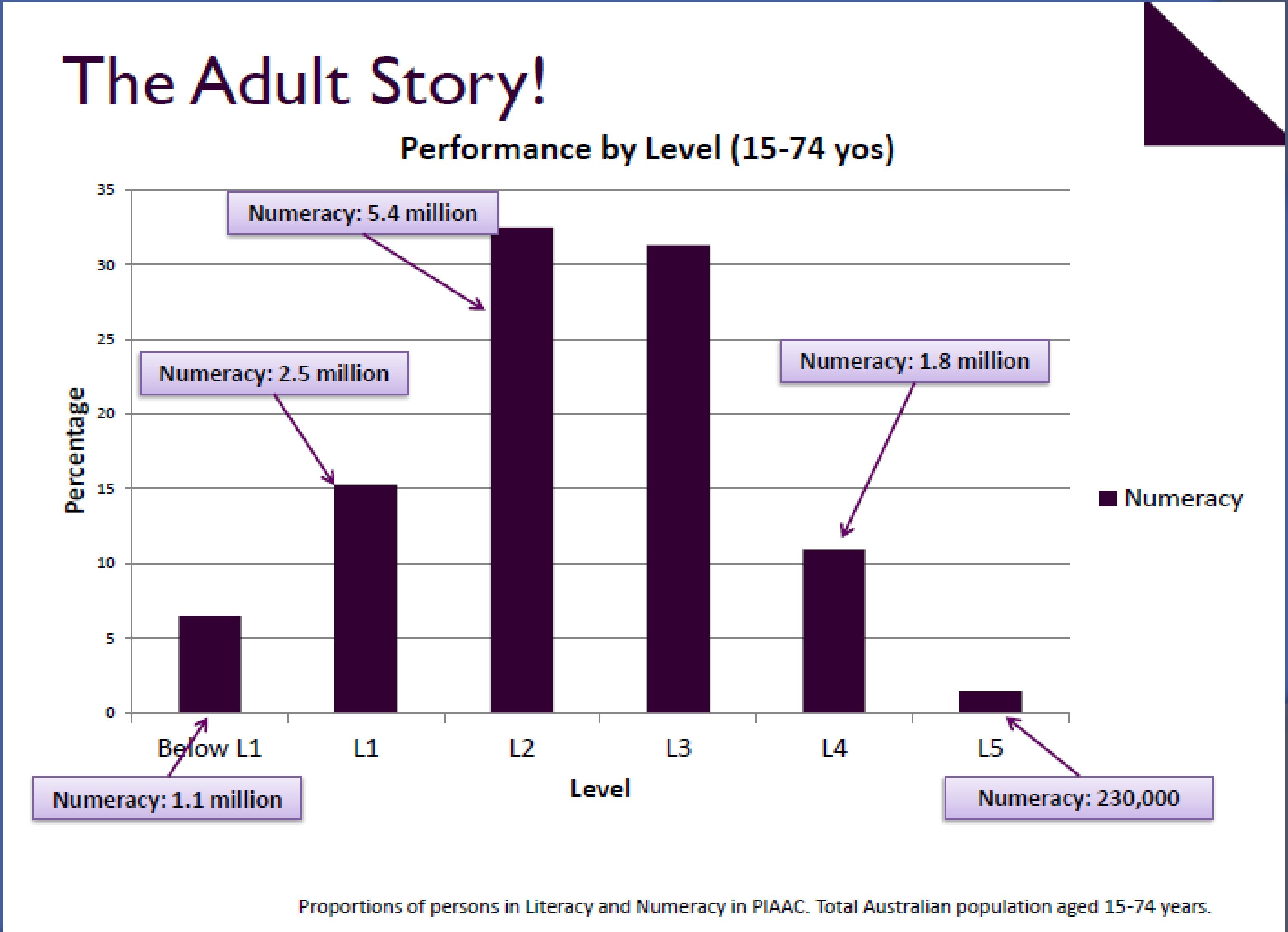
Building Teacher Efficacy in Numeracy through Formative Assessment

Karen McCord
Josh Morris
Colin Johnson
Rob Proffitt-White

A response to the growing problem in mathematical knowledge, attitude and disposition with Australia



The Adult Story!

Performance by Level (15-74 yos)

Numeracy: 5.4 million

Numeracy: 2.5 million

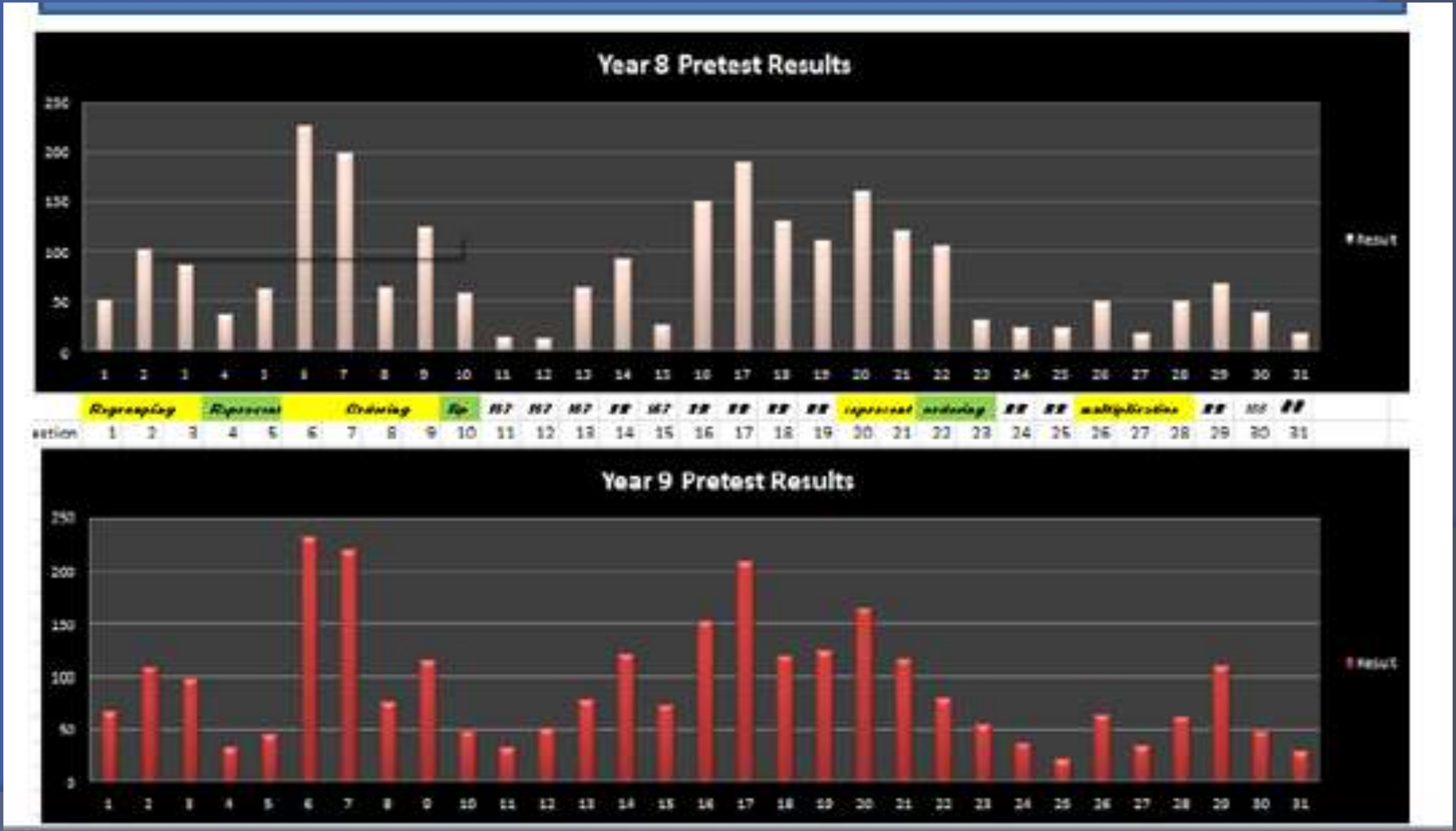
Numeracy: 1.8 million

Numeracy: 1.1 million

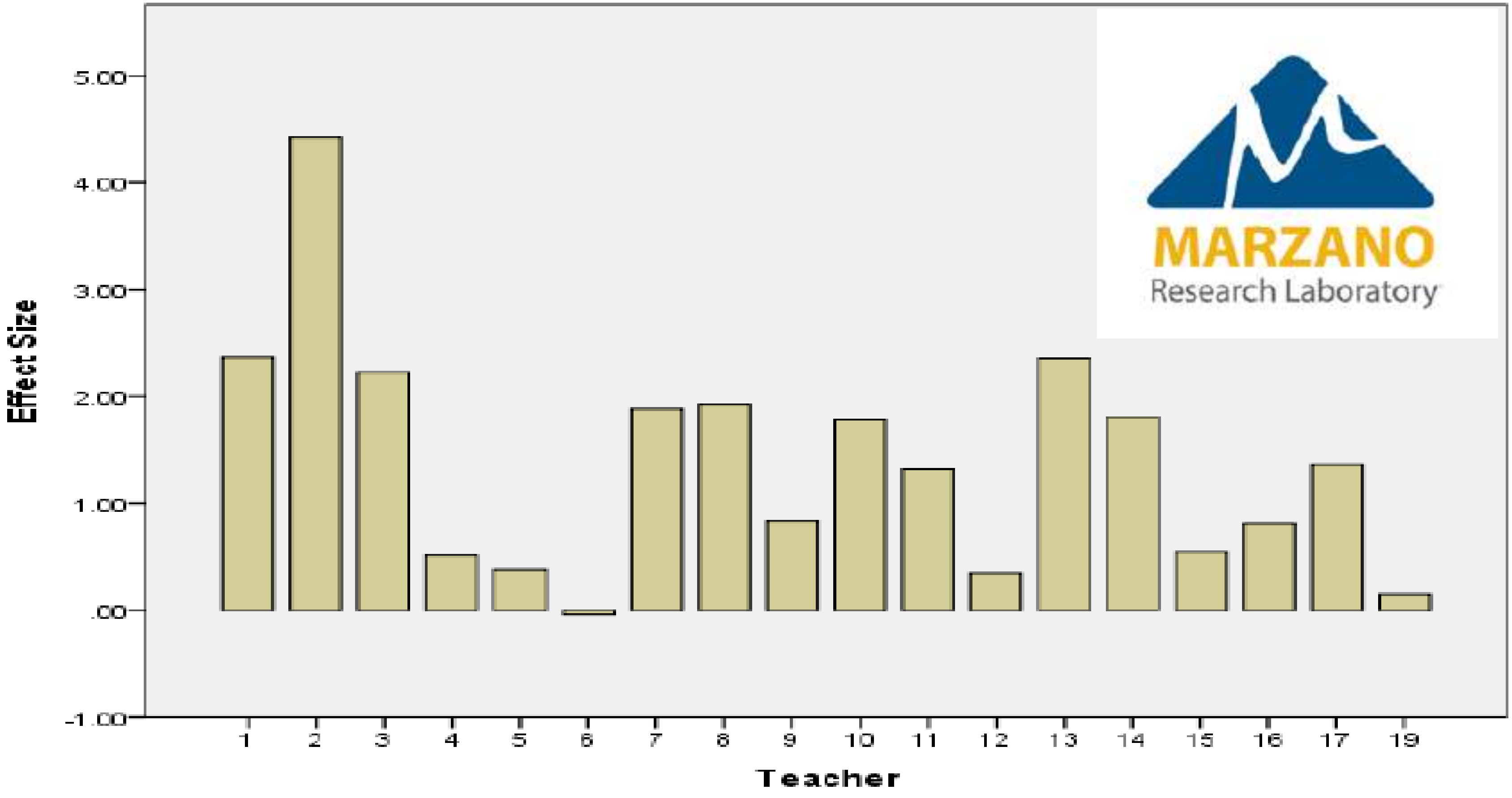
Numeracy: 230,000

Proportions of persons in Literacy and Numeracy in PIAAC. Total Australian population aged 15-74 years.

2012-2013
Tracking key conceptual understandings in 6 High Schools

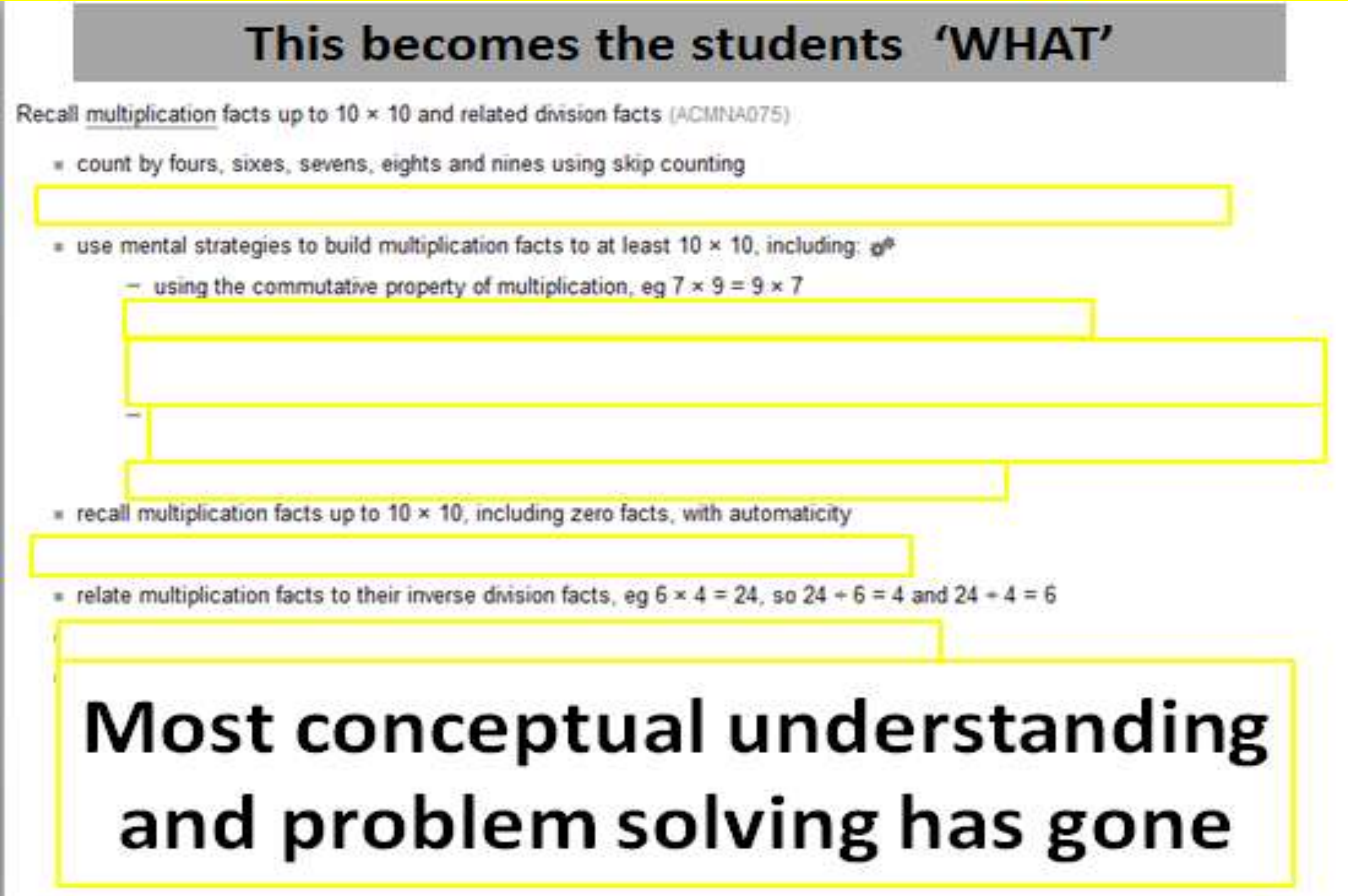


Attitudes and Beliefs as variables!



Under What conditions does size effect work?

Evidence around lack of understanding



This becomes the students 'WHAT'

Recall multiplication facts up to 10 × 10 and related division facts (ACMNA075)

- count by fours, sixes, sevens, eights and nines using skip counting

[redacted]

- use mental strategies to build multiplication facts to at least 10 × 10, including:
  - using the commutative property of multiplication, eg 7 × 9 = 9 × 7

[redacted]

- recall multiplication facts up to 10 × 10, including zero facts, with automaticity

[redacted]

- relate multiplication facts to their inverse division facts, eg 6 × 4 = 24, so 24 ÷ 6 = 4 and 24 ÷ 4 = 6

[redacted]

Most conceptual understanding and problem solving has gone

Procedural V Conceptual

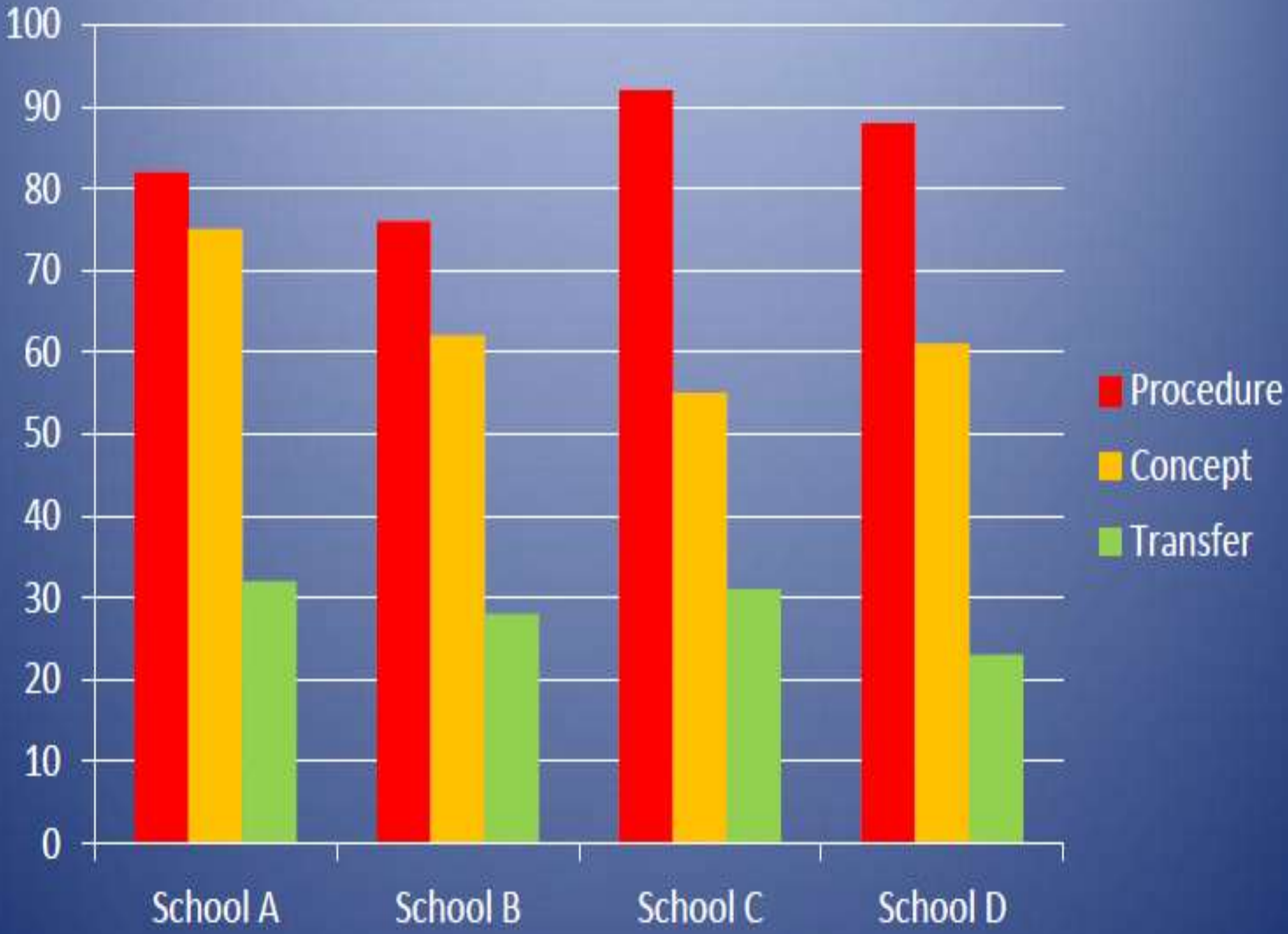
Find the largest number using these 4 digits

Year 3	**92 %**
Year 5	**98%**

Find the third largest number using these 4 digits

Year 3	**42%**
Year 5	**57%**

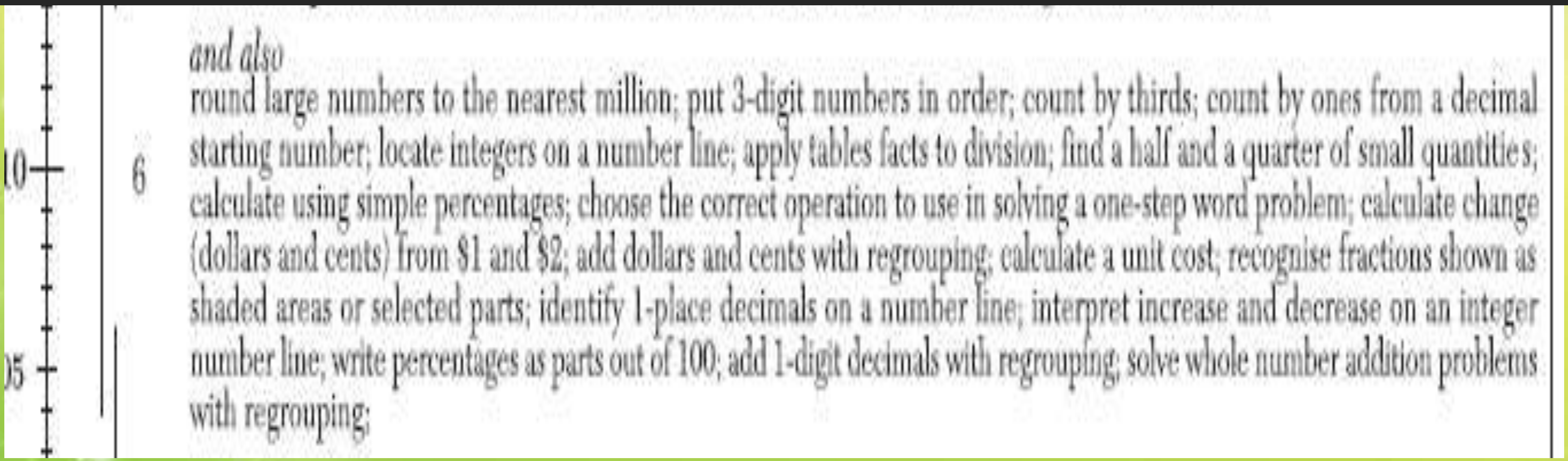
2014: Evidence based: Gaps in capacity



The achievement standards?

- By the end of Year 3, students recognise the connection between addition and subtraction and solve problems using efficient strategies for multiplication. They model and represent unit fractions. They represent money values in various ways. Students identify symmetry in the

2011-2013 National Partnership Findings



and also
round large numbers to the nearest million; put 3-digit numbers in order; count by thirds; count by ones from a decimal starting number; locate integers on a number line; apply tables facts to division; find a half and a quarter of small quantities; calculate using simple percentages; choose the correct operation to use in solving a one-step word problem; calculate change (dollars and cents) from $1 and $2; add dollars and cents with regrouping; calculate a unit cost; recognise fractions shown as shaded areas or selected parts; identify 1-place decimals on a number line; interpret increase and decrease on an integer number line; write percentages as parts out of 100; add 1-digit decimals with regrouping; solve whole number addition problems with regrouping;

Data Tools and Data Literacy

Pre Post Testing Success

Size effects were measuring procedural only

Colourful charts and displays

Computer generated %, charts, graphs

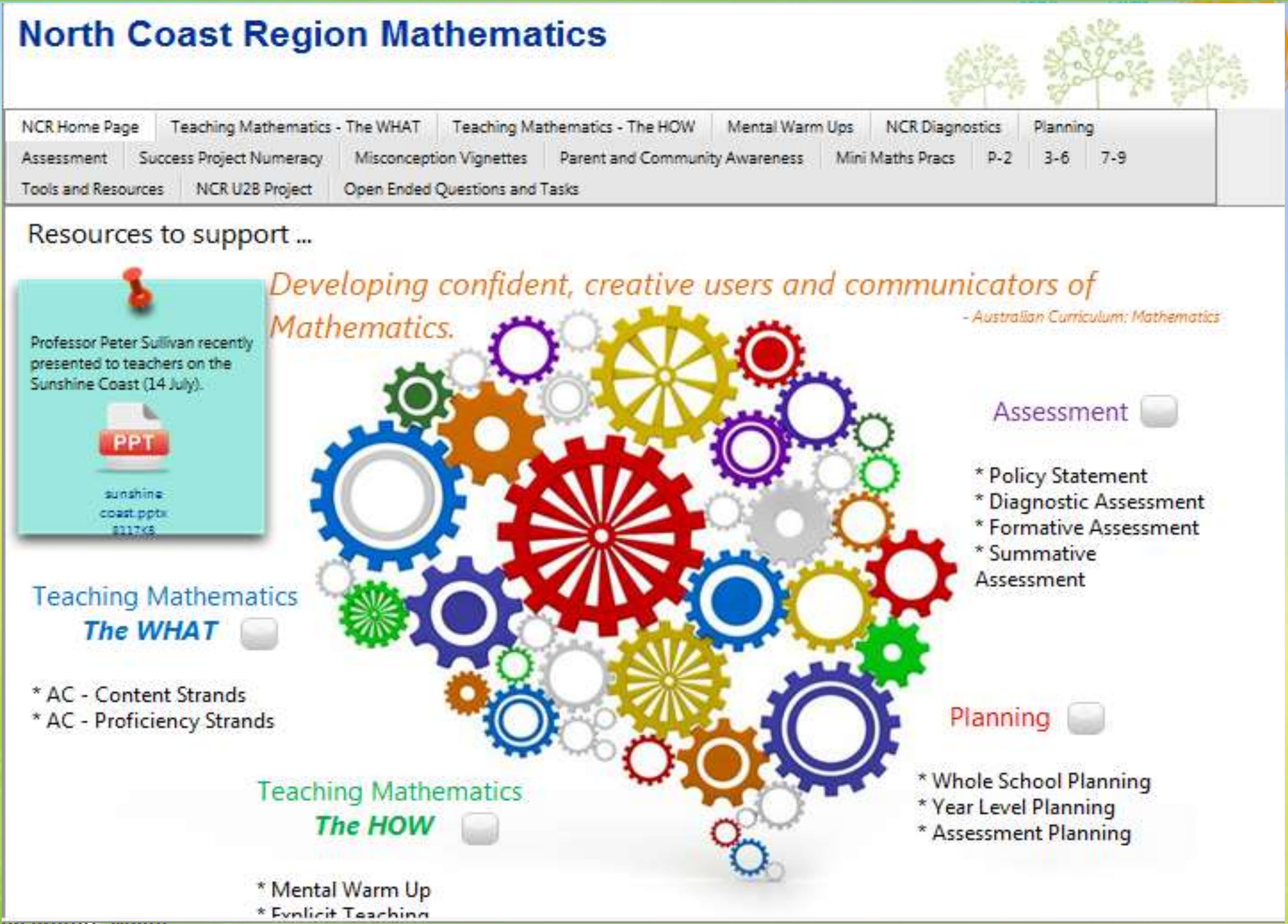
Assessment Questions still procedural

Most were multiple choice/online

Proficiencies missing

Initial gains not sustained, often forgotten

SET UP A STATEWIDE LEARNING PLATFORM FOR ALL TEACHERS



North Coast Region Mathematics

NCR Home Page
Teaching Mathematics - The WHAT
Teaching Mathematics - The HOW
Mental Warm Ups
NCR Diagnostics
Planning
Assessment
Success Project Numeracy
Misconception Vignettes
Parent and Community Awareness
Mini Maths Pracs
P-2
3-6
7-9
Tools and Resources
NCR U2B Project
Open Ended Questions and Tasks

Resources to support ...

Professor Peter Sullivan recently presented to teachers on the Sunshine Coast (14 July).

PPT
sunshine coast.pptx
8117KB

Developing confident, creative users and communicators of Mathematics.

- Australian Curriculum: Mathematics

Teaching Mathematics
The WHAT ☐

* AC - Content Strands
* AC - Proficiency Strands

Assessment ☐

* Policy Statement
* Diagnostic Assessment
* Formative Assessment
* Summative Assessment

Planning ☐

* Whole School Planning
* Year Level Planning
* Assessment Planning

Teaching Mathematics
The HOW ☐

* Mental Warm Up
* Explicit Teaching

Warm ups

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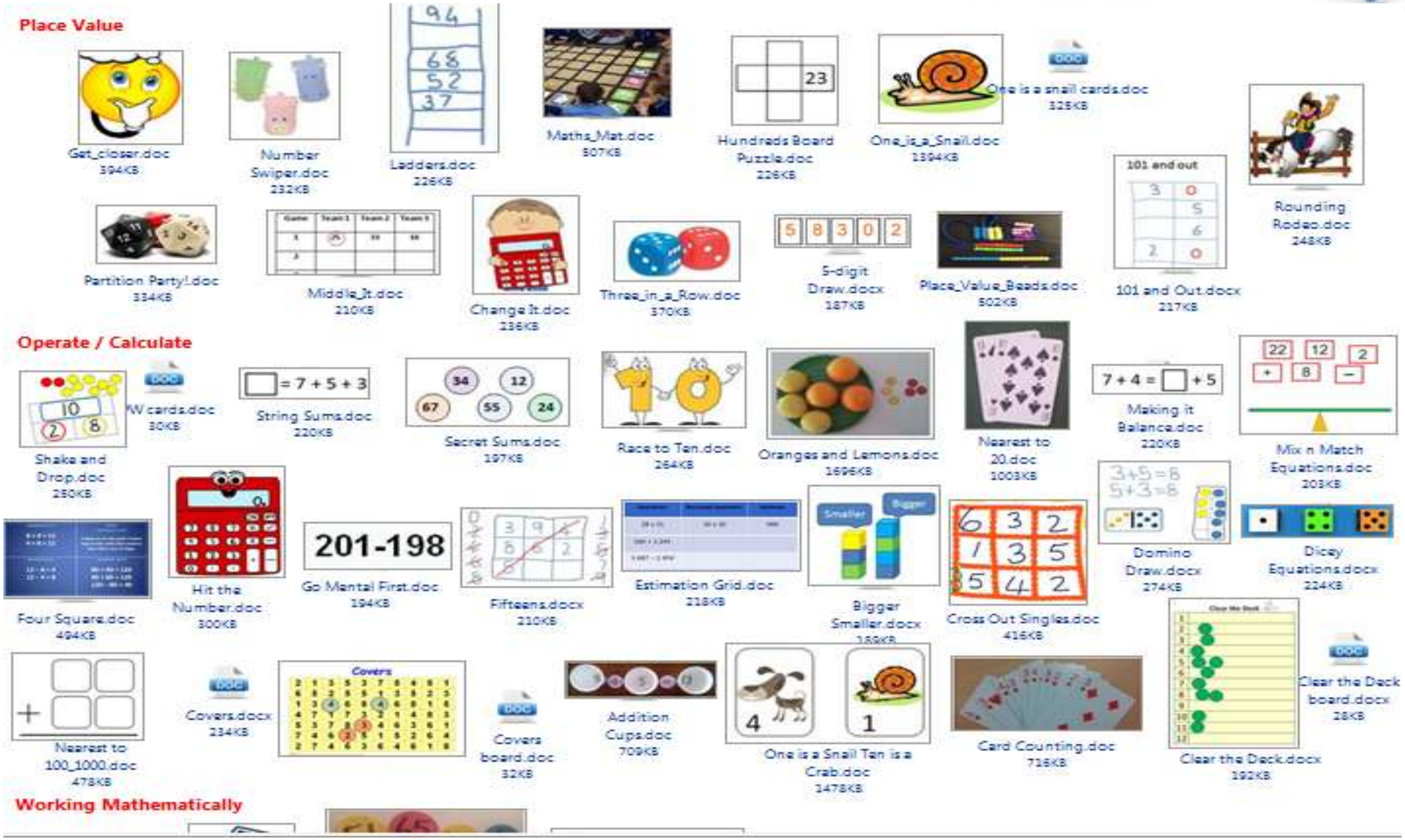
North Coast Region
Mathematics



Place Value

Get_closer.doc 394KB
Number Swiper.doc 232KB
Ladders.doc 226KB
Maths_Mat.doc 307KB
Hundreds Board Puzzle.doc 226KB
One_is_a_Snail.doc 1394KB
One is a snail cards.doc 325KB
Rounding Rodeo.doc 248KB
101 and Out.docx 217KB
Partition Party!.doc 334KB
Middle_It.doc 210KB
Change It.doc 236KB
Three_in_a_Row.doc 370KB
5-digit Draw.docx 187KB
Place_Value_Beads.doc 302KB

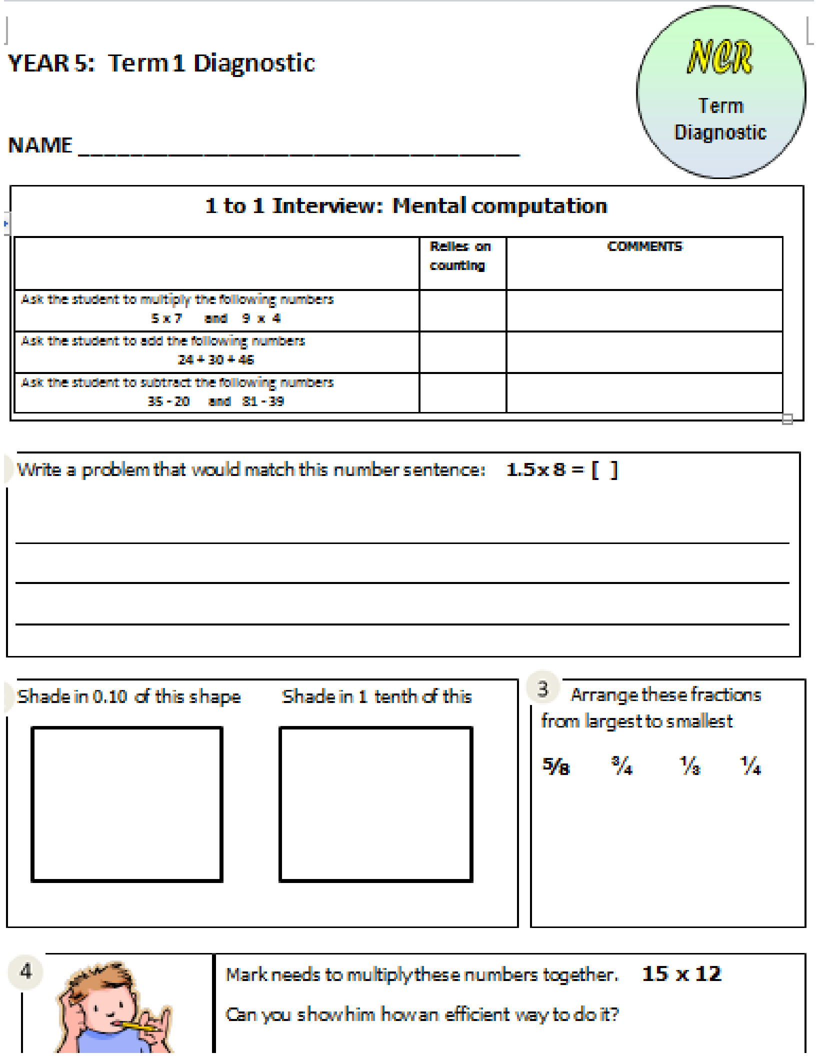
Operate / Calculate

Shake and Drop.doc 250KB
W cards.doc 30KB
String Sums.doc 220KB
Secret Sums.doc 197KB
Race to Ten.doc 264KB
Oranges and Lemons.doc 1696KB
Nearest to 20.doc 1003KB
Making it Balance.doc 220KB
Mix n Match Equations.doc 203KB
Four Square.doc 494KB
Hit the Number.doc 300KB
Go Mental First.doc 194KB
Fifteens.docx 210KB
Estimation Grid.doc 218KB
Bigger Smaller.docx 189KB
Cross Out Singles.doc 416KB
Domino Draw.docx 274KB
Dicey Equations.docx 224KB
Nearest to 100_1000.doc 478KB
Covers.docx 234KB
Covers board.doc 32KB
Addition Cups.doc 709KB
One is a Snail Ten is a Crab.doc 1478KB
Card Counting.doc 716KB
Clear the Deck.docx 192KB
Clear the Deck board.docx 28KB

Working Mathematically

Diagnostic Tests
Pre and Post

North Coast Region
Mathematics



YEAR 5: Term 1 Diagnostic

NCR
Term Diagnostic

NAME ________________________________

1 to 1 Interview: Mental computation

	Relies on counting	COMMENTS
Ask the student to multiply the following numbers 5 x 7 and 9 x 4		
Ask the student to add the following numbers 24 + 30 + 46		
Ask the student to subtract the following numbers 35 - 20 and 81 - 39		

Write a problem that would match this number sentence: **1.5x 8 = [ ]**

Shade in 0.10 of this shape

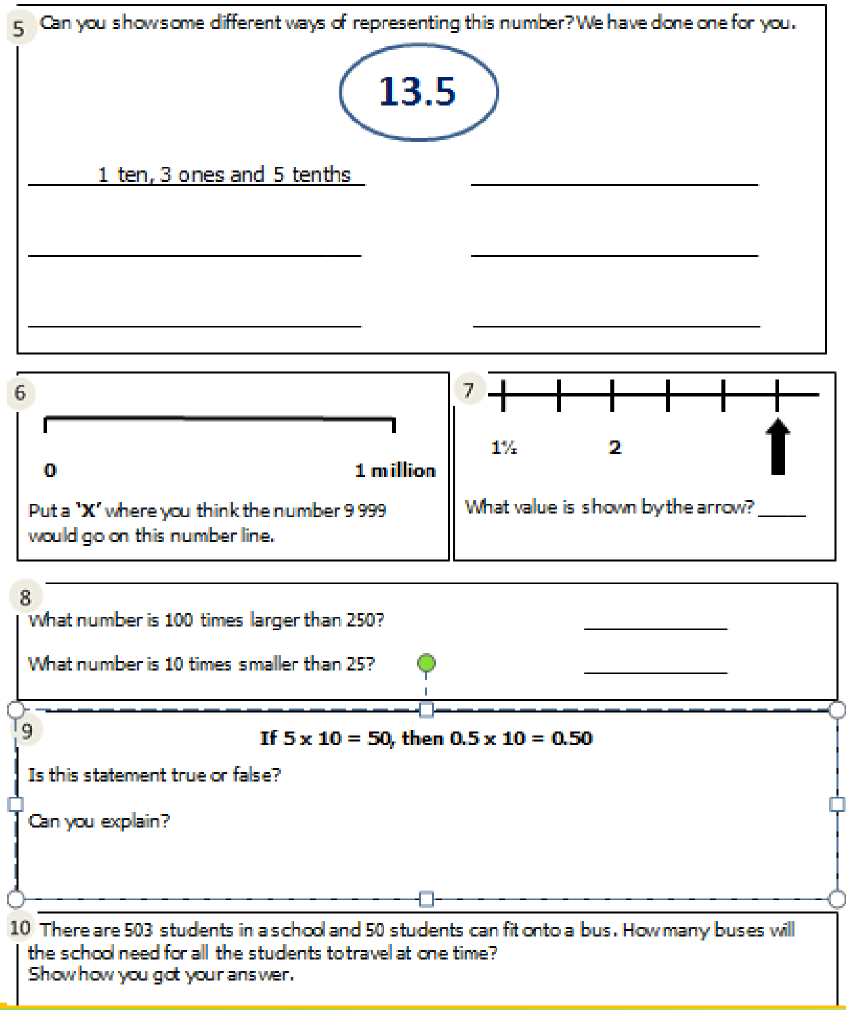
Shade in 1 tenth of this

3 Arrange these fractions from largest to smallest

⅝ ¾ ⅓ ¼

4 Mark needs to multiply these numbers together. **15 x 12**

Can you show him how an efficient way to do it?



5 Can you show some different ways of representing this number? We have done one for you.

13.5

1 ten, 3 ones and 5 tenths

6 **0** **1 million**

Put a **'X'** where you think the number 9 999 would go on this number line.

7 **1½** **2**

What value is shown by the arrow? _____

8 What number is 100 times larger than 250? __________

What number is 10 times smaller than 25? __________

9 **If 5 x 10 = 50, then 0.5 x 10 = 0.50**

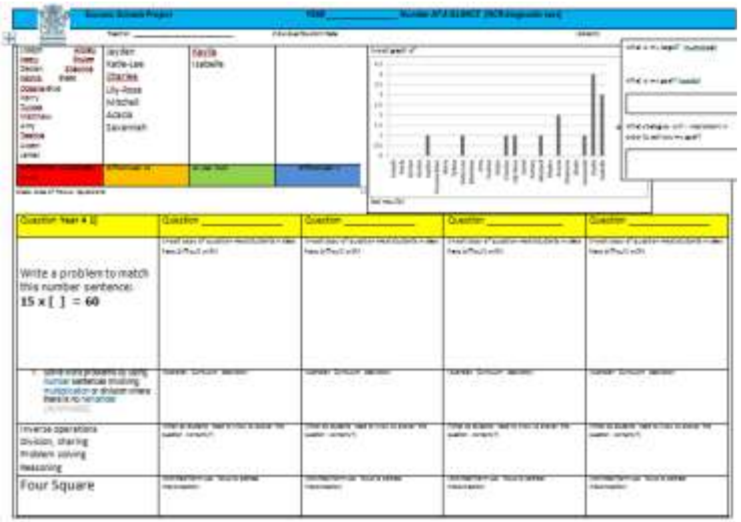
Is this statement true or false?

Can you explain?

10 There are 503 students in a school and 50 students can fit onto a bus. How many buses will the school need for all the students to travel at one time?
Show how you got your answer.

NCR Resources to support the development of quality teaching and learning

North Coast Region
Mathematics



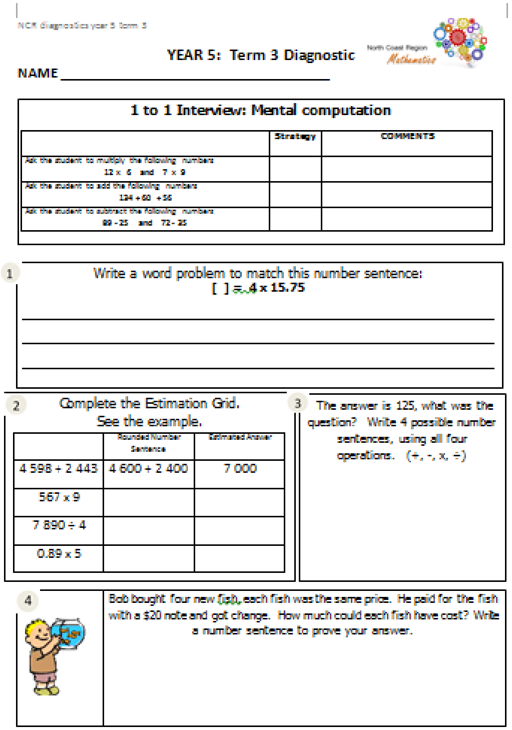
Jayden
Katie-Lee
Charlee
Lily-Rose
Mitchell
Acacia
Savannah

Isabelle

Write a problem to match this number sentence:
15 x [ ] = 60

Inverse operations
Division, sharing
Problem solving
Reasoning

Four Square



NCR diagnostics year 5 term 3

YEAR 5: Term 3 Diagnostic

North Coast Region *Mathematics*

NAME ________________________________

1 to 1 Interview: Mental computation

	Strategy	**COMMENTS**
Ask the student to multiply the following numbers 12 x 6 and 7 x 9		
Ask the student to add the following numbers 134 + 60 + 56		
Ask the student to subtract the following numbers 89 - 25 and 72 - 35		

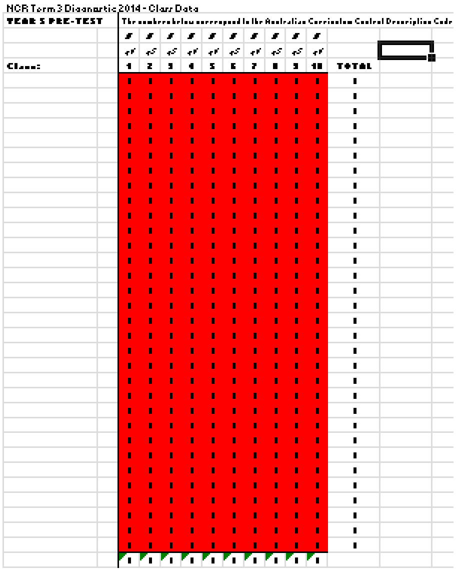
1 Write a word problem to match this number sentence:
[ ] = 4 x 15.75

2 Complete the Estimation Grid.
See the example.

	Rounded Number Sentence	Estimated Answer
4 598 + 2 443	4 600 + 2 400	7 000
567 x 9		
7 890 ÷ 4		
0.89 x 5		

3 The answer is 125, what was the question? Write 4 possible number sentences, using all four operations. (+, -, x, ÷)

4 Bob bought four new fish, each fish was the same price. He paid for the fish with a $20 note and got change. How much could each fish have cost? Write a number sentence to prove your answer.

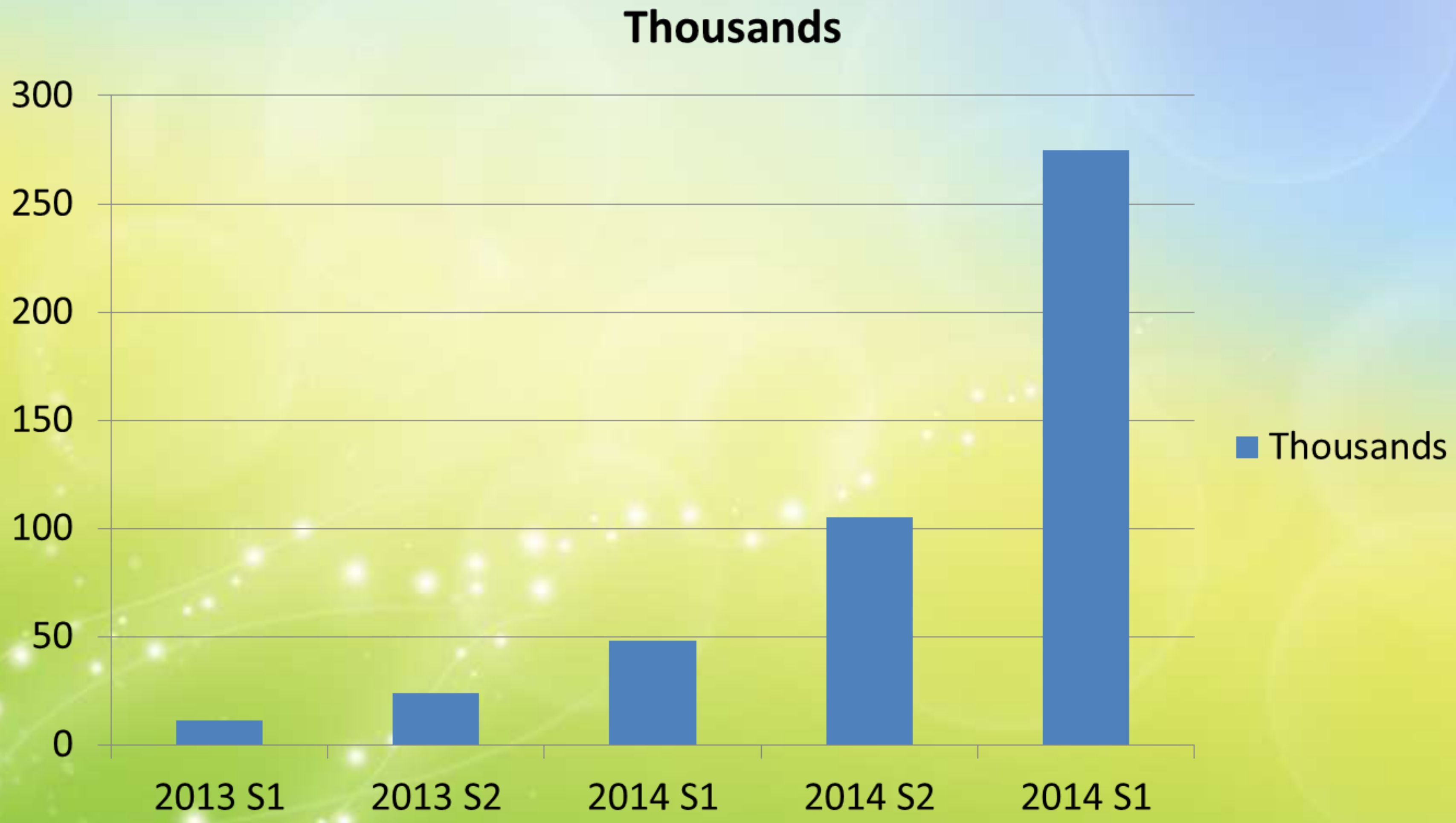


NCR Term 3 Diagnostic 2014 - Class Data

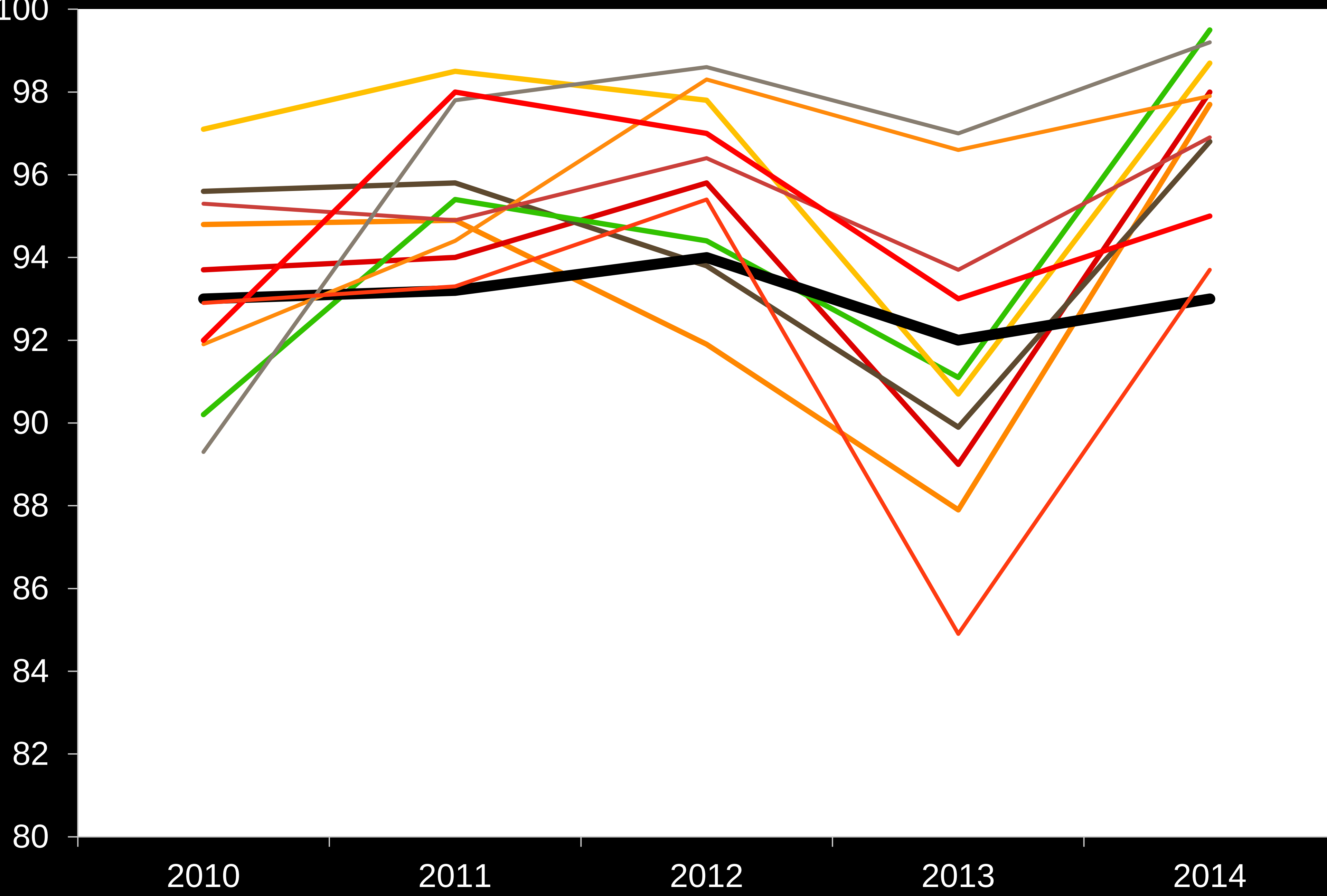
YEAR 5 PRE-TEST	The numbers below correspond to the Australian Curriculum Content Description Code										
Class:	1	2	3	4	5	6	7	8	9	10	TOTAL

Year 6 Data
501
Year 7 Dat

Tracking the HITS on the Learning Platform from 2012



Encouraging initial data and subsequent scaling up



Aim of Success Team

We make mathematics enjoyable and accessible by all; teachers and students

Develop assessment literacy

Promote and instill assessment AS and FOR

Initiate and sustain an internal expert team

Make students instructional resources of their own learning

Student’s mathematical achievement is unlikely to improve without professional development focusing on mathematics content.

(Telese, 2008)

10 visits per semester

Initiate Instructional Rounds

Leadership create strategic key team

Coach, mentor and collaborate

Build capacity to create resources

Initiate PLCs and school networks

PHASE A: January 2014 – June 2014
PHASE B: July 2014 – December 2014
PHASE C: January 2015 – June 2015
PHASE D: July 2015 – December 2015

Phase A and B are sustaining the momentum

13 State High Schools
3 P-12 Colleges
22 State Primary Schools

Intended, Implemented, Attained

SULLIVAN: Understanding Mathematical Proficiencies

ASKEW: Traits of effective mathematics teachers

HATTIE: Visible learning

STACEY/ANDERSON: Problem Solving culture

FULLAN: Instructional Leadership

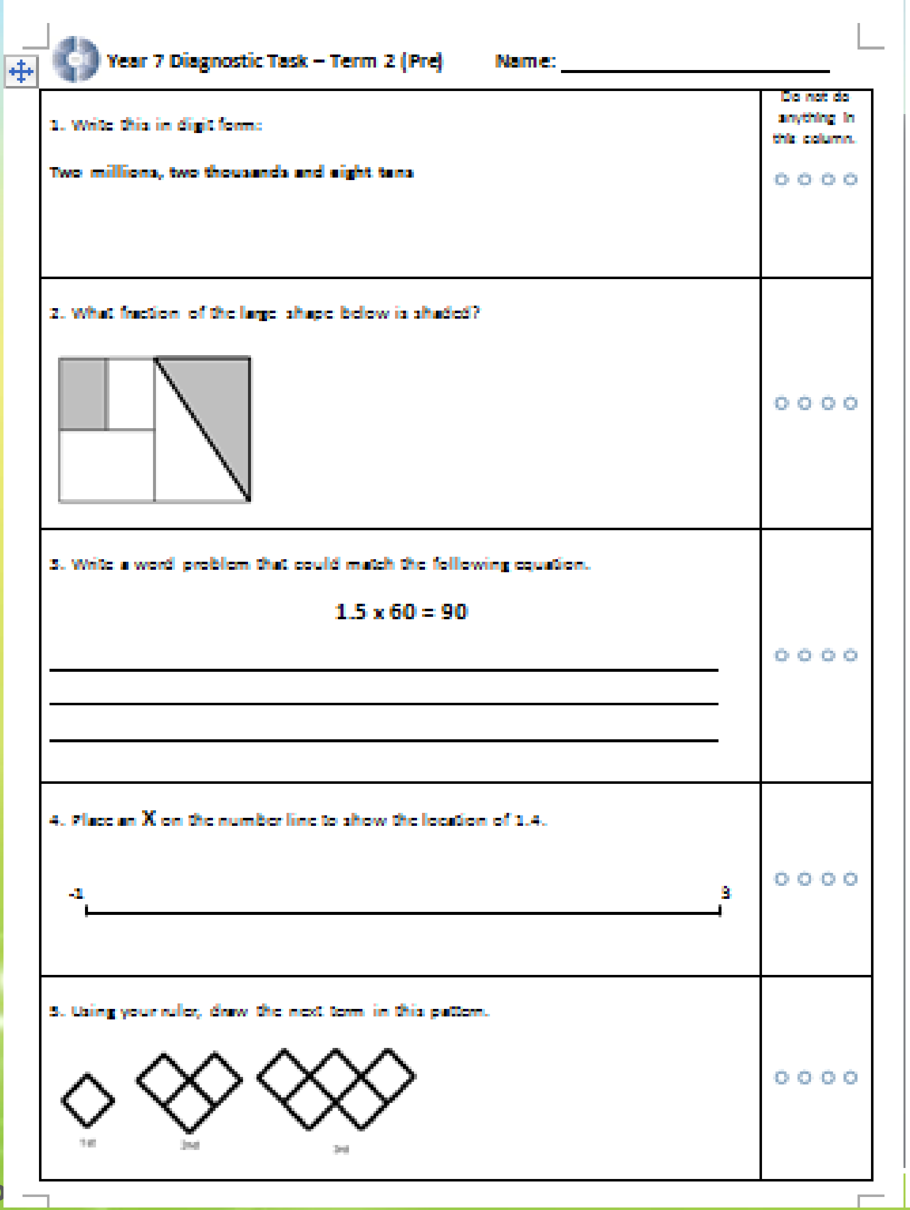
DuFour: Professional Learning Communities

MARZANO: High Reliability Schools: Level 3 GVC

BOALER: Positive Classroom Norms

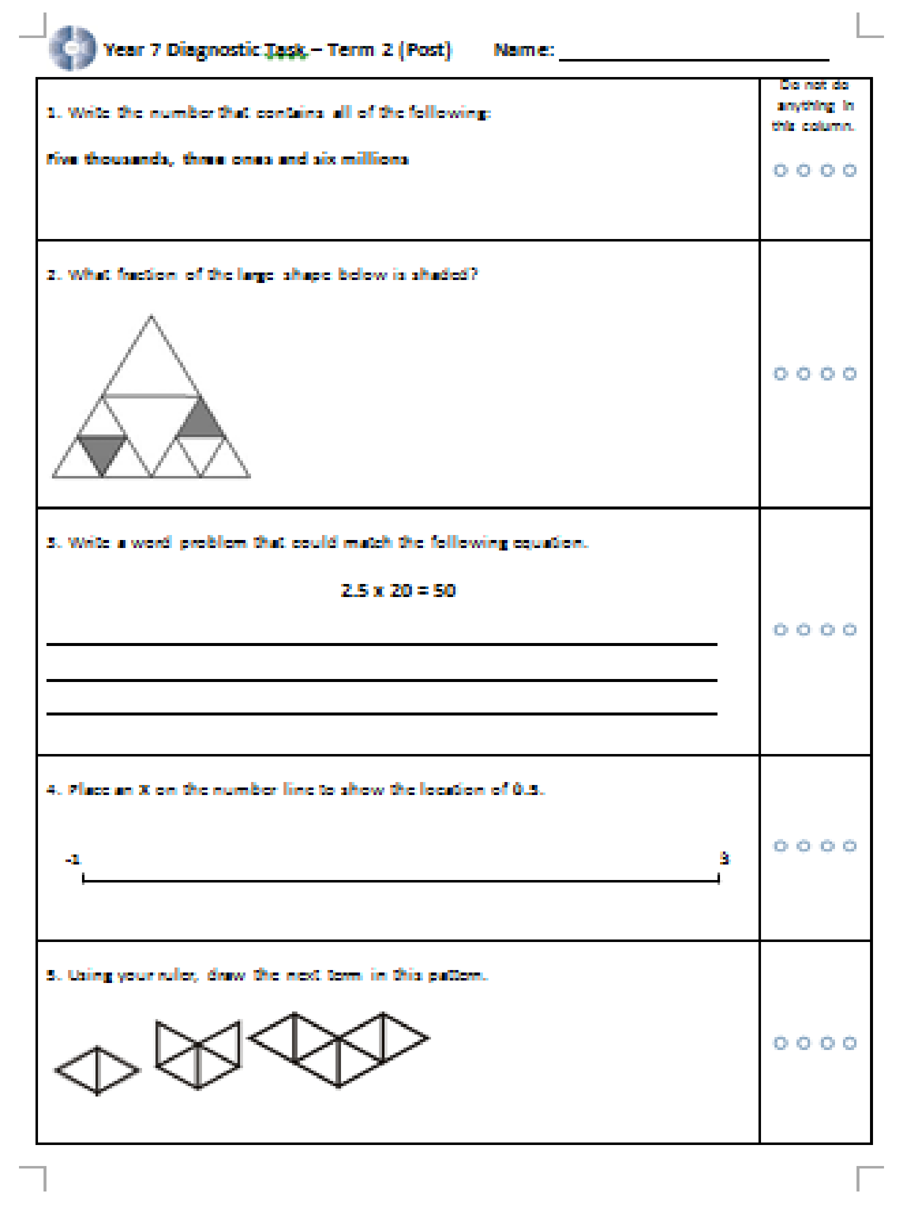
DWECK: Fixed and Growth Mindsets

Creation of a short term diagnostic by key



Year 7 Diagnostic Task – Term 2 (Pre) **Name:** ____________________

	Do not do anything in this column.
1. Write this in digit form: Two millions, two thousands and eight tens	○ ○ ○ ○
2. What fraction of the large shape below is shaded?	○ ○ ○ ○
3. Write a word problem that could match the following equation. 1.5 x 60 = 90 ____________________ ____________________ ____________________	○ ○ ○ ○
4. Place an X on the number line to show the location of 1.4. -1 3	○ ○ ○ ○
5. Using your ruler, draw the next term in this pattern. 1st 2nd 3rd	○ ○ ○ ○



Year 7 Diagnostic Task – Term 2 (Post) **Name:** ____________________

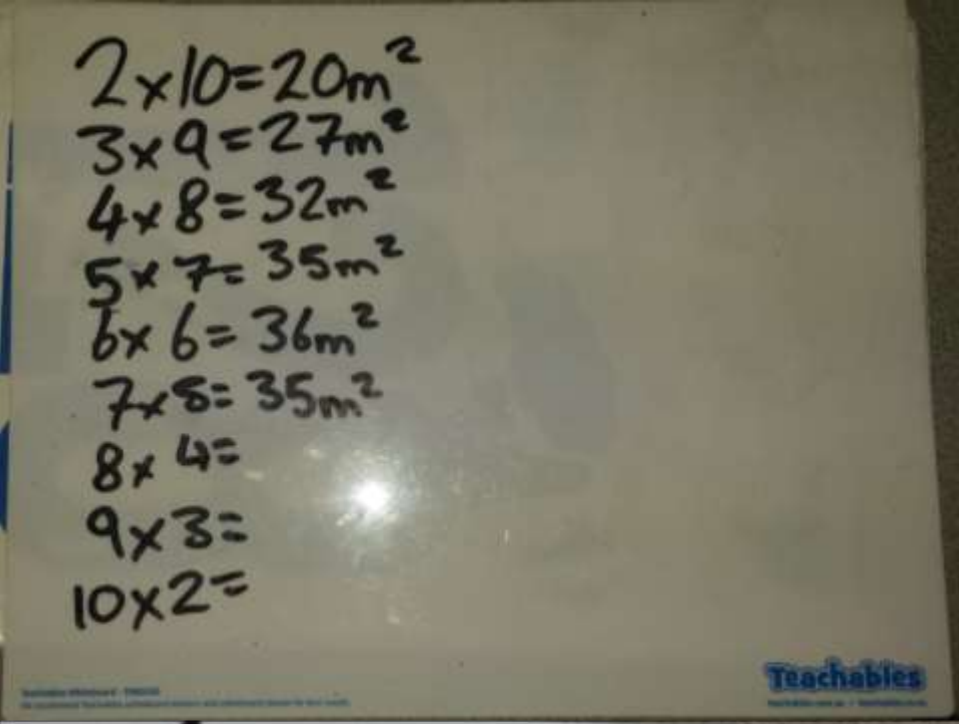
	Do not do anything in this column.
1. Write the number that contains all of the following: Five thousands, three ones and six millions	○ ○ ○ ○
2. What fraction of the large shape below is shaded?	○ ○ ○ ○
3. Write a word problem that could match the following equation. 2.5 x 20 = 50 ____________________ ____________________ ____________________	○ ○ ○ ○
4. Place an X on the number line to show the location of 0.5. -1 3	○ ○ ○ ○
5. Using your ruler, draw the next term in this pattern.	○ ○ ○ ○

A room has a perimeter of 24m

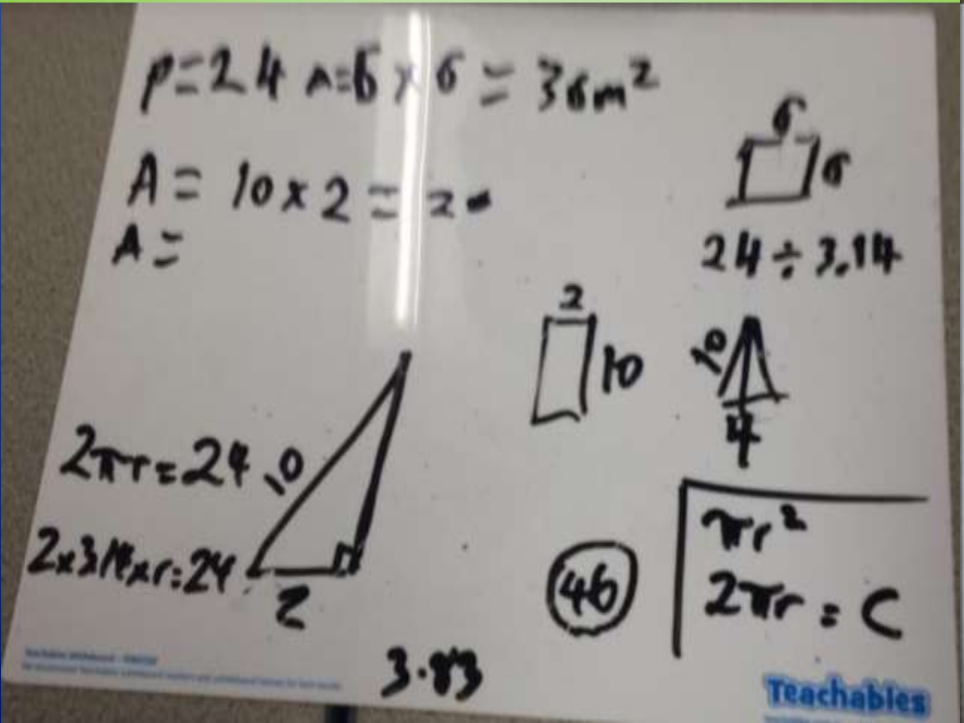
Investigate how many different areas this room can have.

Enabler: Reminder of P and A

Extender: What is max/min area?



2×10=20m²
3×9=27m²
4×8=32m²
5×7=35m²
6×6=36m²
7×8=35m²
8×4=
9×3=
10×2=



p=24 A=6×6=36m²
A= 10×2 = 2
A=

6
6

24÷3.14

2
10

10
4

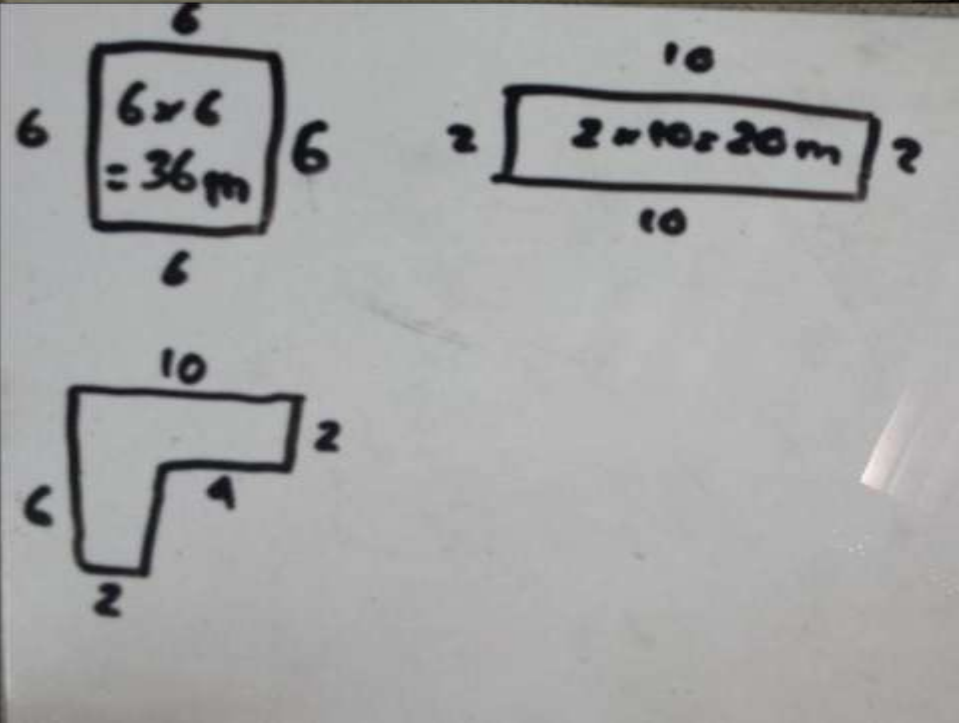
2πr=24
2×3.14×r=24

10
2

(46)

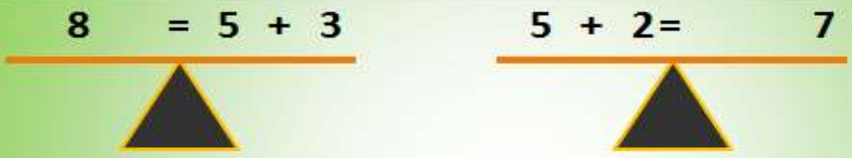
πr²
2πr = C

3.83



6
6
6×6
=36m
6
6
10
2
2×10=20m
2
10
10
2
4
6
2

‘Same As’ Scales

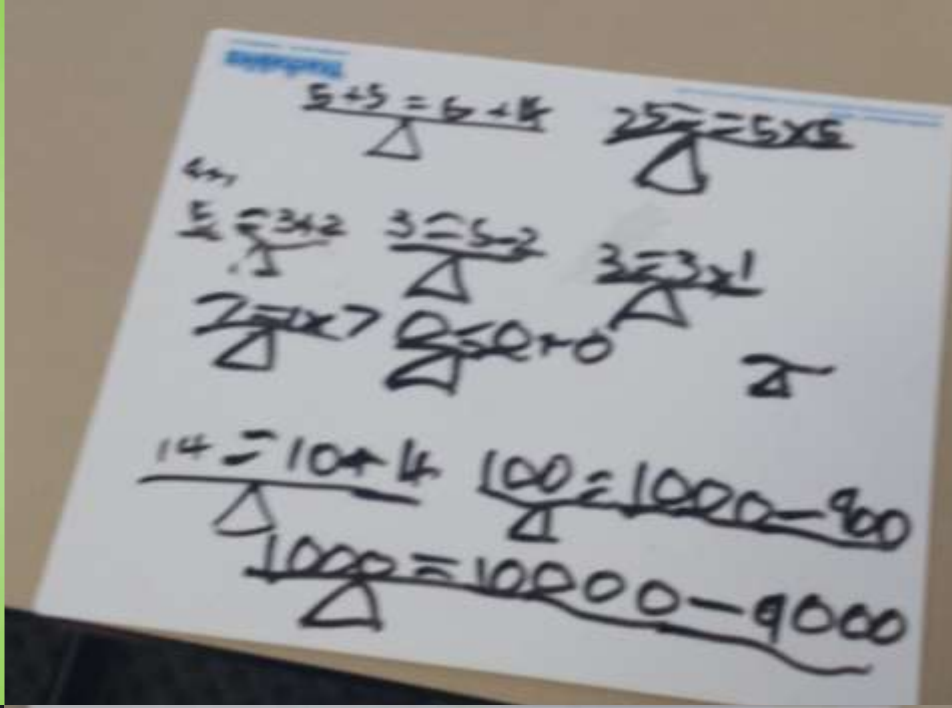

8 = 5 + 3

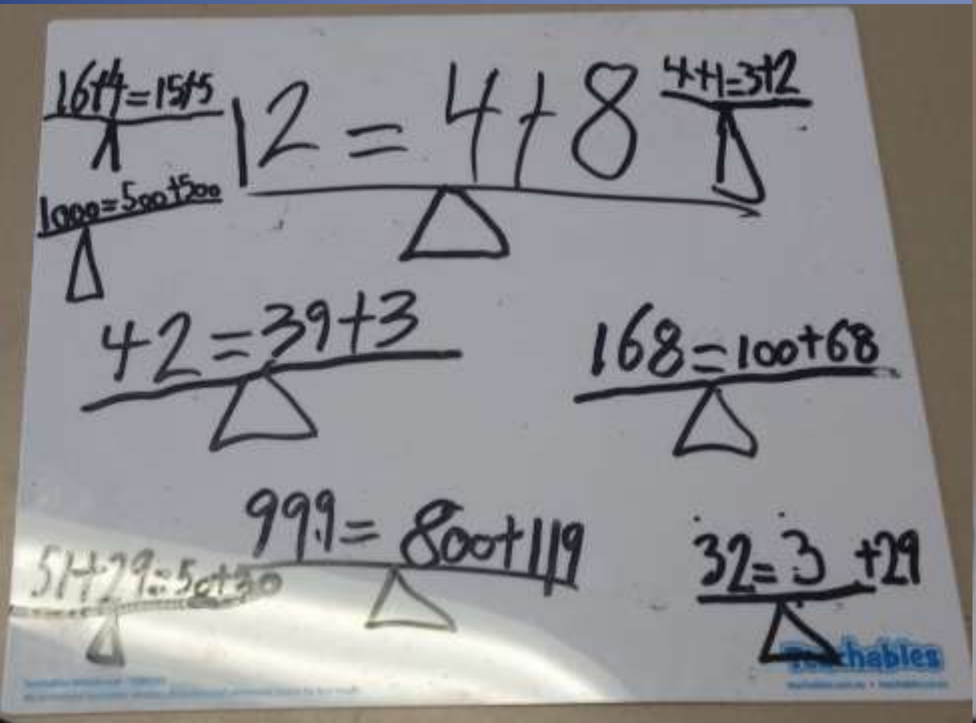
5 + 2= 7

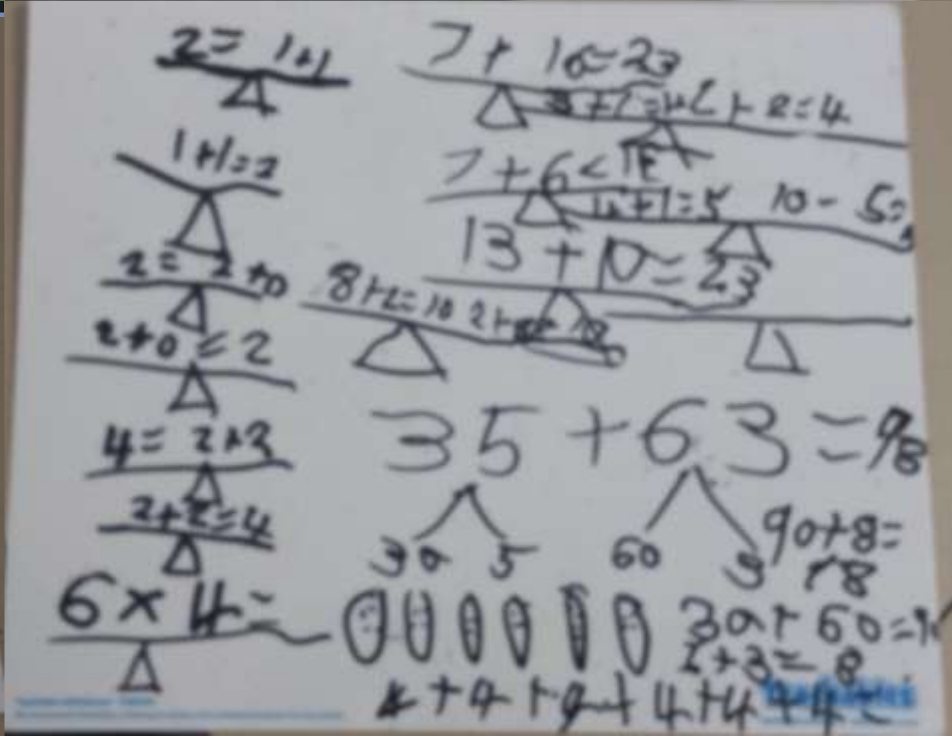
How many scales can you design at your table groups? Feel free to share your ideas

Enable: Use abacus, counters etc

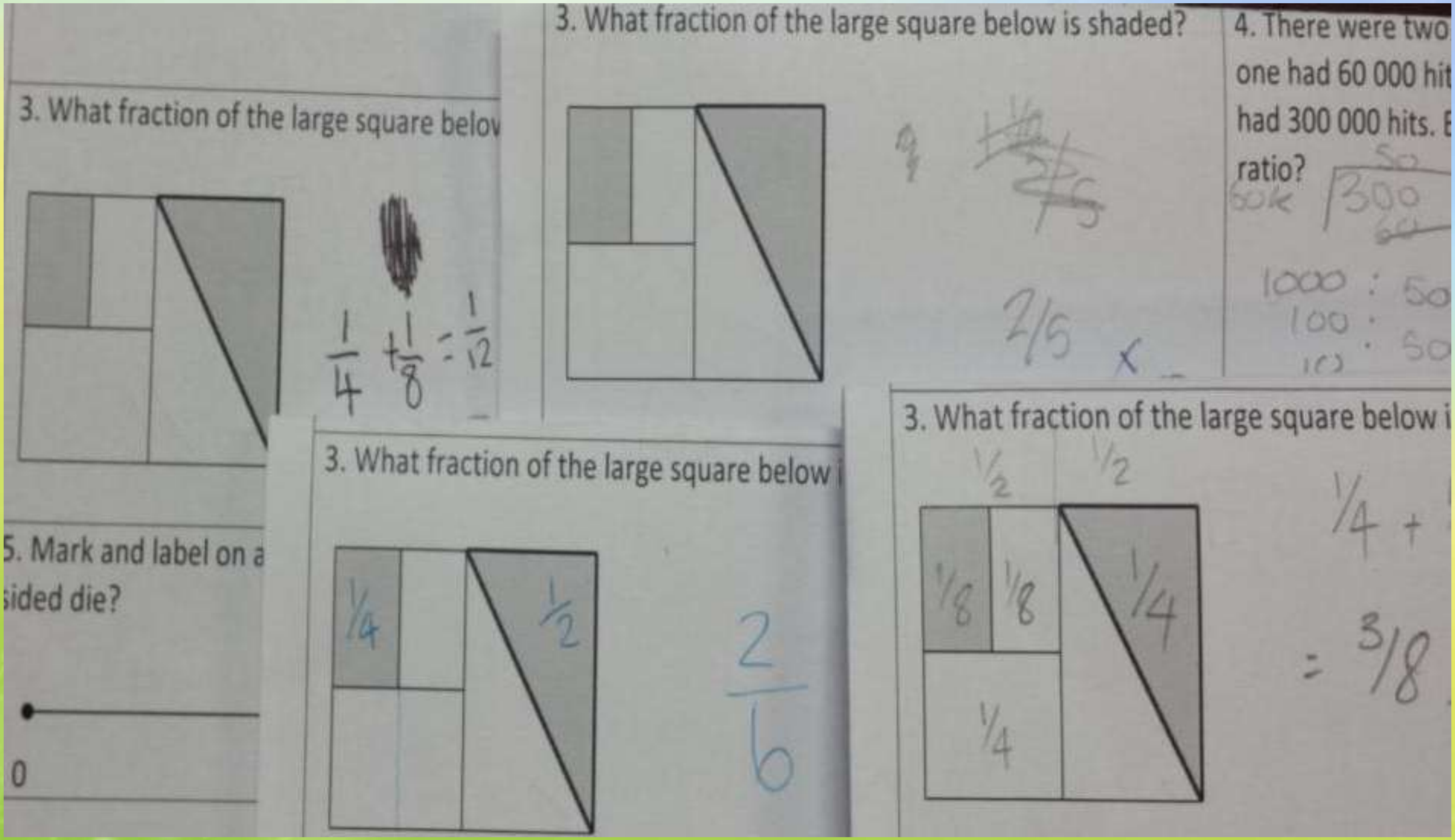
Extend: Operation both sides.


5+5=6+4
25=5x5
5=3+2
3=5-2
3=3x1
7=1x7
0=0+0
14=10+4
100=1000-900
1000=10000-9000


16+4=15+5
12=4+8
4+1=3+2
1000=500+500
42=39+3
168=100+68
999=800+119
32=3+29
51+29=50+30
Teachables


2=1+1
7+16=23
1+1=2
7+6<18
10-5=5
13+10=23
2=2+0
8+2=10
2+0=2
4=2+2
35+63=98
30 5 60 3
90+8=98
6x4=
30+60=90
4+4+4+4+4+4

Trial samples used to elicit levels of student understanding. Formulate a scale



3. What fraction of the large square belov

$\frac{1}{4} + \frac{1}{8} = \frac{1}{12}$

3. What fraction of the large square below is shaded?

~~2/5~~

2/5 x

4. There were two
one had 60 000 hit
had 300 000 hits. E
ratio?

60k

300

1000 : 50
100 : 50

5. Mark and label on a
sided die?

0

3. What fraction of the large square below i

1/4 1/2

$\frac{2}{6}$

3. What fraction of the large square below i

1/2 1/2

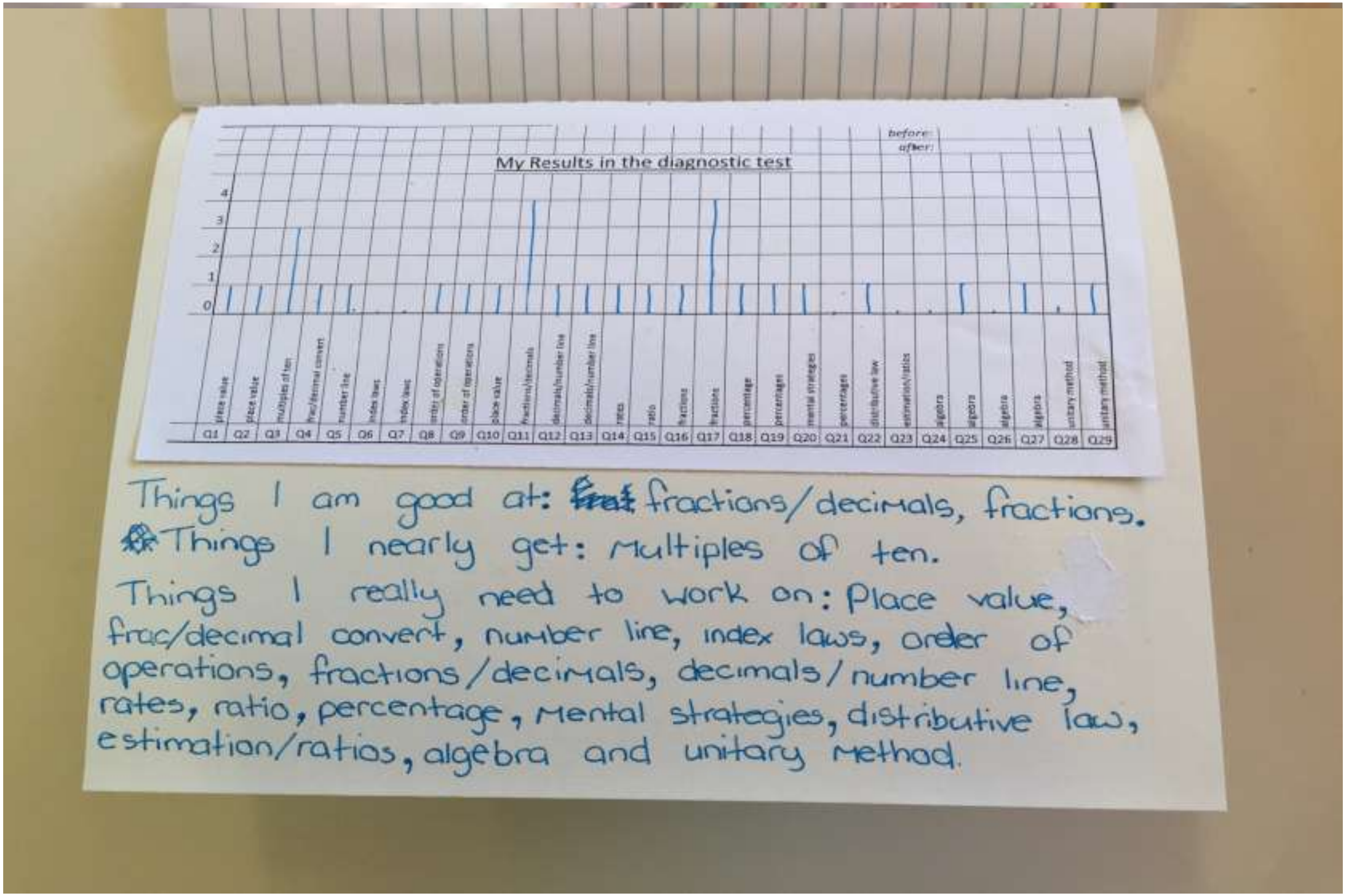
1/8 1/8 1/4

1/4

1/4 +

= 3/8

Initiate ‘Visible Learning’ where students


My Results in the diagnostic test
before
after:
4
3
2
1
0
place value
place value
multiples of ten
frac/decimal convert
number line
index laws
index laws
order of operations
order of operations
place value
fractions/decimals
decimals/number line
decimals/number line
rates
ratio
fractions
fractions
percentage
percentages
mental strategies
percentages
distributive law
estimation/ratios
algebra
algebra
algebra
algebra
unitary method
unitary method
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
Q13
Q14
Q15
Q16
Q17
Q18
Q19
Q20
Q21
Q22
Q23
Q24
Q25
Q26
Q27
Q28
Q29

Things I am good at: fractions/decimals, fractions.

Things I nearly get: multiples of ten.

Things I really need to work on: Place value, frac/decimal convert, number line, index laws, order of operations, fractions/decimals, decimals/number line, rates, ratio, percentage, mental strategies, distributive law, estimation/ratios, algebra and unitary method.

Rob Proff

Ensuring School Assessment promotes the Mathematics Proficiencies

Know about their learning & can plan next learning steps with teacher

Are active in their learning

Understand the assessment tools being used and what results mean

Understand the learning goals/intentions of the lesson

An self assess accurately against success criteria and know their next learning goal

Can peer assess against success criteria and give feedback based on the criteria

Can use SMART goals, then self monitor their progress

Can answer: WHERE AM I GOING, HOW AM I GOING, WHERE TO NEXT

What do we expect our students to learn?

How will we know they are learning?

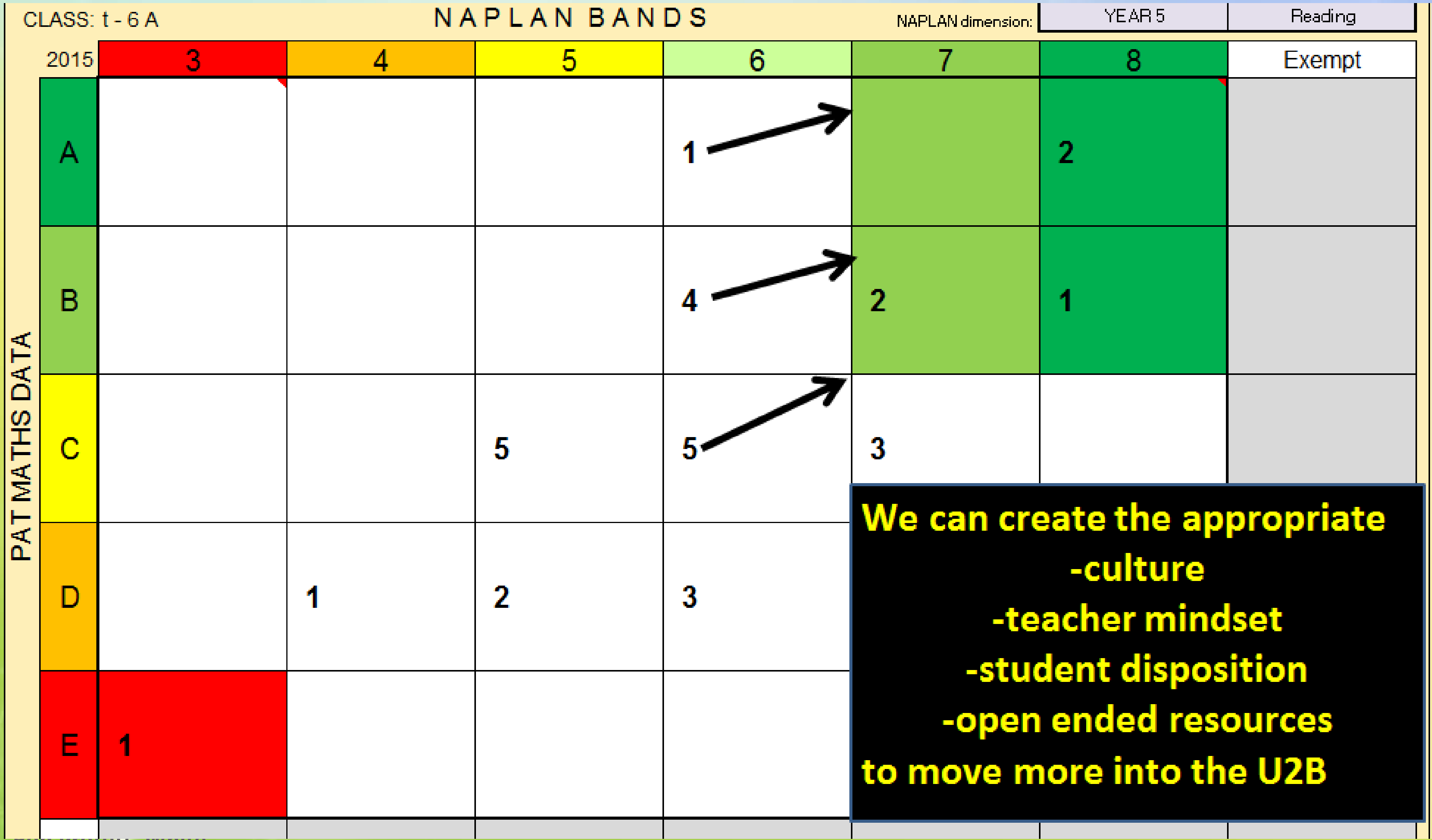
How will we respond when they don't learn?

How will we respond if they already know it?

Students who experience skills-focused instruction otend to master them, but do not do well when tested on problem solving and conceptual understanding.

(Schoenfeld, 2007)

Data grids to inform teachers of intervention strategies.



CLASS: t - 6 A

NAPLAN BANDS

NAPLAN dimension: YEAR 5 | Reading

PAT MATHS DATA

2015	3	4	5	6	7	8	Exempt
A				1 →		2	
B				4 →	2	1	
C			5	5 →	3		
D		1	2	3			
E	1						

We can create the appropriate
-culture
-teacher mindset
-student disposition
-open ended resources
to move more into the U2B

The NCR Mathematics Team are a result of longevity, ongoing PD and consistent investment- WE have endurance, leverage and readiness

Passionate and Persuasive

Reflective and Perceptive

Coach, mentor, collaborator

Innovative & Influential

Engaging and Understandable

Organised and Effective

In a position to effect change

Exceptional Pedagogical Content Knowledge-

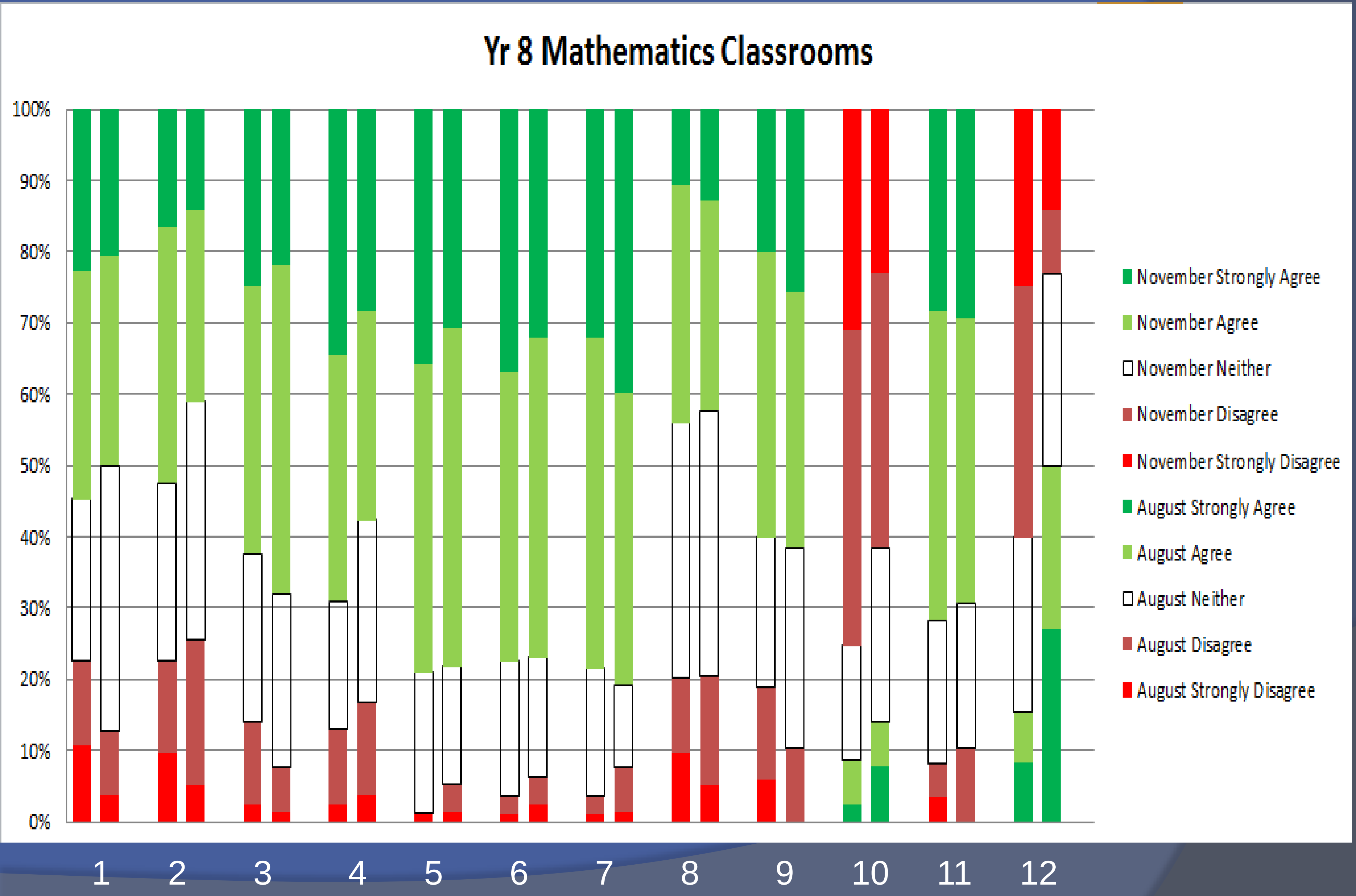
Exceptional Mathematical Content Knowledge

Student Disposition to Mathematics

- Focus
  - Enjoyment
  - Purpose
  - Understanding

Questions

1	Mathematics is an area I do well in
2	Mathematics is a subject that I am enthusiastic about
3	I see the relevance of mathematics to other subjects
4	I see the relevance of mathematics to the real world
5	In class we have opportunities to discuss our answers
6	My teacher explains mathematics in a way I can understand
7	It doesn’t matter whether I use efficient or inefficient methods as long as you get the right answer in the end.
8	In my mathematics class we celebrate achievements
9	I am confident to raise my hand in my mathematics class
10	We learn mathematics by the teacher demonstrating an example and we keep practicing until we get it right.
11	I can see how the mathematics we are learning now connects to what I have learnt in previous years.
12	It is possible to do well in mathematics without having to reason or explain your answer


Yr 8 Mathematics Classrooms
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
November Strongly Agree
November Agree
November Neither
November Disagree
November Strongly Disagree
August Strongly Agree
August Agree
August Neither
August Disagree
August Strongly Disagree
1
2
3
4
5
6
7
8
9
10
11
12

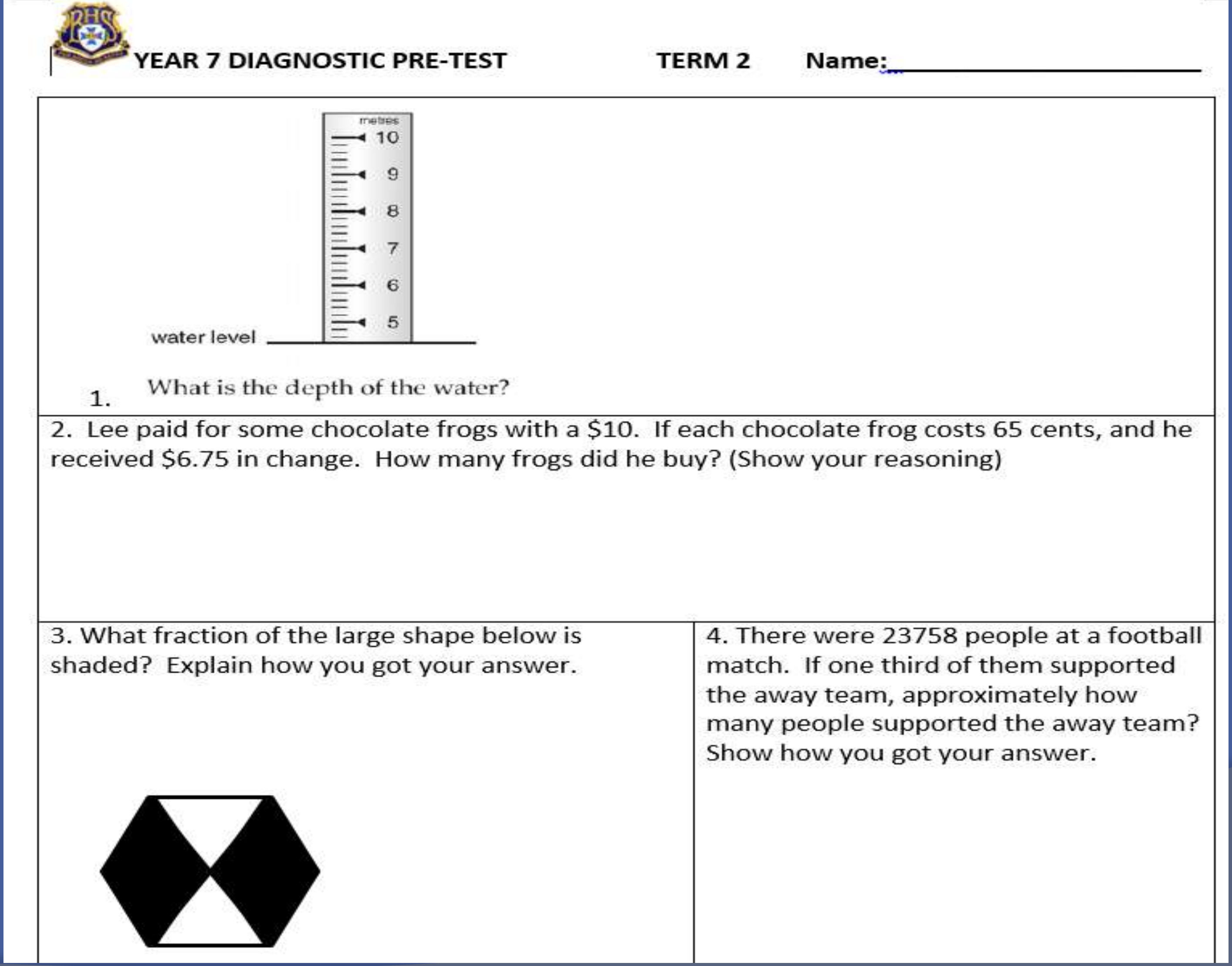
Raising Awareness of Project Intent

- Target Areas
    - Student Engagement
    - Problem Solving and Reasoning
- Contextualised Demos
- Collaborative Discussion

Key Team

- Identification of key staff to lead the agenda
- Development of own resources for use within the Faculty
    - Diagnostic Tests
    - Warmup activities to address misconceptions
- Diagnostic tests include identified core skills (individually identified for each cohort) to track from Year 7
- Warmup activities – open ended tasks based on Peter Sullivan research

Diagnostic Tests


metres
10
9
8
7
6
5
water level

YEAR 7 DIAGNOSTIC PRE-TEST **TERM 2** **Name:**____________________

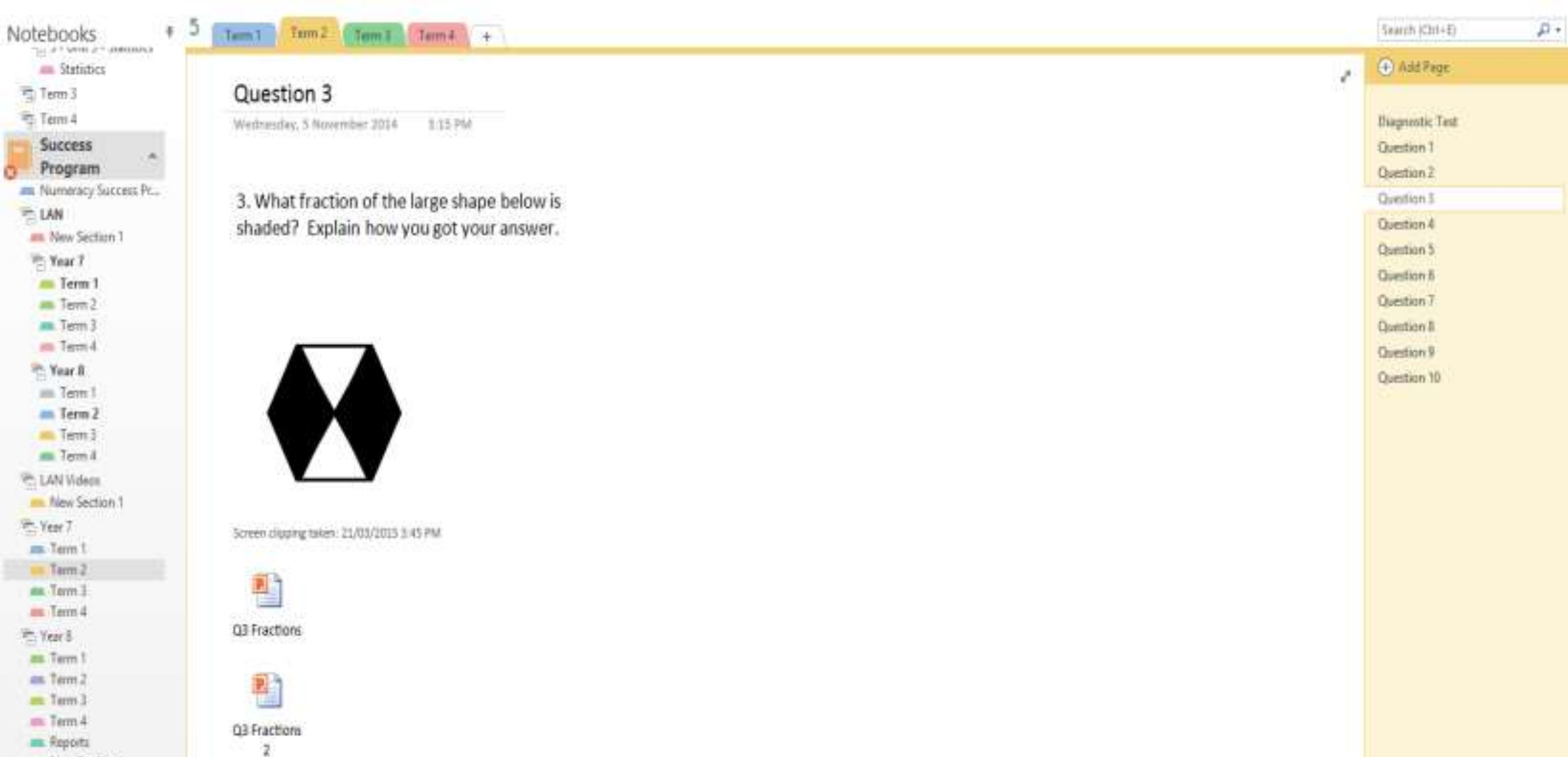
1. What is the depth of the water?

2. Lee paid for some chocolate frogs with a $10. If each chocolate frog costs 65 cents, and he received $6.75 in change. How many frogs did he buy? (Show your reasoning)

3. What fraction of the large shape below is shaded? Explain how you got your answer.

4. There were 23758 people at a football match. If one third of them supported the away team, approximately how many people supported the away team? Show how you got your answer.

OneNote Resource Bank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+
Search (Ctrl+E)
Add Page
Diagnostic Test
Question 1
Question 2
Question 3
Question 4
Question 5
Question 6
Question 7
Question 8
Question 9
Question 10
Q3 Fractions
Q3 Fractions 2

Question 3

Wednesday, 5 November 2014 3:15 PM

3. What fraction of the large shape below is shaded? Explain how you got your answer.

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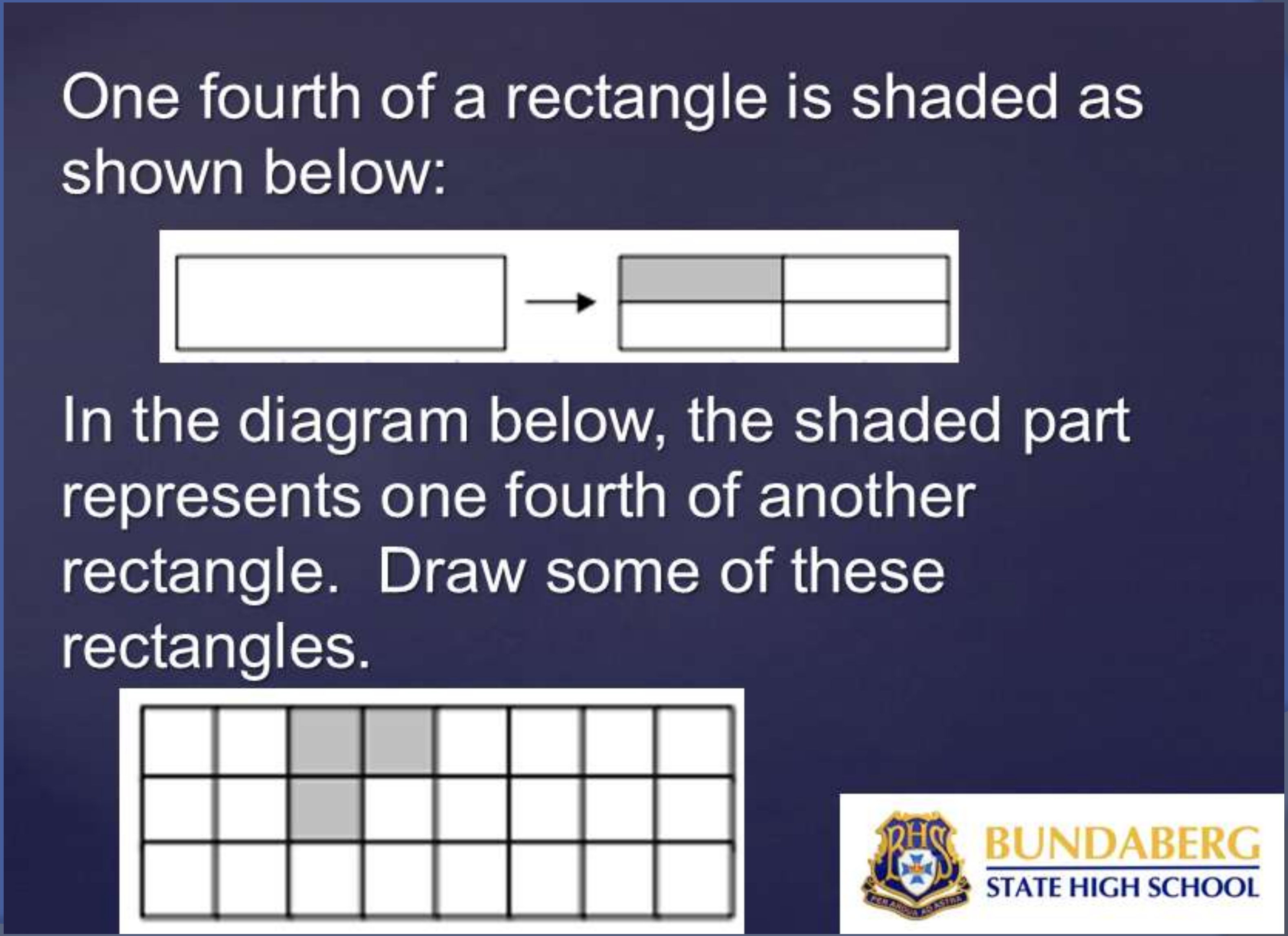
Warmup Slide Example



One fourth of a rectangle is shaded as shown below:

In the diagram below, the shaded part represents one fourth of another rectangle. Draw some of these rectangles.

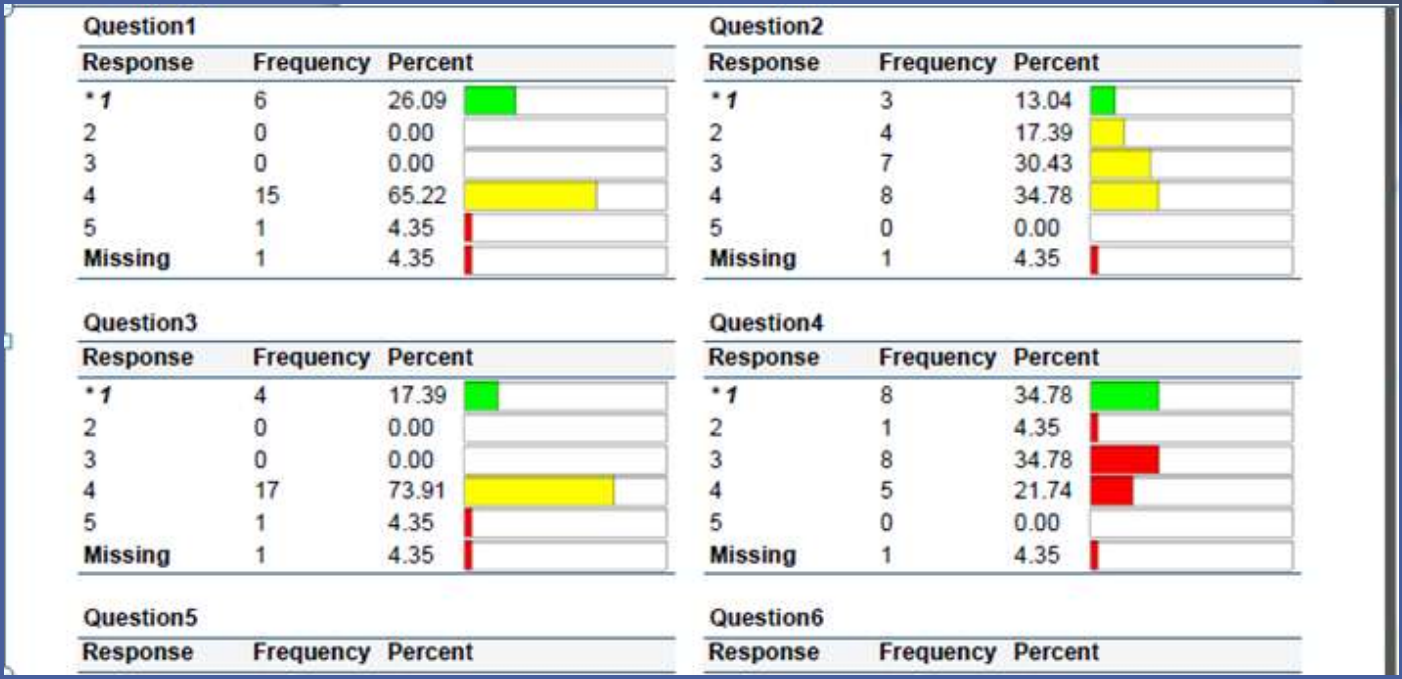
BUNDABERG
STATE HIGH SCHOOL

Moderation and Discussion

- Diagnostic Tests moderated at Faculty level
- Identified common student misconceptions

Collection and Collation of Data

- Use of Remark software to quickly process student responses
- Data returned to teachers
  - Analysis and identification of misconceptions at a class level
  - Informed choice of warmups for each teacher



Question1

Response	Frequency	Percent
*1	6	26.09
2	0	0.00
3	0	0.00
4	15	65.22
5	1	4.35
Missing	1	4.35

Question2

Response	Frequency	Percent
*1	3	13.04
2	4	17.39
3	7	30.43
4	8	34.78
5	0	0.00
Missing	1	4.35

Question3

Response	Frequency	Percent
*1	4	17.39
2	0	0.00
3	0	0.00
4	17	73.91
5	1	4.35
Missing	1	4.35

Question4

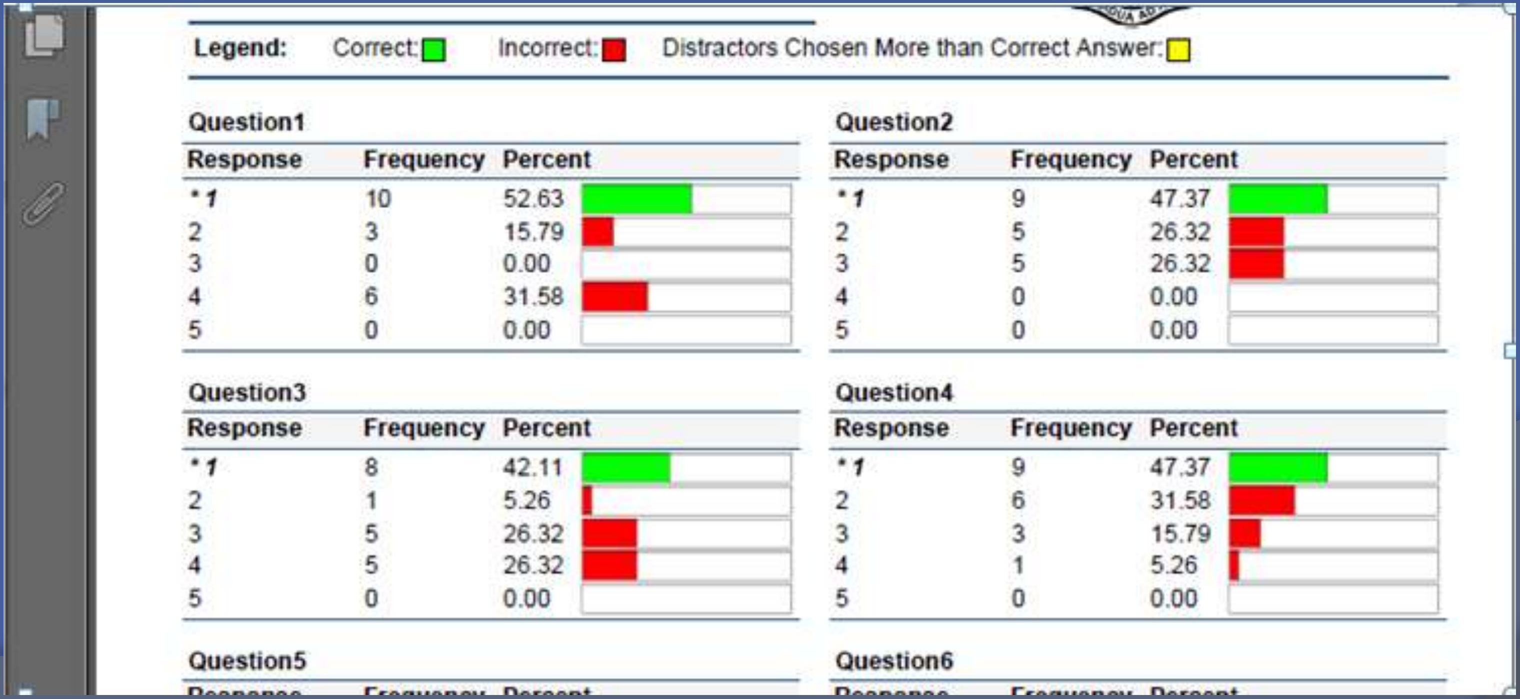
Response	Frequency	Percent
*1	8	34.78
2	1	4.35
3	8	34.78
4	5	21.74
5	0	0.00
Missing	1	4.35

Question5

Response Frequency Percent

Question6

Response Frequency Percent



Legend: Correct: 🟩 Incorrect: 🟥 Distractors Chosen More than Correct Answer: 🟨

Question1

Response	Frequency	Percent
*1	10	52.63
2	3	15.79
3	0	0.00
4	6	31.58
5	0	0.00

Question2

Response	Frequency	Percent
*1	9	47.37
2	5	26.32
3	5	26.32
4	0	0.00
5	0	0.00

Question3

Response	Frequency	Percent
*1	8	42.11
2	1	5.26
3	5	26.32
4	5	26.32
5	0	0.00

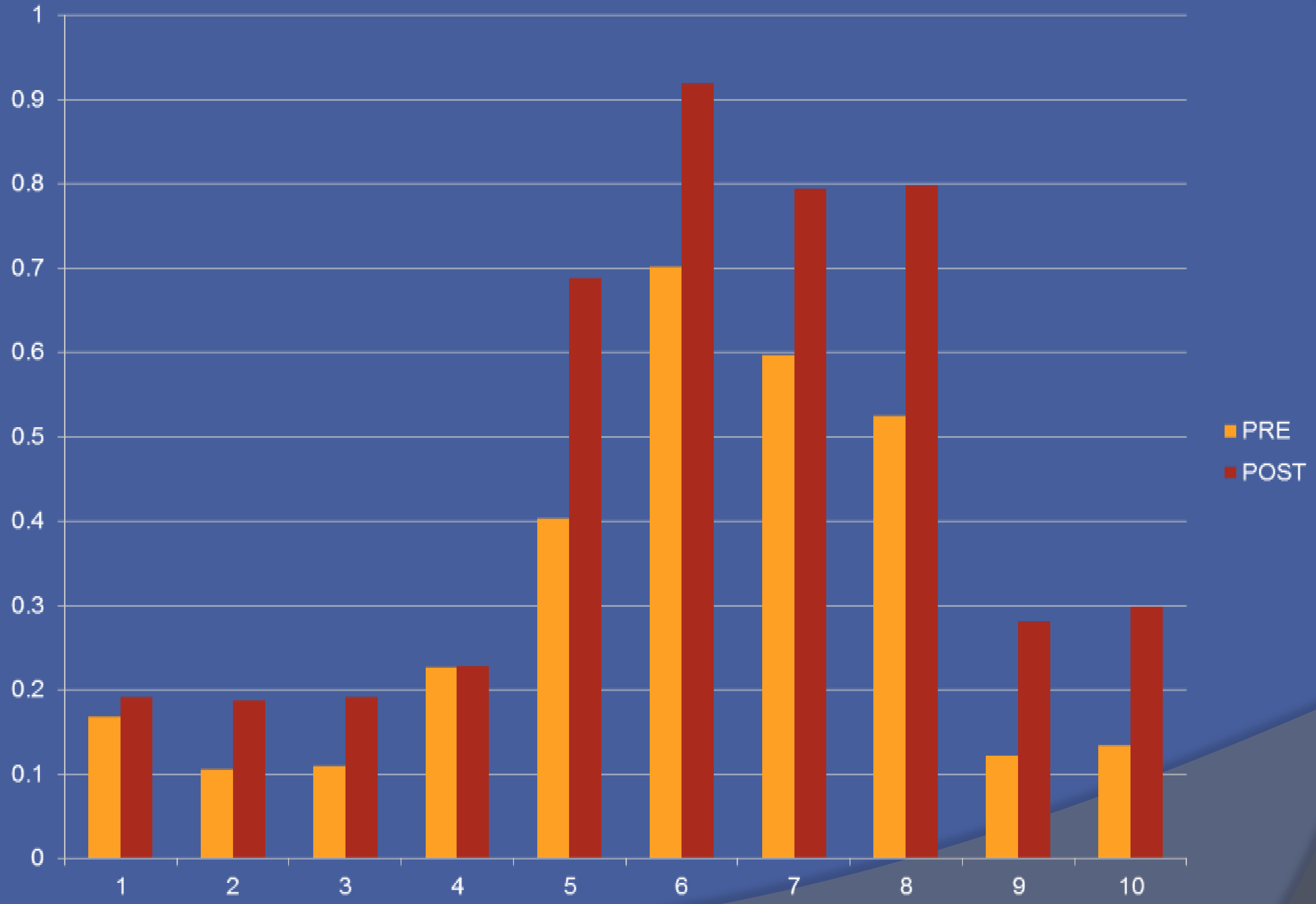
Question4

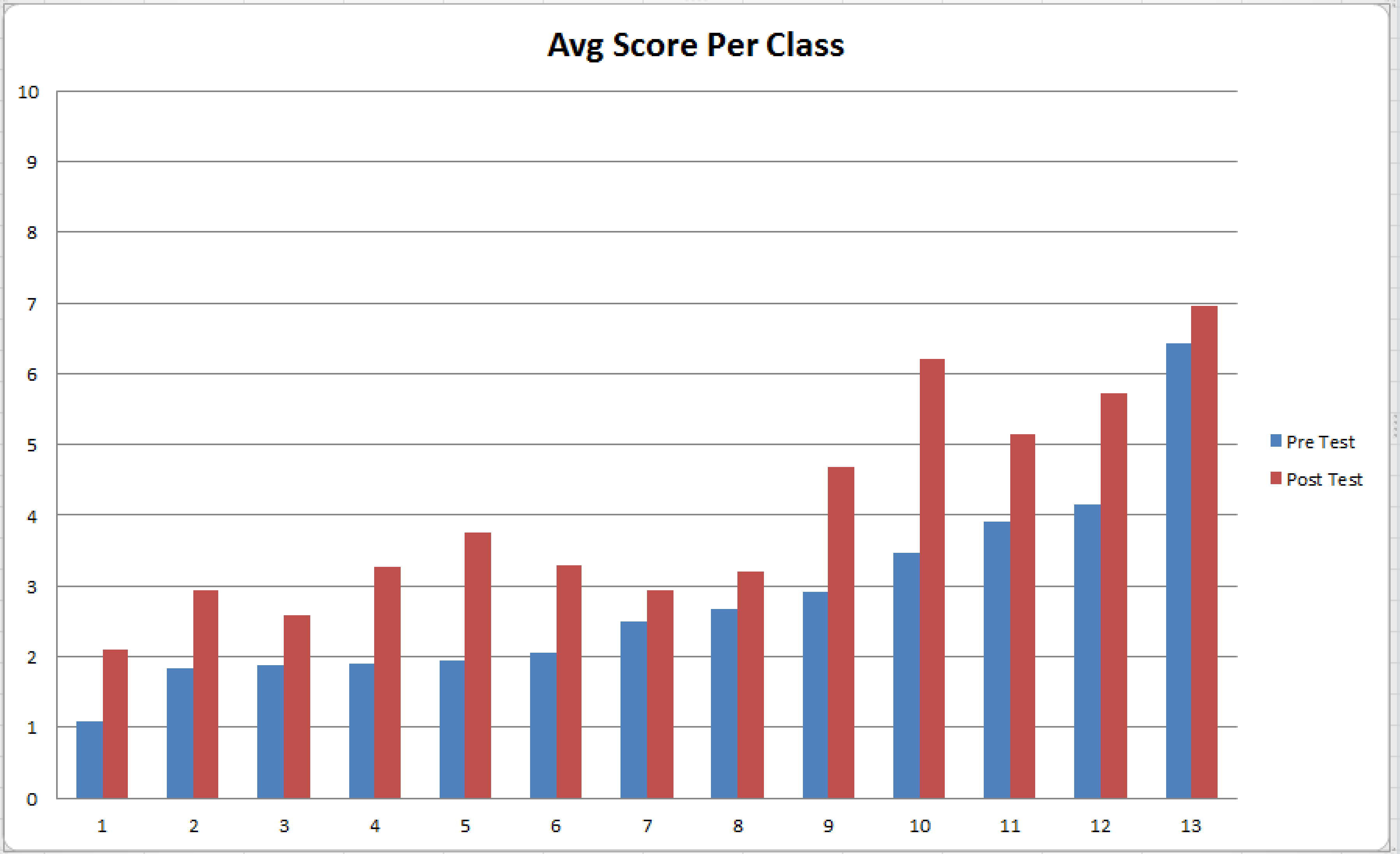
Response	Frequency	Percent
*1	9	47.37
2	6	31.58
3	3	15.79
4	1	5.26
5	0	0.00

Question5

Question6

Cohort Average Pre/Post Per Question




Avg Score Per Class
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Pre Test
Post Test

Support for Teachers

- Resource Bank
- Numeracy Coach
- Development Time and Talking Time

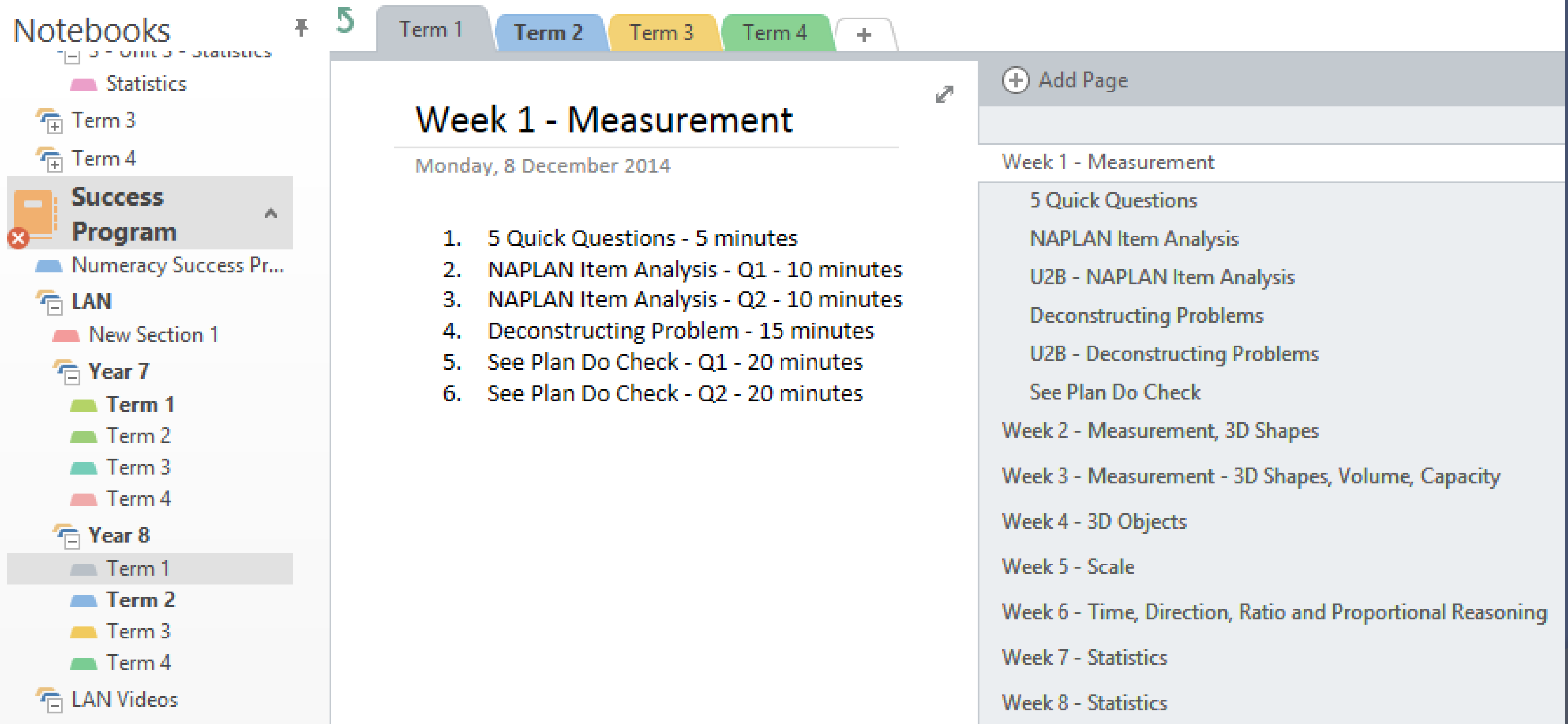
Ongoing Support and Moderation

- Key team meets once a term to:
  - Peruse feedback from teaching staff
  - Act on feedback to modify assessment tasks
  - Develop further questions and warmup activities
- Collaboration with another local high school to share and develop open ended tasks

LAN Program

- Literacy and Numeracy Program
- Conducted for Year 7 and 8 students
- Numeracy Program provides all students the opportunity to problem solve and reason

LAN – OneNote Resource Bank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Term 1
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Term 4
LAN Videos
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Term 3
Term 4
+
Add Page

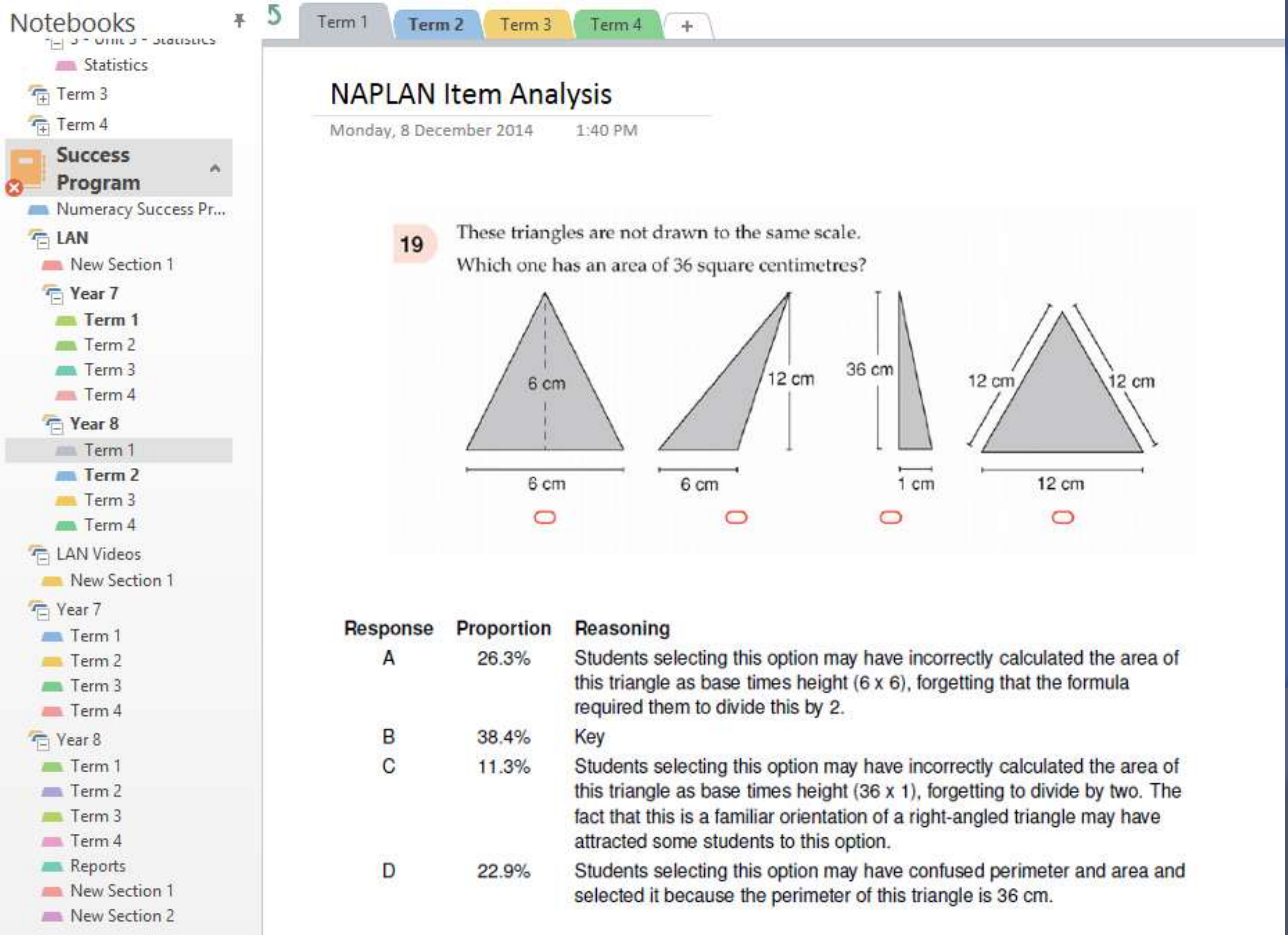
Week 1 - Measurement

Monday, 8 December 2014

1. 5 Quick Questions - 5 minutes
2. NAPLAN Item Analysis - Q1 - 10 minutes
3. NAPLAN Item Analysis - Q2 - 10 minutes
4. Deconstructing Problem - 15 minutes
5. See Plan Do Check - Q1 - 20 minutes
6. See Plan Do Check - Q2 - 20 minutes

Week 1 - Measurement
  5 Quick Questions
  NAPLAN Item Analysis
  U2B - NAPLAN Item Analysis
  Deconstructing Problems
  U2B - Deconstructing Problems
  See Plan Do Check
Week 2 - Measurement, 3D Shapes
Week 3 - Measurement - 3D Shapes, Volume, Capacity
Week 4 - 3D Objects
Week 5 - Scale
Week 6 - Time, Direction, Ratio and Proportional Reasoning
Week 7 - Statistics
Week 8 - Statistics

Example of Content in LAN File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Term 3
Term 4
Year 8
Term 1
Term 2
Term 3
Term 4
Reports
New Section 1
New Section 2
Term 1
Term 2
Term 3
Term 4
+
6 cm
6 cm
12 cm
6 cm
36 cm
1 cm
12 cm
12 cm
12 cm

NAPLAN Item Analysis

Monday, 8 December 2014 1:40 PM

19 These triangles are not drawn to the same scale.

Which one has an area of 36 square centimetres?

Response	Proportion	Reasoning
A	26.3%	Students selecting this option may have incorrectly calculated the area of this triangle as base times height (6 x 6), forgetting that the formula required them to divide this by 2.
B	38.4%	Key
C	11.3%	Students selecting this option may have incorrectly calculated the area of this triangle as base times height (36 x 1), forgetting to divide by two. The fact that this is a familiar orientation of a right-angled triangle may have attracted some students to this option.
D	22.9%	Students selecting this option may have confused perimeter and area and selected it because the perimeter of this triangle is 36 cm.

Success

By exposing students to instant success, through the use of pre and post testing, warmups and problem solving we have empowered the students not only with the strategies and content they need to answer the questions, but with the confidence, enthusiasm, security and the desire to discover the satisfaction that success in mathematics brings.

MOVING TEACHERS FROM:-

TRANSMISSION to CONNECTIONIST ORIENTATIONS

by developing growth mind set interventions in schools.

(Boaler, 2010)

Barriers to Success

1. Teachers are content driven, and don’t necessarily value the time it takes to address some of the misconceptions in prior knowledge required
    - Addressed through student engagement evidence motivated teachers to value tasks

2. Having teachers and students understand that success in maths is attained by work and effort – Growth Mindset
    - Addressed through student success in open ended tasks and working with teachers through Faculty meetings and moderation of tasks

3. Time – Resource Development, Moderation, Time to familiarise teachers with project
    - Support from Administration Team to allow project time to grow and realise its potential

Attaining outcomes

Our belief – maths is accessible by all, maths doesn't end in the classroom

Program mantras

- *volunteers*
- *staff own it,*
- *must build capacity,*
- *must be sustainable,*
- *No matter how long it takes – just do it properly because teacher attitude and feeling does make a difference,*
- *teachers need to have a voice in the actions toward the program – it is their program….*

How ?

Sales

Access to experts - sold to general staff as “you don’t waste $500 000 when it is offered to you” (4 PEACs at beck and call, 20 days relief for PD, .5 staff member /coach)

Cost

- Minimal to start with – staff didn’t want to lose class time, used spares etc
- Once momentum began, used 20 TRS plus 20 more (6 months)
- *Loss of class time for training/developing resources was biggest impact*
- 2 HODs key agenda
- Strategic Team – PEAC, Performance HOD, Maths HOD, coach, JS DP’s, myself
- Year level team - volunteer teachers work with Rob and HOD, coach

Future Potential Costs

- 0.5 Numeracy Coach
- Growth coaching for Maths team – ensure substantive conversation

Unintended Initial Outcomes

- *Number of volunteers*
- *Speed of uptake by staff*
- *Desire to get the activities right using own time*
- *Energy within the department, rejuvenation of teachers*
- *SCI Faculty - jumping on board*
- *After presentation of warm ups to all staff, pockets of staff in other faculties tried them – for their curriculum areas and have embedded them into their class routines*