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| Bernie O’Donoghue |
| LNMTI Grading Rubric |
| [Document subtitle] |

**Question 1: *Irrational Numbers and Calculator***

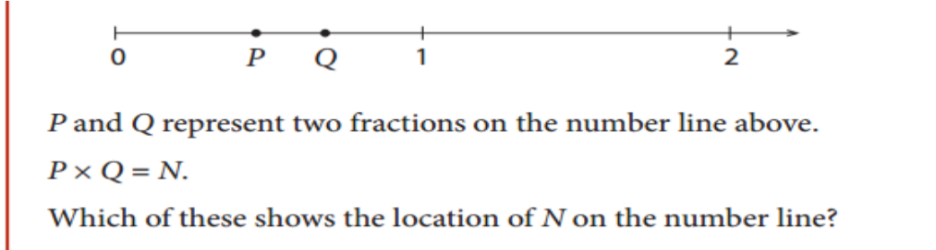
*The class are discussing rational and irrational numbers. One student claims that is an irrational number because his calculator shows 0.53488372 when 23 is divided by 43 and there is no repeating pattern of digits.*

*In the role of the teacher, write the response you would make to this student’s claim?*

This item requires participants to react to a student contribution. It is examining the participants ability to express knowledge of basic mathematical concepts (Numeracy) and calculator use as an example of digital media. It is also examining adaptive reasoning (the capacity for logical thought, reflection, explanation, justification and communication (Literacy)

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| **Value** | **Definition** | **Anchor example for High** |
| Not Present | Incorrect response; Response is confusing and lacks clarity; Response does not develop student understanding | Ask the student to recall the definition of a rational number:  Rational Numbers are any number of the form  Ask the student to position this number in relation to the definition: 23 and 43 are both integers, therefore is a rational number  Eventually the digits would repeat but the calculator has a limited digit display. |
| Low | Responds in a pro-forma way. |
| Mid | Response has some features listed under high |
| High | Response encourages the student to think about claim by asking an appropriate question(s) that develops student understanding.  Mathematical definition of rational/irrational number given  References to digital media given, i.e., the limitation of the calculator display. |

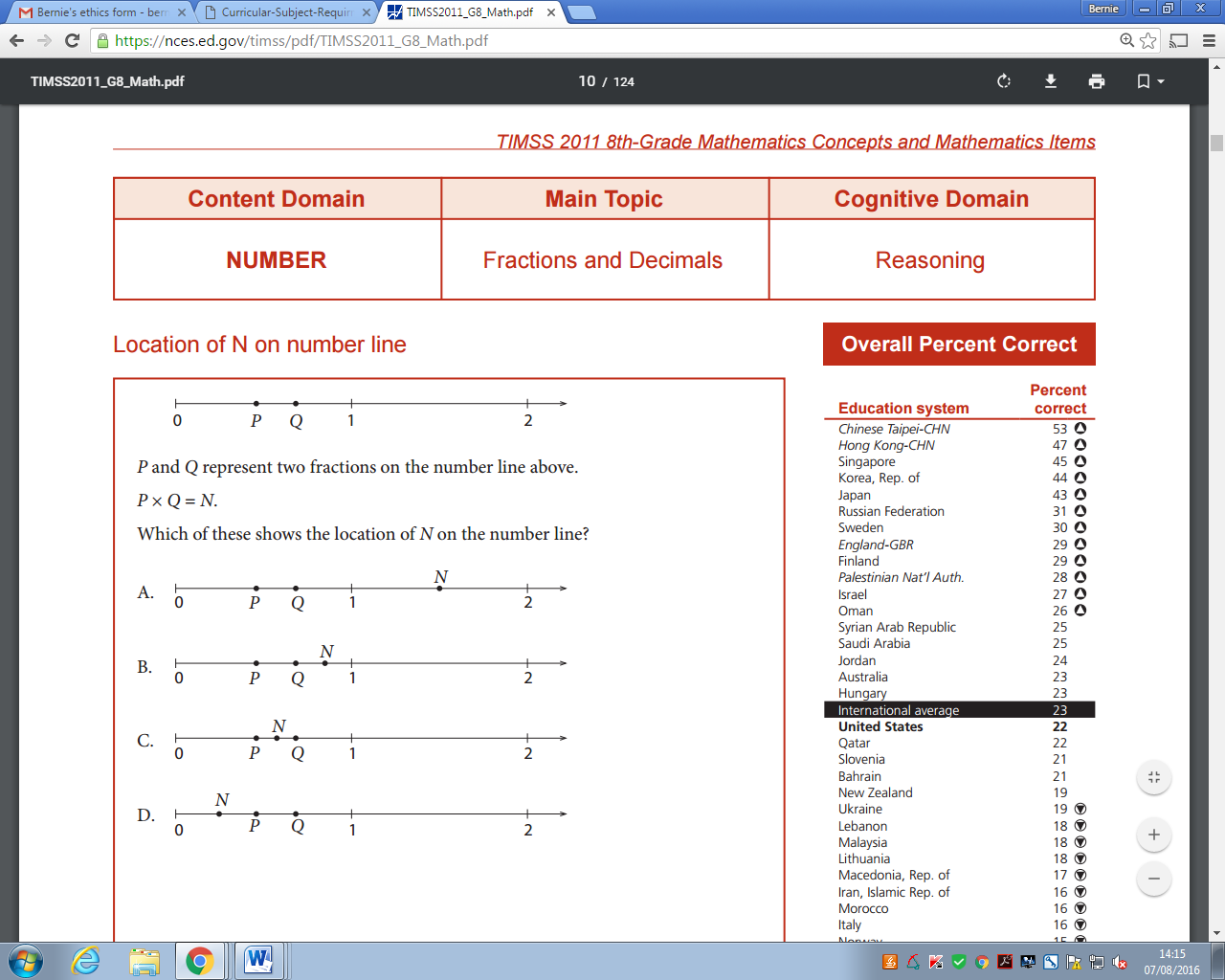
**Question 2: *Multiplication of Real Numbers between O and 1***

*The following question appeared in a first year summer test: P and Q represent two fractions on the number line*.

*. Show the location of on the number line.*

*Evaluate this student’s answer to the question*.

***Student’s Answer*:**

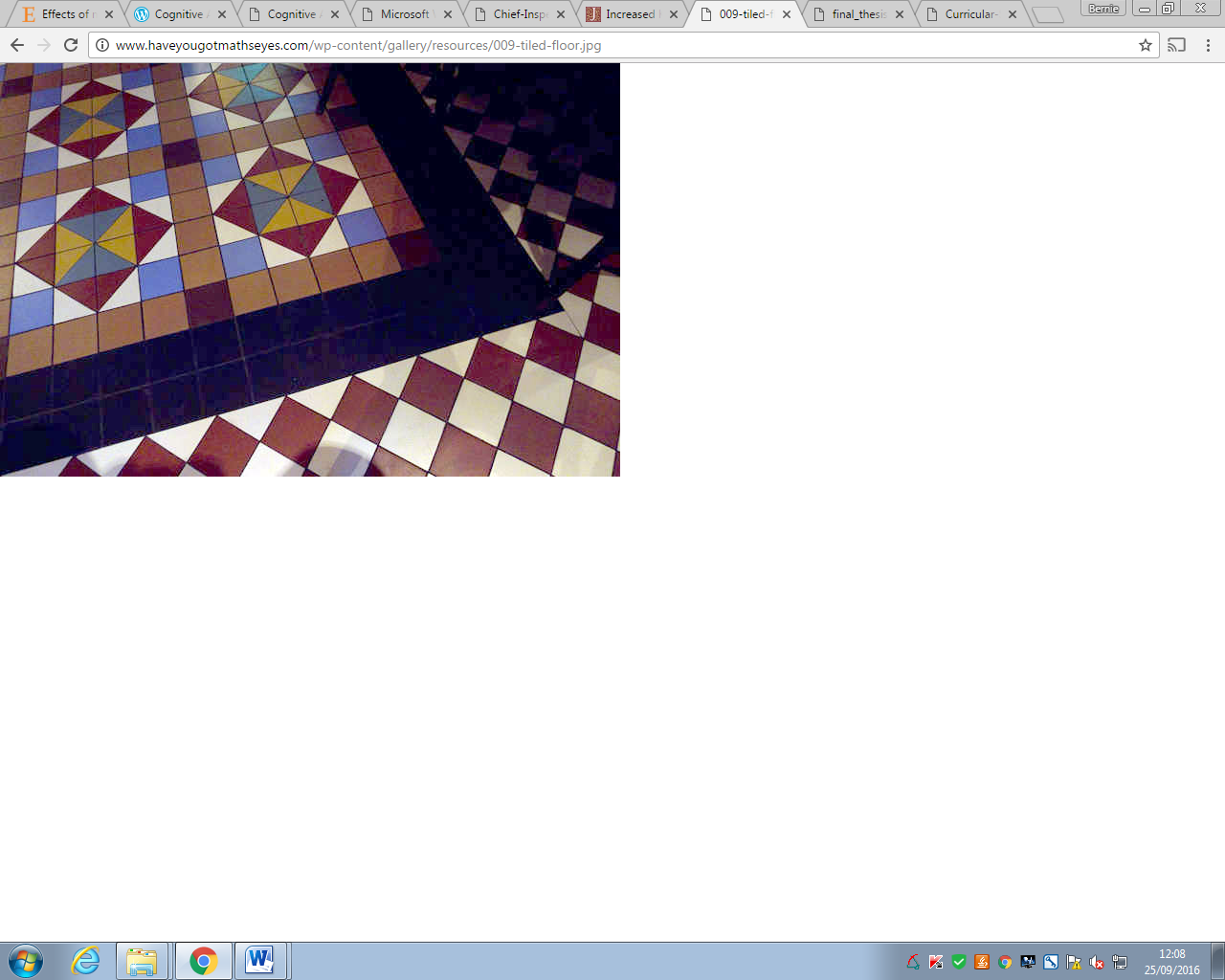


This item requires participants to display mathematical sense making (Numeracy) and communicate the reasonableness of a solution effectively (Literacy)

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| **Value** | **Definition** | **Anchor example for High** |
| Not Present | Incorrect response; response is confusing and lacks clarity; response does not develop student understanding | The student is confused about the operations of addition and multiplication for real numbers between 0 and 1.  Using specific numerical examples, ask the student to:   1. multiply two fractions between 0 and 1 and represent the answer on the number line. 2. Add two fractions between 0 and 1 and represent the answer on the numberline   Ask the student if they can identify any pattern (the answers lie between 0 and P for multiplication and greater than Q for addition) |
| Low | Identifies possible student error/misconception, but does not address this |
| Mid | Identifies possible student error/misconception and makes an effort to address this. |
| High | Giving meaning of numbers in symbolic form.  Giving meaning to the number in the number line representation.  Giving meaning of operations for real numbers between 0 and 1.  Focus on the reasonableness of a solution. |

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| **Value** | **Definition** | **Anchor example for High** |
| Not Present | Identifies some shapes/Incorrect definitions | A **triangle** is a polygon with three edges and three vertices.  Isosceles triangles have at least two equal sides (or angles).  A **rectangle** is a quadrilateral having right angles at all four vertices.  A **rhombus** is a quadrilateral having all four sides equal **or**  A **square** is a rectangular rhombus.  A **parallelogram** is a quadrilateral for which both pairs of opposite sides are parallel.  A t**rapezium** is a quadrilateral for which at least one pair of parallel sides. |
| Low | Identifies some shapes/Some correct definitions |
| Mid | Identifies all shapes/Mostly correct definitions  **or**  Identifies most shapes/All definitions are correct’ |
| High | Identifies all shapes/Correct definitions |

**Question 3*: Geometry Definitions***

Examine the photograph of this tiled floor and answer the following questions:

(a)Identify the shapes in this tiled floor

(b) Define each shape

This item requires participants to display basic spatial awareness by identifying geometric shapes in the photograph as well as using the specialist language of mathematics (a literacy outcome) in defining the shapes. In the following scheme: ‘all’ shapes refers to at most 5: triangle, rectangle, square/rhombus, parallelogram and trapezoid. ‘Most’ refers to 3 or 4 shapes and ‘some’ means 1 or 2 shapes. Allow for references to 3D shapes.

**Question 4: *Similar Triangles***

*******Six identical rectangles with height and width are arranged as shown. The line segment intersects the vertical side of one rectangle at  and the horizontal side of another rectangle at . If the right-angled triangle  is such that  = 2*

1. *Find the value of*
2. *Write a response to this statement: This question is suitable for Junior Certificate Higher Level*

The assessment objectives for this question were for literacy: the ability to understand and use mathematical notation, read a diagram, communicate knowledge of the syllabus and for numeracy: in a geometry context, solve a problem and think and communicate quantitatively.

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| **Value** | **Definition** | **Anchor example for High** |
| Not Present | Incorrect or irrelevant work presented; no relevance to syllabus identified | The triangles PAQ and XYZ are similar and so:    It is suitable for Junior Certificate level  Similar triangles: (p.61 JC syllabus)  Work with ratios to develop an understanding of proportionality which can be applied to solve single and multi-step problems in numerous contexts.(p.21 JC syllabus) |
| Low | Identifies similar triangles but ratios are incorrect and/or identifies suitability for JCHL |
| Mid | Uses similar triangles to establish correct  ratios but has incorrect solution and/or  identifies suitability for JCHL |
| High | Uses similar triangles to establish correct ratios and correct solution and identifies suitability for JCHL |

**Question 5: *Linear Patterns***

*A teacher gives his/her students the following problem:*

*A toy train has 100 cars. The first car is red, the second is blue, the third is yellow, the fourth is green, and the fifth is red and sixth is blue, and so on.**What is the colour of the 39th car?*

*The teacher is moving through the room observing how the students are progressing. S/he stops and points at one student’s work and says:*

***Teacher:*** *Why is the 39th car yellow?*

***Student****: Because the 3rd car is yellow and 39 is a multiple of 3.*

1. *Identify the student error/misconception in this instance*
2. *Outline how you would help the student correct the error/misconception.*

This question attempts to address the ability of the teacher to analyse and express student errors and difficulties (literacy and numeracy) using the following approaches to remediation (Harvard Graduate School of Education 2018).

* Simple corrections: for example: it’s multiples of 4 in this pattern – they do not address student difficulty
* Conceptual remediation: identifying the source for example: yellow is the third colour and 39 is a multiple of three – student thinks this is a proportional relationship and three is the constant of proportionality etc
* Procedural remediation: corrects students problems and procedures
* Pre-remediation calls students’ attention to a common error

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| **Value** | **Definition** | **Anchor example for High** |
| Not Present | 1. remediation does not go beyond correcting the student answer  2. remediation is confusing | The student’s reasoning is incorrect. The reason the 39th car is yellow is because the yellow cars are in this sequence 3, 7, 11, 15, 19, 23, 27, 31, 35, 39 and it is described by this rule:  I would ask him/her to find the second yellow car in this sequence by drawing the pattern and/or listing the terms in the sequence  I would ask him/her to write out the multiples of 3  I would ask him/her to examine the position of green cars in the sequence.  Compare the position of the green cars with the yellow cars. |
| Low | brief conceptual remediation occurs or brief procedural remediation |
| Mid | 1. moderate conceptual remediation or extensive procedural remediation  2. use of counter example |
| High | 1. identifies the source of the student error  2. focuses on conceptual remediation at length by use of counter example |

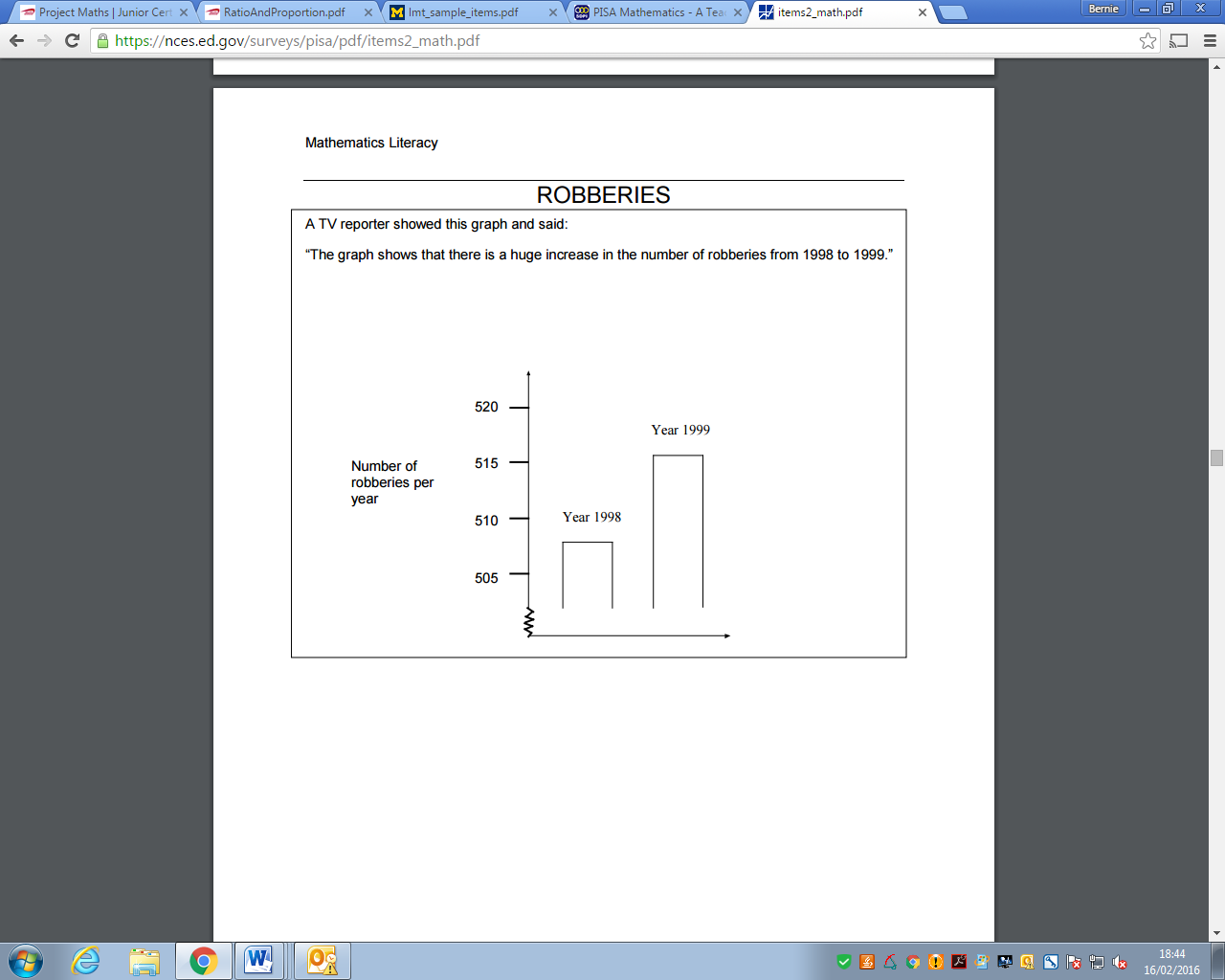
**Question 6:** ***Simplifying Algebraic Fractions***

*Ciara is a second year Junior Certificate student with good mathematical ability. She simplifies the following rational algebraic expression correctly:*

1. *Show how she does this.*
2. *Explain the reason for each step in simplifying the above expression as you would to a student preparing for Junior Certificate Higher Level.*

Simplifying algebraic fractions assesses participants’ ability to execute and explain using correct mathematical language (literacy and numeracy) a familiar mathematical procedure. Mathematical language focuses on the fluency of the participant.

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| **Value** | **Definition** | **Anchor example for High** |
| Not Present | correct solution and incorrect explanation | A reference must be made to A. Participants may reference B-D to support A.   1. simplifying a fraction using the concept of equivalent fractions 2. Factorise the quadratic expression in the denominator 3. Divide the numerator and the denominator by the highest common factor of both numerator and denominator 4. When the highest common factor of the numerator and denominator is 1, then the fraction is simplified |
| Low | correct solution; describes the procedures without referencing equivalent fractions |
| Mid | correct solution with most of the features of High |
| High | correct solution; correction explanation; identifies the formation of equivalent fractions; uses mathematical language appropriately and fluently |

**Question 7:** ***Reading Graphs***

1. *Represent this data numerically/In tabular form*
2. *Comment on the reasonableness of the reporter’s statement using mathematical evidence to support your answer*.

Department of Educat;ion and Skills have a publication titled: *PISA Mathematics: A Teacher’s Guide* that analyses this question

The single item in this unit was difficult for students, with just 13% in Ireland achieving full credit compared to the OECD average of 15%. On the other hand, 37% of students in Ireland achieved partial credit, compared to an OECD average of 28%. This may reflect the fact that, on the one hand, the material is on the syllabus, but that, on the other hand, the interpretation of misleading graphs has not generally been emphasised in textbooks or examinations. Students due to sit the Junior Certificate examination in 2003 (a few months after taking the PISA tests) or later may have had experience in giving verbal explanations for their answers, as this is a feature of the revised course examined for the first time in 2003; students who sat for the examinations before 2003 would probably have been less accustomed to this (p.13).

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| **Value** | **Definition** | **Anchor example for High** |
| Not Present | response is incorrect or poorly executed | .   |  |  |  | | --- | --- | --- | | **Year** | **1998** | **1999** | | **No. of robberies** | 508 | 516 |   The reporter’s statement is exaggerated. There are 8 more robberies reported which is an percentage increase of 1.6% |
| Low | response has 1 feature listed under High |
| Mid | response has 2 features listed under High |
| High | Response has the following:   1. Correct Numerical representation/ Numerical representation in tabular form and/or displays a broader understanding of ‘numerical representation’ vis-à-vis JC syllabus, 2. Identifies increase/relative size, 3. References the exaggerated use of the word ‘huge’. |

**Question 8: *Probability Concepts***

The following problem appears in a Leaving Certificate Ordinary Level Examination Paper, 2013:

*Katie tossed a coin 200 times and threw 109 heads. Joe tossed the same coin 400 times and threw 238 heads. Lucy tossed the same coin 500 times and threw 291 heads. Lucy uses all the above data and calculates that the best estimate of the probability of throwing a head with this coin is 0·58. Show how Lucy might have calculated this probability.*

One student works through the problem in the following way. Evaluate this student’s method and final answer:

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| Step 1 | Step 2 | Step 3 |
| Katie:  Joe:  Lucy: |  |  |

This question assesses how participants can identify a basic error in probability concepts and other student work.

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| **Value** | **Definition** | **Anchor example for High** |
| Not Present | incorrect response | To get more accurate results for the experiment, the student should have counted up the total number of trials (1100) from Kate, Joe and Lucy and the total number of successes (638) and then calculated the probability:  The student performed the calculation on the left on side which is not equivalent to the required calculation on the rhs  The student made a slip by incorrectly changing 1.722 to 0.1722  The student rounded incorrectly. |
| Low | Core misconception addressed but explanation is very brief |
| Mid | Core misconception addressed with some explanation |
| High | Core misconception addressed and explained in detail;  Other features may include:  Gives counter example or generalises the procedure – example: *What if Katie had got 2 heads out of 20 tosses, and Lucy used her procedure to estimate the probability?*  Identifies student slip/error moving from step 2 to step 3. |