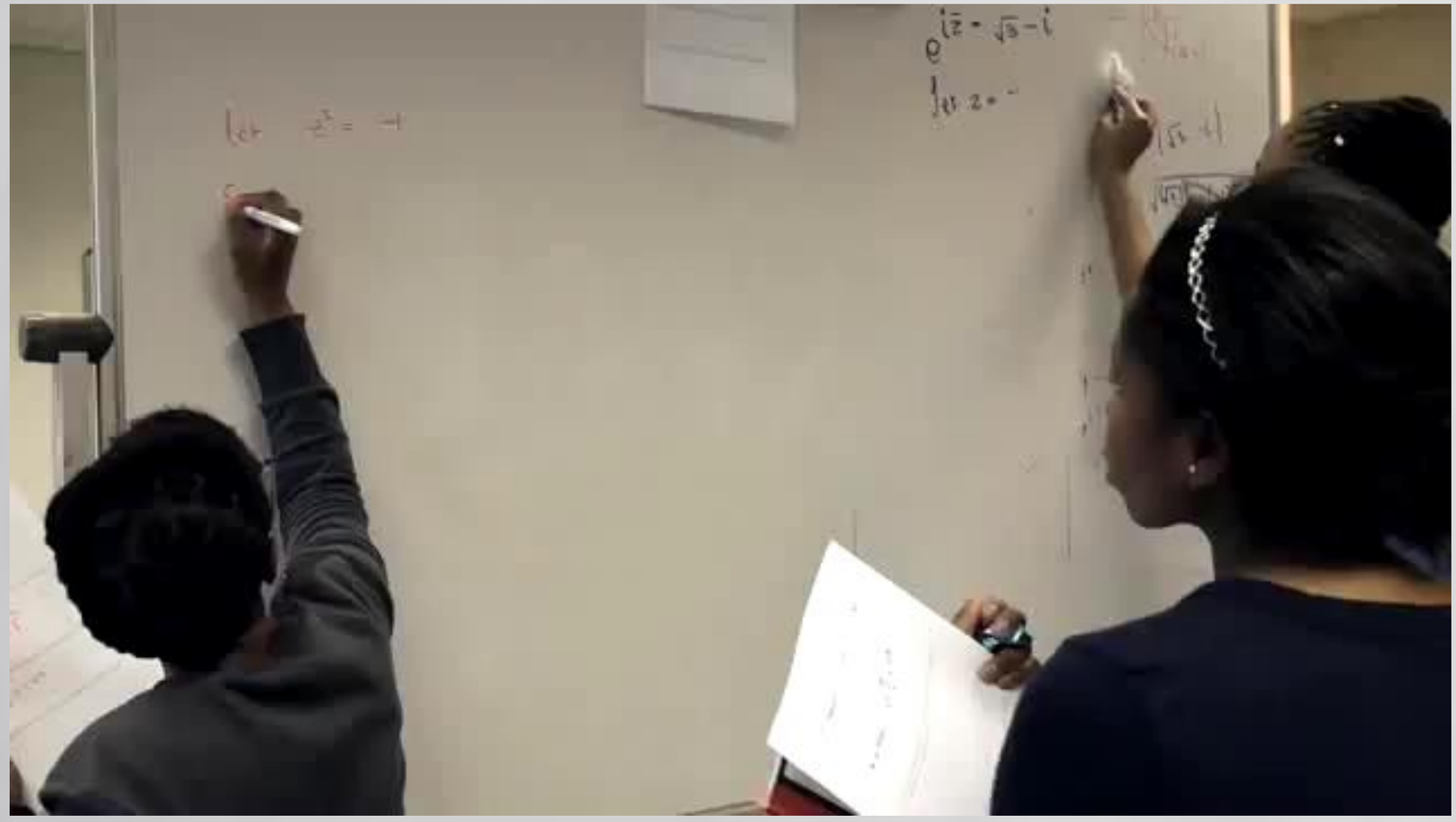

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This is not an exhaustive list, but is a rough outline of some of the things I've tried. I'm happy to have criticism and ideas!

Thank you!