Diverse assessments to encourage diverse outcomes (and an intro to criteria-based marking)

Heather Lonsdale

Curtin University

June 29, 2018

Caroline Baillie, "Teaching people as individuals: A workshop for misshapen carrots", WAND T&L Forum, 2015.

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- University moving towards a recommended maximum of 4 assessment pieces to avoid over-assessing students

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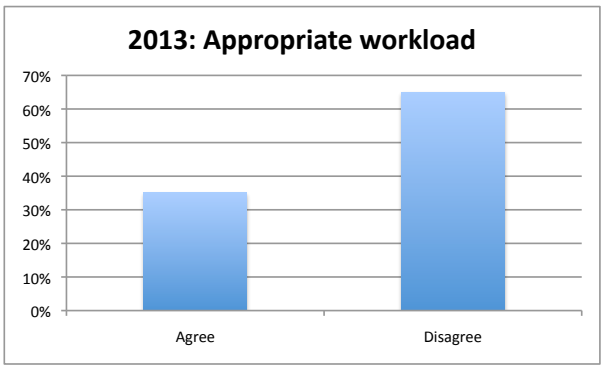

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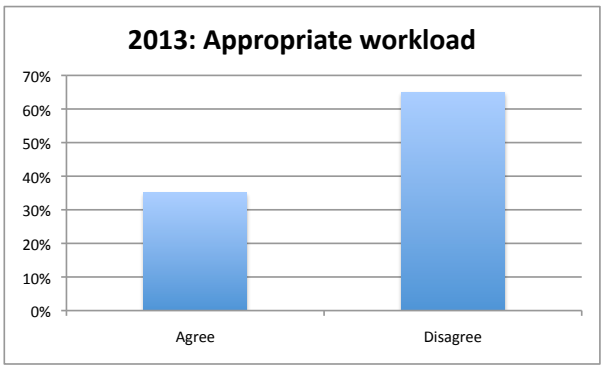

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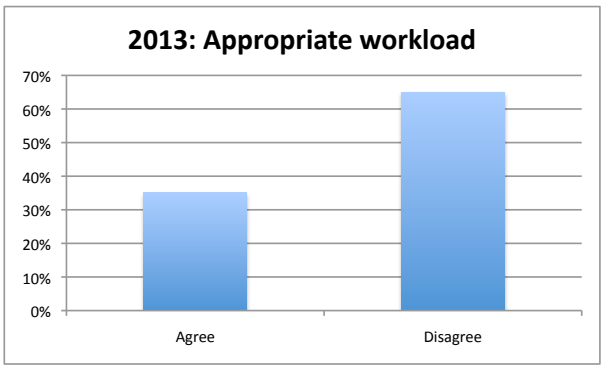

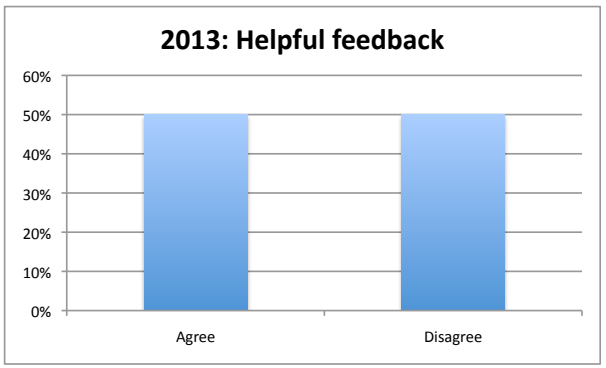

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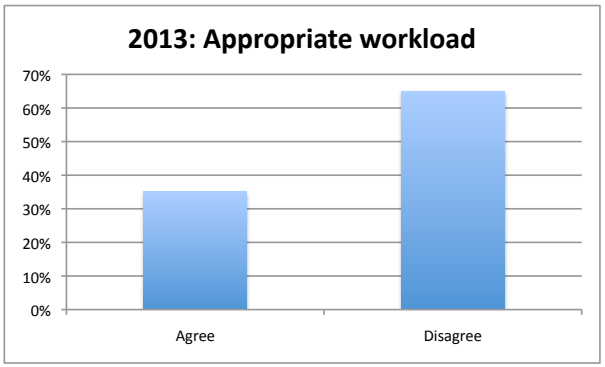

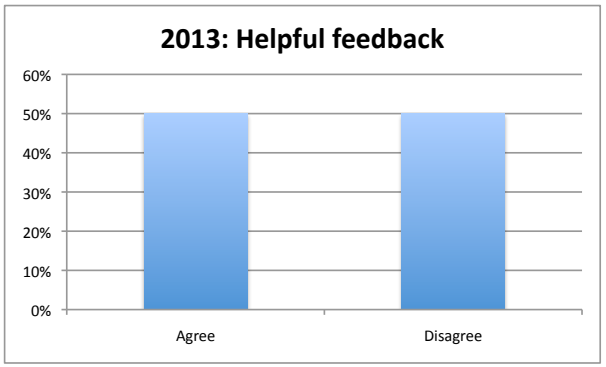

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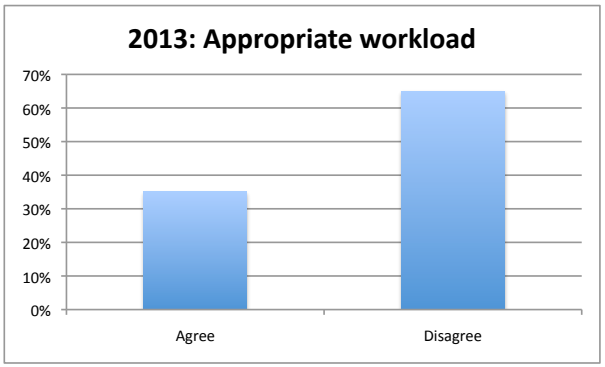

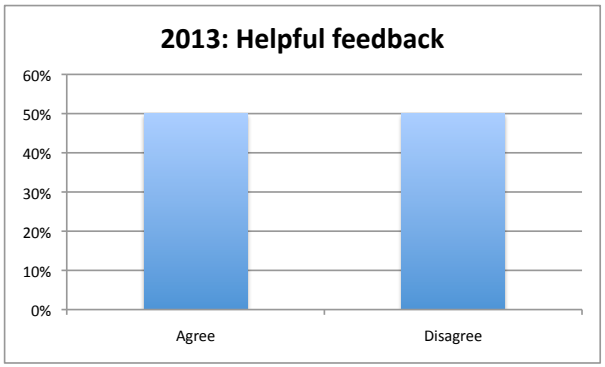

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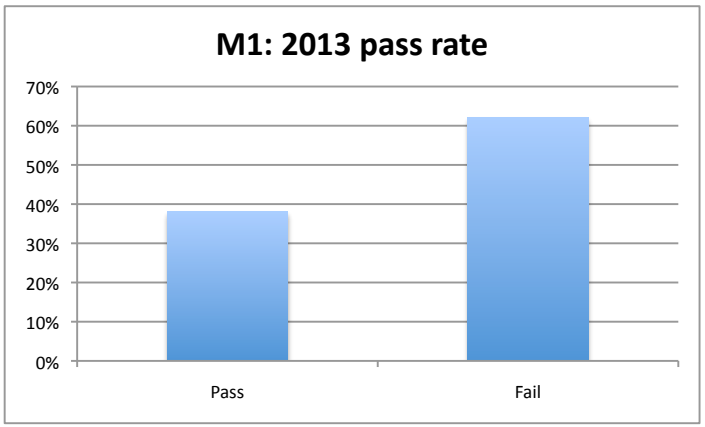
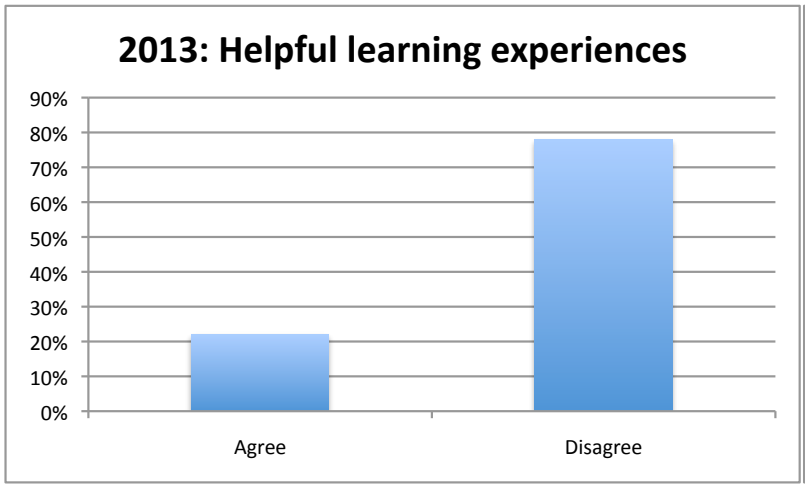
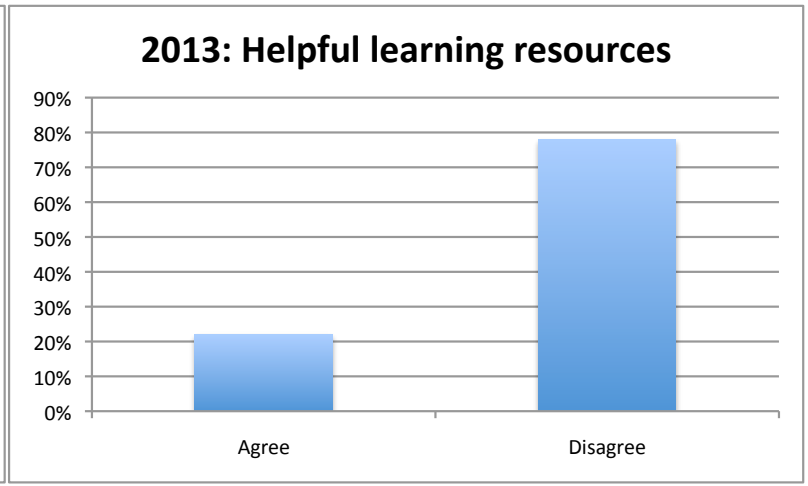
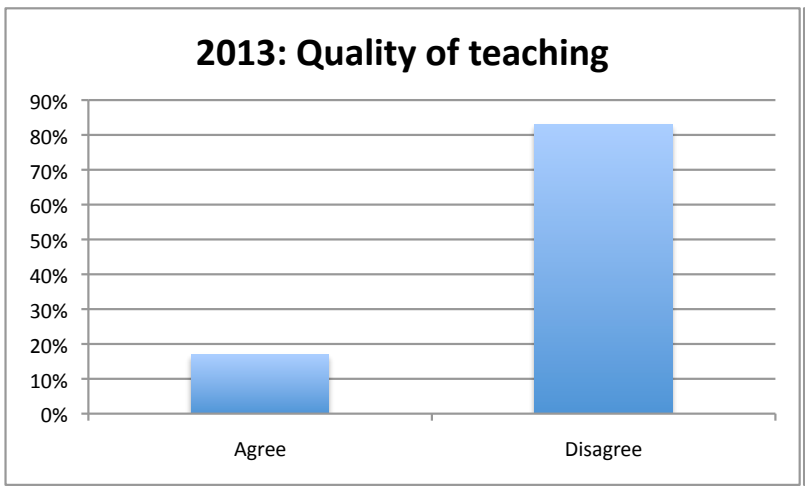
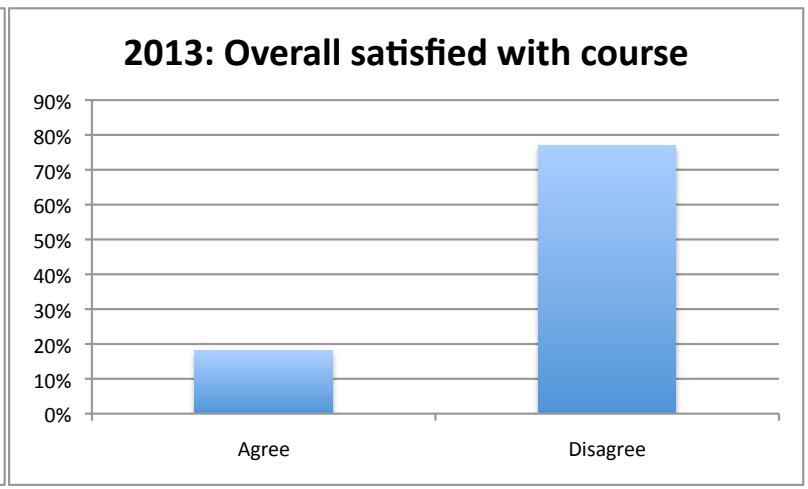


Cohort 1 previous survey results

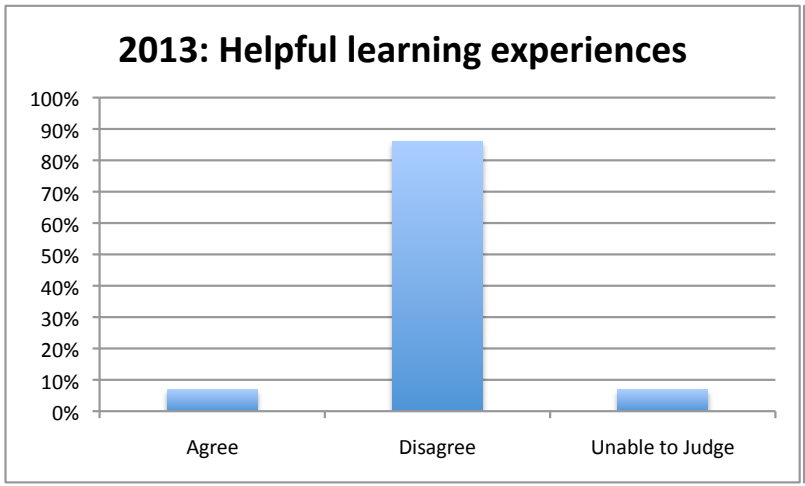


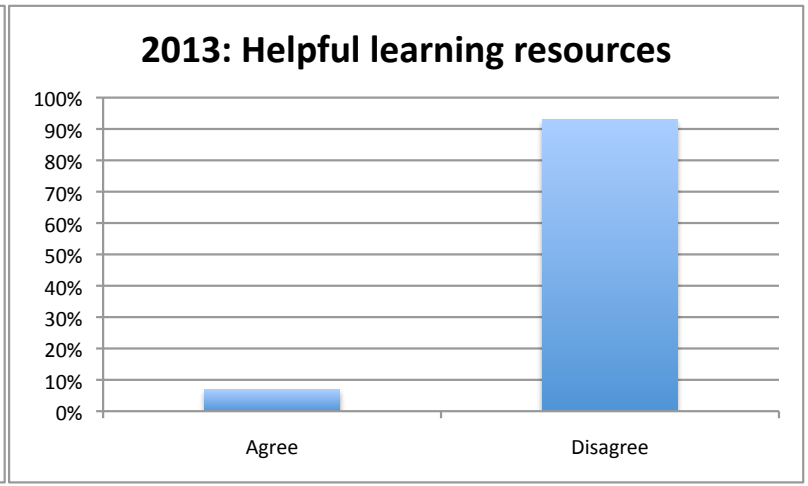


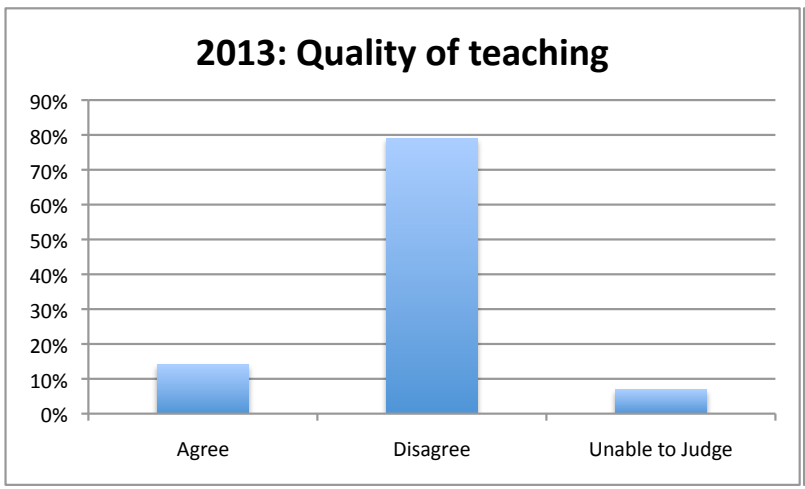


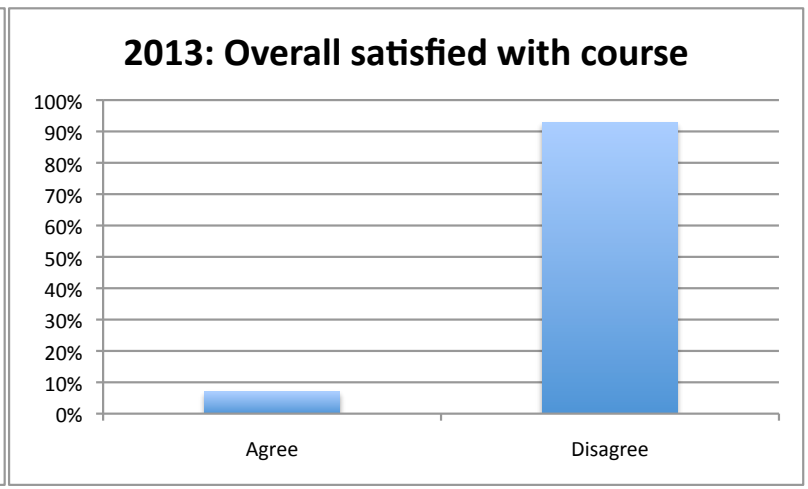


Cohort 2 previous survey results



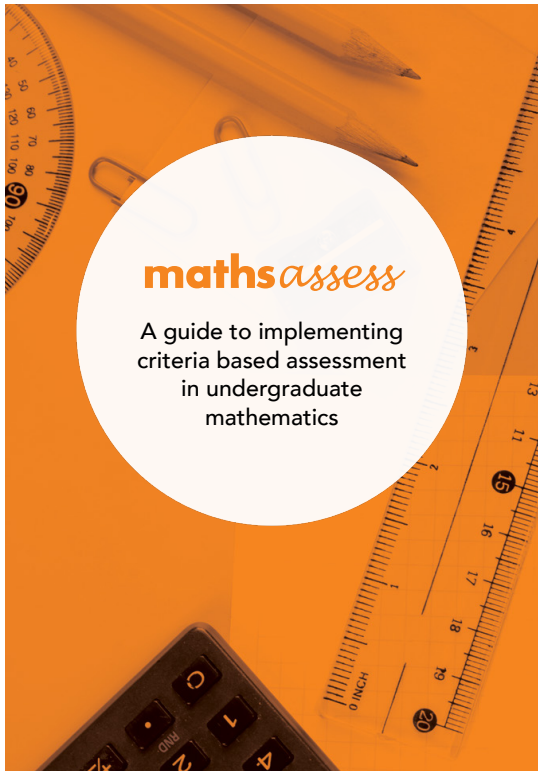






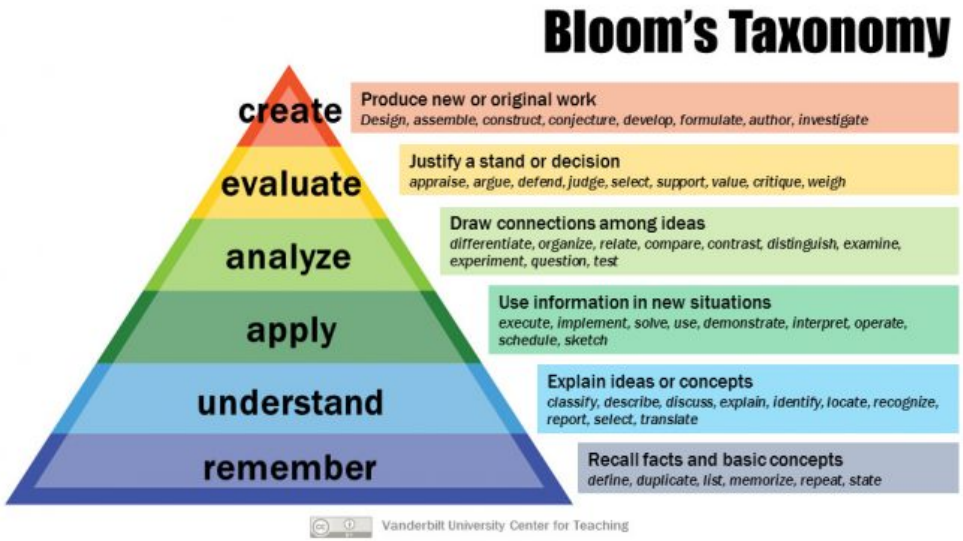
Criteria-based marking

- Inspired by "Mathsassess" project, looking at criteria based marking.
- Lead to discussions about assessing communication, and problem-solving skills.



Varsavsky, C., Coady, C., King, D., and Hogeboom, K. Office for Learning and Teaching; 2014. Mathsassess: A Guide to Implementing Criteria Based Assessment in Undergraduate Mathematics.

Marking criteria: aligned with learning outcomes



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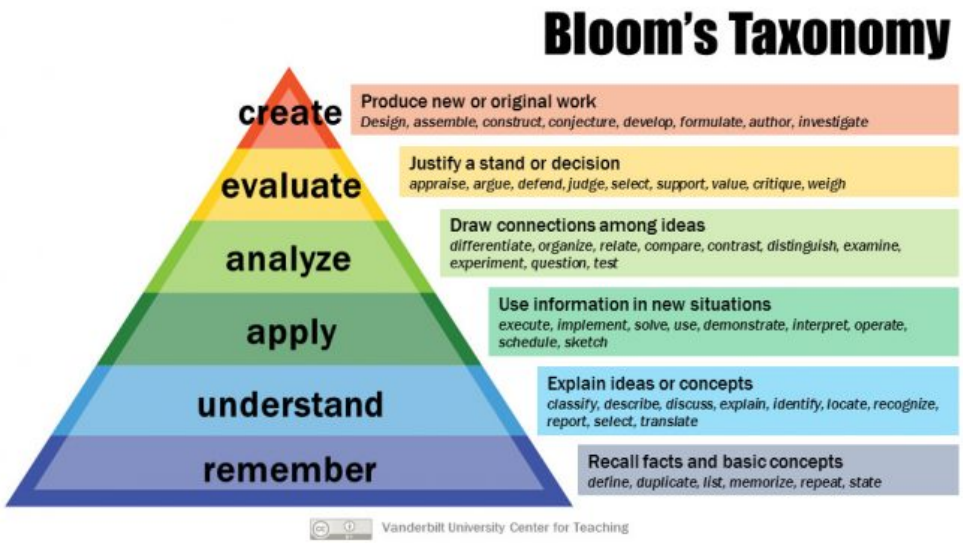

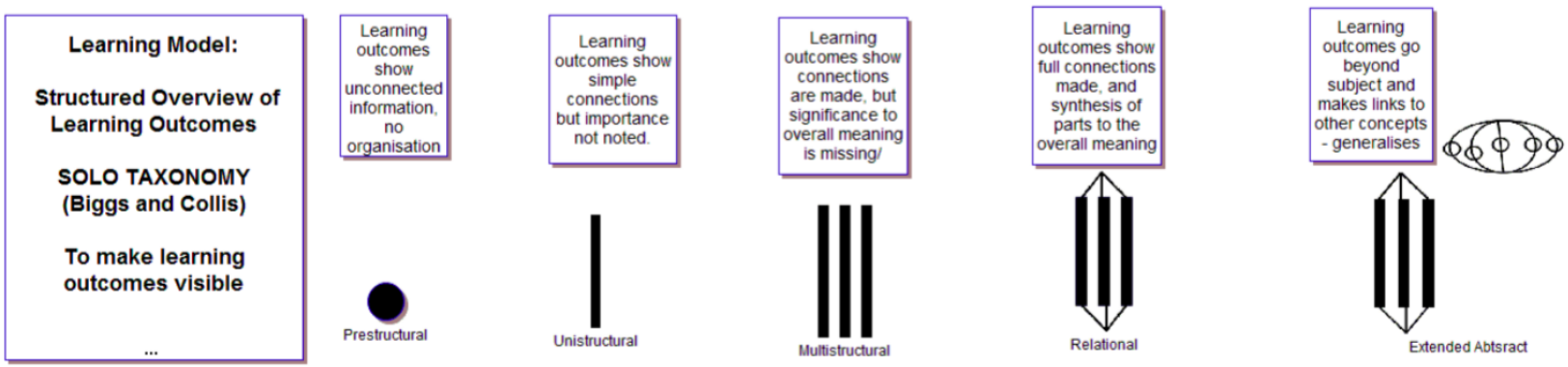

Hybrid: criteria/marking scheme

Solutions and marking scheme

The marking scheme includes marks of the following different types:

1M — this indicates one *method* mark, where the mark is for applying a correct method. Note this is NOT for the accuracy of the calculation. Sometimes the method will be implicit rather than explicitly shown.

1A — this indicates one *answer / accuracy* mark, for a correct answer or calculation. To get this mark, students must have this exact answer (in any equivalent form). Give these marks consequentially, following on from any earlier accuracy marks.

1R — this indicates one *reasoning* mark, for an explanation or justification. Generally this will be a worded answer, but there may be a variety of ways to give the required reasoning and this might include giving formulae or graphs.

Hybrid: criteria/marking scheme

$$\left[\begin{array}{ccc|c} 1 & 2 & 3 & 10 \\ 4 & 5 & 6 & 52 \end{array}\right] \sim \left[\begin{array}{ccc|c} 1 & 2 & 3 & 10 \\ 0 & -3 & -6 & 12 \end{array}\right] (R_2 - 4R_1)$$

$$\sim \left[\begin{array}{ccc|c} 1 & 2 & 3 & 10 \\ 0 & 1 & 2 & -4 \end{array}\right] (-\tfrac{1}{3}R_2)$$

Let $z = t$, $t \in \mathbb{R}$.

From R_2, we have:

$$y + 2z = -4 \Rightarrow y = -4 - 2t$$

From R_3, we have:

$$x + 2y + 3z = 10 \Rightarrow x = 10 - 3t - 2(-4 - 2t) = 18 + t$$

So the intersection, in vector form, is

$$\boxed{[x, y, z] = [18, -4, 0] + t\,[1, -2, 1],\ t \in \mathbb{R}}$$

This is a line in the direction of the vector $[1, -2, 1]$, passing through the point $(18, -4, 0)$.

1M *Row operations or equivalent to simplify*

1M *Simplifying equation (either in matrix or later)*

1A *Introduce parameter for z. Give half mark if it is not specified that $t \in \mathbb{R}$ either here or in vector equation.*

1M *Expressing x and y in terms of t*

1A *Correct x and y*

1A *Correct vector equation*

1R *Correct interpretation of intersection (as a line). Students may instead draw a rough sketch/visualisation of two planes intersecting along a line*

Marking Rubric

Generic overall marking rubric for criteria-based marking

	Levels of Achievement			
Criteria	Excellent	Good	Developing	Unsatisfactory
Method	**3 marks** All methods used are valid and properly demonstrated.	**2 marks** Small errors in methods used or in demonstrating them.	**1 mark** Significant or repeated errors in method.	**0 marks** Very little demonstration of correct methods.
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TOTAL:	/10			

Learning outcomes as criteria

Achievement/demonstration of learning outcomes (method and accuracy)

Learning outcomes assessed	Question	Achievement		
		Full	Part	None
• calculate vectors in cartesian coordinates	1(a)	✓	✓	
• find scalar and vector projections	1(b)	✓ ✓		
• find unit vectors	2(a)		✓	✓
• determine the angle between vectors	1(b), 2(a)		✓ ✓	
• compute matrix addition, scalar multiplication and matrix multiplication	2(b)	✓	✓	
• perform elementary row operations on an augmented matrix to solve a system of equations	2(b)		✓ ✓	

Colour-coded feedback (or linked via Turnitin or similar)

As the scalar projection is negative, this means $\boldsymbol{a}$ is not projecting onto vector $\boldsymbol{b}$. The projection is in the opposite direction.
Also with the projection being negative, this indicates the angle between vectors $\boldsymbol{a}$ and $\boldsymbol{b}$ is greater than 90°, but not by a large amount as the value of the projection is relatively small.
The values of vectors $\boldsymbol{a}$ and $\boldsymbol{b}$ would suggest the magnitude of vector $\boldsymbol{b}$ is greater than the magnitude of vector $\boldsymbol{a}$.

Does the scalar or vector projection itself tell us anything about the relative lengths?

Question 2:

Let a be the number corresponding to the day of your birthday (eg a = 25), b be the number of the month you were born (eg if April, b = 4), and c be the number of letters in your first name (e.g. if Heather, c = 7).

$$a = 5, b = 8, \qquad c = 7$$

a) Find two unit vectors parallel to $\langle a, b \rangle$, and two unit vectors perpendicular to $\langle b, c \rangle$.

Each of these should be in vector notation (bold is fine). Also I suggest giving the vectors different names - eg u and v, to avoid confusion.

$$\hat{\boldsymbol{u}} = \frac{\boldsymbol{u}}{|\boldsymbol{u}|} = \frac{\langle 5,8 \rangle}{\sqrt{89}}$$

$$\text{Parallel unit vector 1} = \left\langle \frac{5}{\sqrt{89}}, \frac{8}{\sqrt{89}} \right\rangle$$

$$\text{Parallel unit vector 2} = \left\langle \frac{-5}{\sqrt{89}}, \frac{-8}{\sqrt{89}} \right\rangle$$

$$\hat{\boldsymbol{u}} = \frac{\boldsymbol{u}}{|\boldsymbol{u}|} = \frac{\langle 8,7 \rangle}{\sqrt{113}}$$

Describe method - how did you get these, and/or how do we know they are perpendicular? Note we can use a vector property to check this.

Perpendicular

$$\text{~~Parallel~~ unit vector 1} = \left\langle \frac{-7}{\sqrt{113}}, \frac{8}{\sqrt{113}} \right\rangle$$

$$\text{~~Parallel~~ unit vector 2} = \left\langle \frac{8}{\sqrt{113}}, \frac{-7}{\sqrt{113}} \right\rangle$$

Why oral assessment?

Discussion in mathematics has been shown to:

- increase student learning;
- motivate students;
- support teachers in understanding and assessing student thinking;

Cirillo, M. (2013). *What does research say the benefits of discussion in mathematics class are?*, National Council of Teachers of Mathematics, Research Brief No 19.

Why oral assessment?

- increase diversity of assessment
- aligning assessment with teaching and learning style
- able to give formative feedback that is acted on immediately
- "assessment *as* learning", not just "assessment *of* learning"
- development of communication and problem-solving skills
- a form of *visible learning*

Hattie, J. (2012). *Visible Learning for Teachers: Maximizing Impact on Learning*, Routledge.

Oral assessment in the whiteboard tutorial

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Tutorial setting:

- Students work on whiteboards around the room
- Tutorial questions are given out during class
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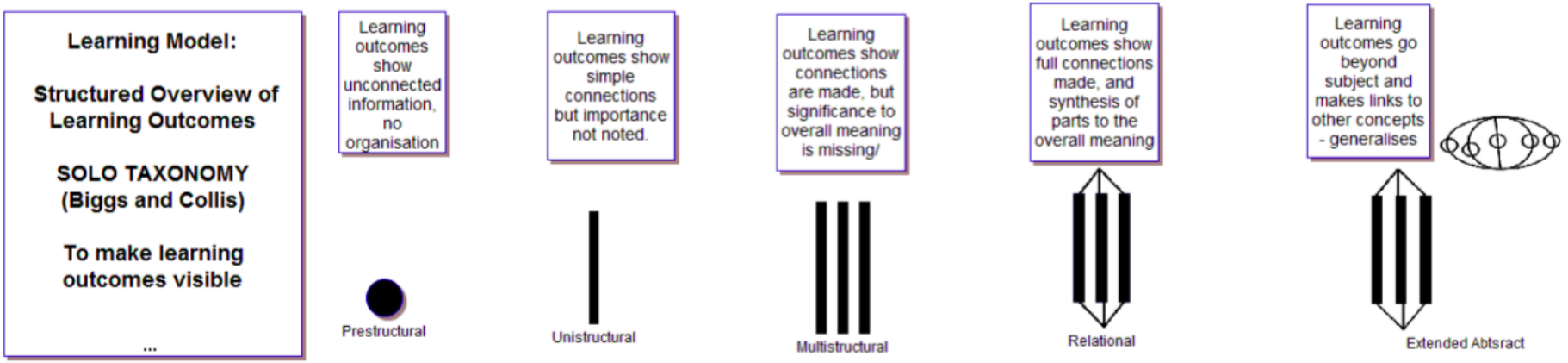
Also works well for conceptual ideas requiring deeper understanding.

Marking criteria

Criteria	Students should demonstrate they can:
Method (WHAT)	• list possible methods to be used • apply a valid method for solving each problem • demonstrate all methods thoroughly
Communication (HOW)	• clearly describe the process followed • give a big-picture overview of the method • speak clearly and use appropriate terminology • respond thoroughly to questions
Justification (WHY)	• explain why a particular method has been selected • explain why not to use another method • explain any restrictions or assumptions

Level of achievement using SOLO



Why draft assignments?

- supports student learning (Freestone, 2009)
- can be used to promote critical thinking skills (Oliver-Hoyo, 2003)
- encourages self-regulation, positive motivational benefits, and self-esteem (Nicol & Macfarlane-Dick, 2006)
- helps with transition and retention (Taylor, 2008) and (Fisher et al, 2009)

Why draft assignments?

- Ensure students are building on formative feedback
- Allow more open-ended or unfamiliar questions (scaffolding through the draft process, as needed)
- Allow students to take risks / try different things / ask for directed feedback. Adaptive to different levels of ability.
- Allows a safe space for failure as a learning experience.
- Part of a shift from surface to deep learning

Assessment design:

Desirable features of draft assignments:

- individualised
- more open-ended / exploratory questions
- scope for extension
- incentive to resubmit
- online submission and marking/feedback

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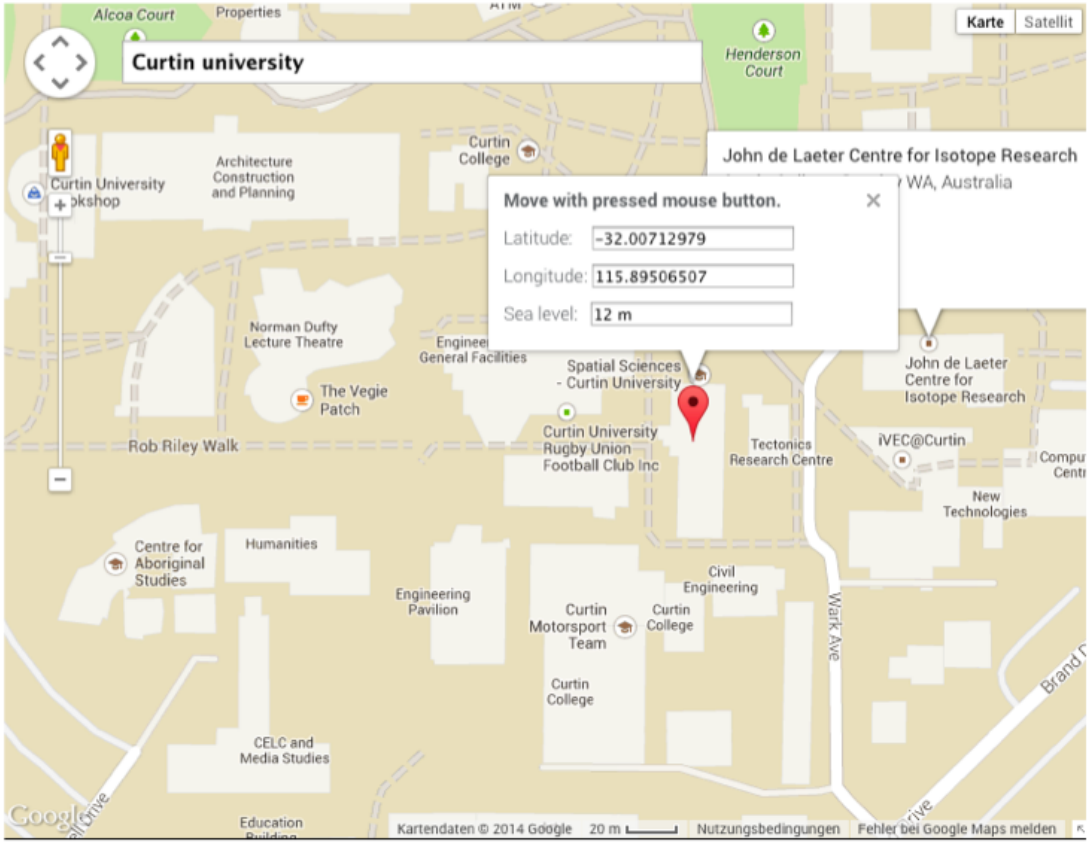

`www.mapcoordinates.net`

Individualised

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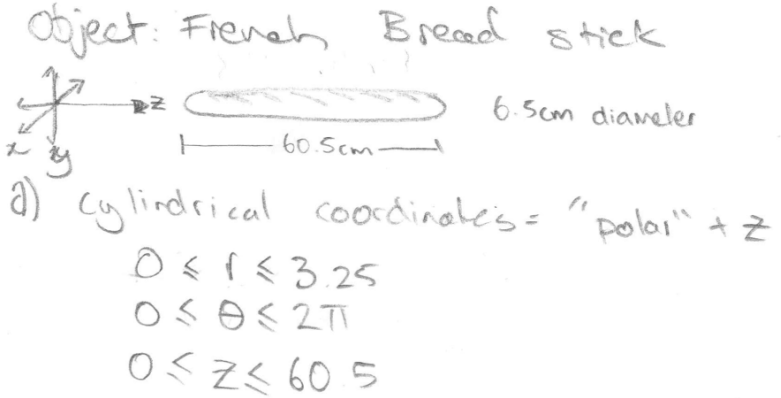

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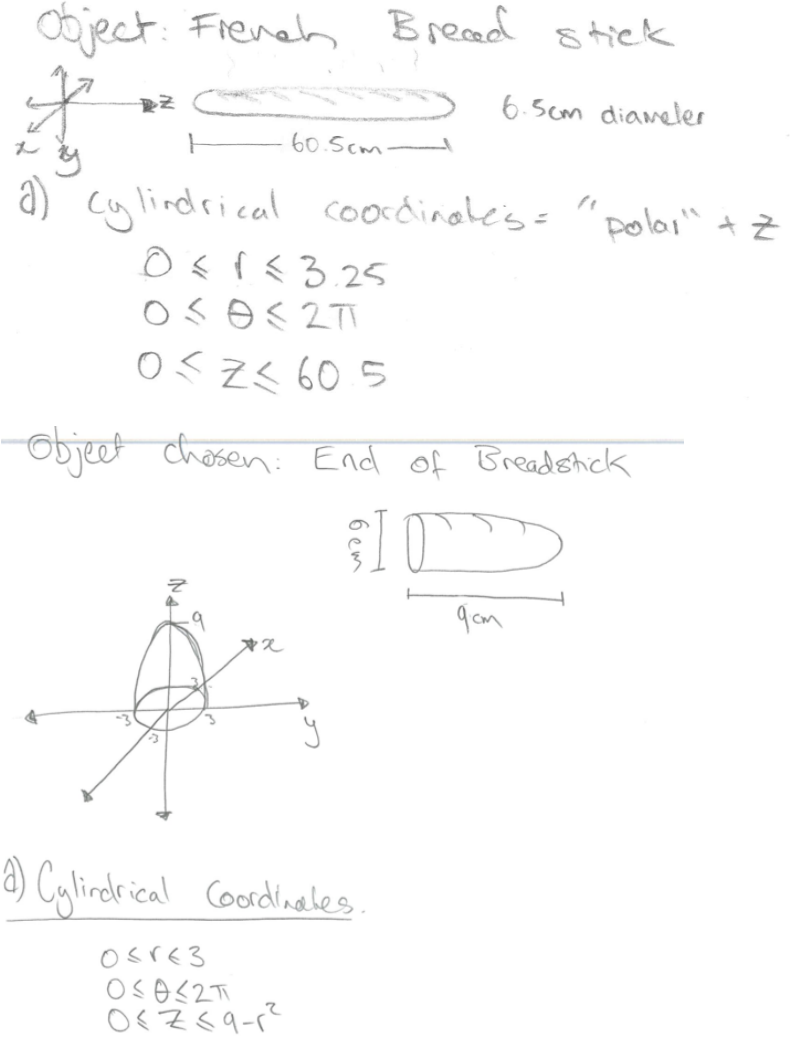

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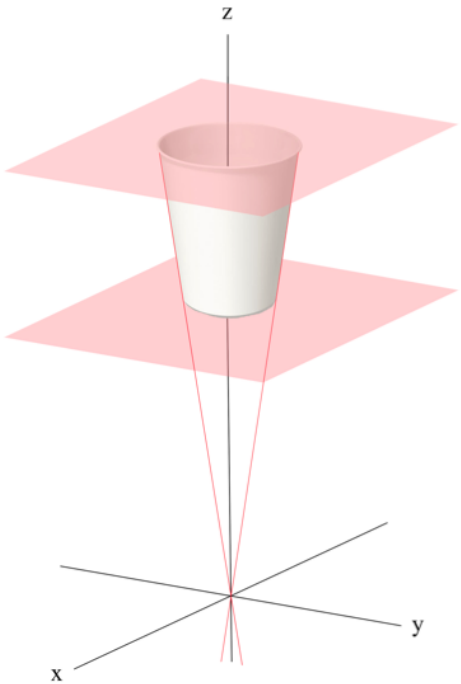

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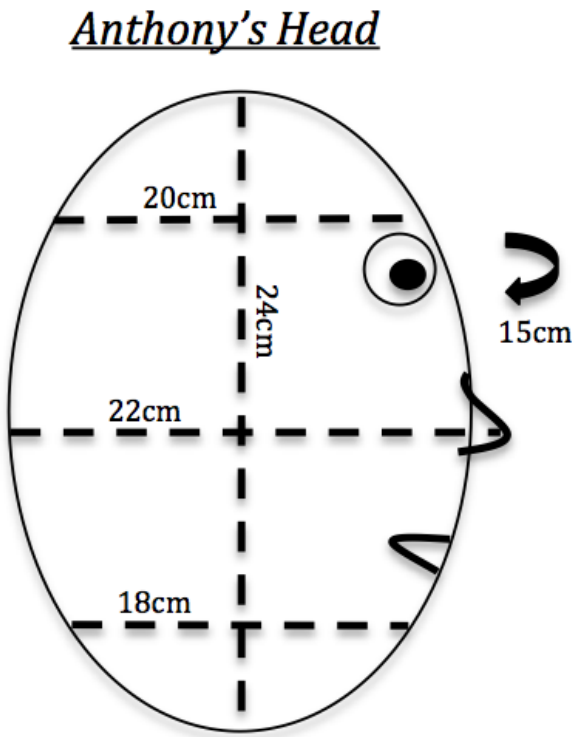
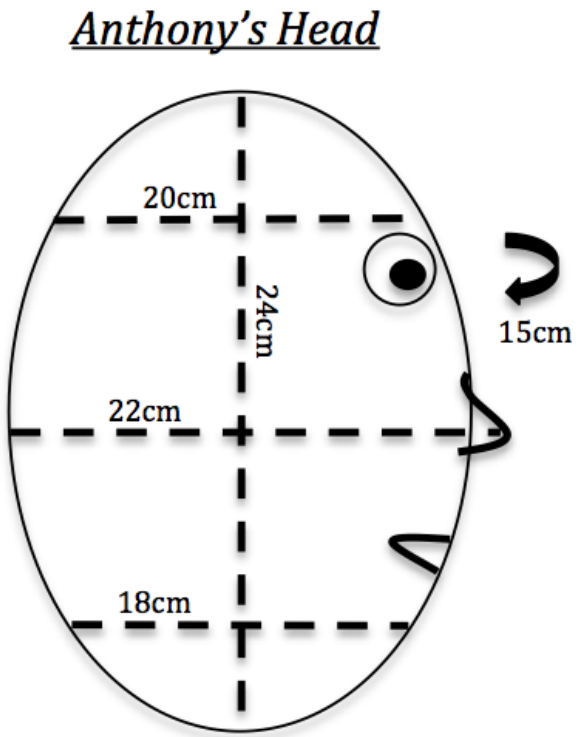


Individualised

Brayden's assignment:



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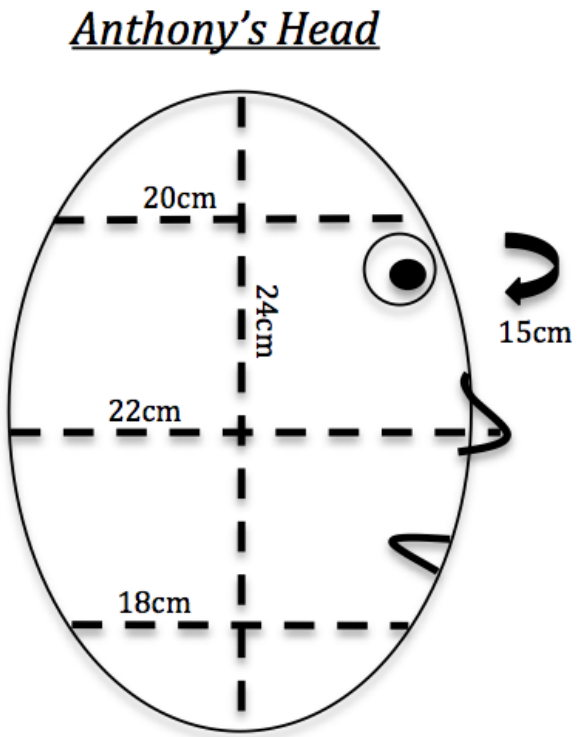

Anthony's assignment: "My shape was originally Brayden's head but it was very difficult to describe it in any coordinate system."

Draft assignments: marking rubric

	Levels of Achievement			
Criteria	Excellent	Good	Developing	Unsatisfactory
Method	**2 marks** All methods used are valid and properly demonstrated.	**1 mark** Small errors in methods used or in demonstrating them.	**0 marks** Significant or repeated errors in method.	**0 marks** Very little demonstration of correct methods.
Accuracy	**2 marks** Correct calculations, manipulations and final answers.	**1 mark** Small errors in calculations or final answers.	**0 marks** Significant or repeated errors in calculation.	**0 marks** Widespread errors in accuracy of calculation.
Communication	**2 marks** Well presented, clearly explained and shows a good level of understanding.	**1 mark** Generally well presented but could be explained more clearly.	**0 marks** Significant or repeated problems with explanation or presentation.	**0 marks** Poor presentation and/or unclear explanation.
Notation	**1 mark** All mathematical notation is correct, and clearly defined.	$\frac{1}{2}$ **mark** Small errors in notation or definition but generally correct.	**0 marks** Significant or repeated errors in notation.	
Response to feedback	**3 marks** Thorough response to feedback, in Q11 and throughout assignment.	**2 marks** Generally responded to feedback but with some omissions.	**1 mark** Limited response to feedback.	**0 marks** No response to feedback given.
TOTAL: (part 3)	/10			

Choose-your-own assessment

To allow student flexibility and autonomy, I have been trialling a range of "choose-your-own assessment" styles.

- Setting the conditions for oral assessment
- Individualised assessment contracts
- "Optional exam" when students have already demonstrated the learning outcomes
- Selecting an assessment that allows them to demonstrate the learning outcomes (and justifying that they have done so)

Choose-your-own assessment

In an oral assessment (where students are assessed on "what", "how" and "why"), students were able to decide the following aspects of the assessment:

- Who: individually or in a group
- When: regularly (after each topic), or once at end of semester
- Where: in the tutorial, during office hours, or online

Over 90% of students chose to do it as recommended: in a group, regularly, in the tutorial session.

Choose-your-own assessment

"Portfolio of Oral Communication" – contract

Each student has the freedom to nominate the setting, mode and frequency of their portfolio assessment. Please complete the details below and select your assessment model.

Name and Student number: _____

Workshop day and time: _____

Setting for assessment (select one)

- ☐ Workshops (recommended)
- ☐ During Heather's office hours
- ☐ Online – via recorded video or video call

Mode of assessment (select one)

- ☐ Group (recommended)
- ☐ Individual

Frequency of assessment (select one)

- ☐ Regularly: 3 times throughout semester (recommended)
- ☐ Once: in the second-last teaching week
- ☐ Other, please specify:

Other details/desired focus of feedback

- Please specify any further details (if you have an alternative assessment proposal)
- Is there any particular area you would like feedback to focus on? (both in the assessment and leading up to it / during all workshops throughout semester)

I agree to have my portfolio of oral communication assessed in the above ways, as selected.

Student signature _____

This contract must be submitted online (via Blackboard) by midnight on **Friday 20 March**. Students can either fill out a paper copy, and scan it in (or take a photo, as long as it is legible), or access the document from Blackboard to edit and submit.