A: Quantity/Number

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| ***A1: 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?* | |
| **Literacy Process** | Understand |
| **Numeracy in Mathematics Content Domain** | JC:3.1/3.2 and LC:3.1/4.1/5.2 |
| **MQI Content Domain** | Teacher Uses Student Mathematical Contributions |
| **Literacy Form Domain** | Spoken Language/Digital Media |
| **Source** | Zazkis, R. (2016) ‘ Dialogues on number theory’, |

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| ***A2: Order of Operations and Calculator***  *How would you explain to a student when you key in into a calculator, the answer is?* | |
| **Literacy Process** | Understand |
| **Numeracy in Mathematics Content Domain** | Quantity/Number: JC:3.1 and LC:3.1 |
| **MQI Content Domain** | Remediation of Student Errors and Difficulties |
| **Literacy Form Domain** | Digital Media |
| **Source** | PMDT (2016), ‘Know how your calculator works’, p.1 |

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| ***A3. Multiplication of Read 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:*** | |
| **Literacy Process** | Use |
| **Numeracy in Mathematics Content Domain** | Quantity/Number: JC:3.1/3.6 and LC:3.1 |
| **MQI Content Domain** | Mathematical Sense-Making |
| **Literacy Form Domain** | Spoken Language/Printed Text |
| **Source** | TIMSS (2011) cited in NCES (2015) |

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| ***A4: Place Value***  *You are teaching mathematics to first year students in second level and they are required to sit a competency test in mathematics after the mid-term break. One of the questions on the paper will be:*  *From the following list, circle the number with the greatest value?*    *Outline the knowledge required for students to answer this question correctly.* | |
| **Literacy Process** | Use |
| **Numeracy in Mathematics Content Domain** | JC: 3.1 and LC: 3.1 |
| **MQI Content Domain** | Mathematical Explanations |
| **Literacy Form Domain** | Spoken Language/Printed Text |
| **Source** | Cai et al (1996), p. 239 |

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| ***A5. Irrational Numbers in Context***  *Your students have been working on number systems. They were given the following task:*  *Determine whether each of the following is an irrational number always, sometimes or never by checking one box in each row.*   |  |  |  |  | | --- | --- | --- | --- | |  | **Always** | **Sometimes** | **Never** | | A. The result of dividing the circumference of a circle by it diameter | ✓ |  |  | | B. The diagonal of a square with a side of length 1 |  | ✓ |  | | C. Result of dividing 22 by 7 |  |  | ✓ |   *One student’s answers are shown below. Correct each answer, and in the space provided, give mathematical evidence why you think it is correct or incorrect.*   |  |  | | --- | --- | |  | **Always** | | A.The result of dividing the circumference of a circle by it diameter | ✓ | |  | |  |  |  | | --- | --- | |  | **Sometimes** | | B. The diagonal of a square with a side of length 1 | ✓ | |  | |  |  |  | | --- | --- | |  | **Never** | | C. Result of dividing 22 by 7 | ✓ | |  | | | |
| **Literacy Process** | Critically Appreciate |
| **Numeracy in Mathematics Content Domain** | JC: 2.1/2.3/3.1/3.4 and LC: 2.1/2.3/3.1/3.4 |
| **MQI Content Domain** | Mathematical Sense-Making |
| **Literacy Form Domain** | Spoken Language/Printed Text |
| **Source** | IEA (2009) TEDS-M 2008, p. 9 |

B: Spatial/Geometry & Trigonometry

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| ***B1: Geometry Definitions***  *Examine the photograph of this tiled floor and answer the following questions:*    <http://www.haveyougotmathseyes.com/wp-content/gallery/resources/009-tiled-floor.jpg>   1. *Identify the shapes in this tiled floor* 2. *Define each shape* | |
| **Literacy Process** | Understand |
| **Numeracy in Mathematics Content Domain** | JC: 2.1 and LC: 2.1 |
| **MQI Content Domain** | Mathematical Sense-Making |
| **Literacy Form Domain** | Digital Media |
| **Source** | Have You Got Maths Eyes (2016), Tiled Floor 009 |

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| ***B2: Multiple Methods***  *5th year students were asked to solve the following problem:*  *Two approaches to the problem are given. Compare the two methods for efficiency, ease of use or other advantages/disadvantages.*   |  |  | | --- | --- | | **Method 1** | **Method 2** | |  | ) | | | |
| **Literacy Process** | | Critically Appreciate |
| **Numeracy in Mathematics Content Domain** | | JC: 2.1/2.2 and LC: 2.1/2.2 |
| **MQI Content Domain** | | Multiple Procedures or Solution Methods |
| **Literacy Form Domain** | | Printed Text |
| **Source** | | PMDT (2016), Workshop 6 |
| ***B3: 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’.* | | |
| **Literacy Process** | 1. Understand (b) Use | |
| **Numeracy in Mathematics Content Domain** | JC: 2.1 and LC: 2.1 | |
| **MQI Content Domain** | Mathematical Language | |
| **Literacy Form Domain** | Printed Text | |
| **Source** | PMDT (2016) Problem Solving at Junior Cert, p.2 | |

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| ***B4: Theorem***  *If three parallel lines cut off equal segments on some transversal line, then they cut off equal segments on any other transversal.*   1. *Draw the diagram to illustrate this theorem statement.* 2. *Use mathematical symbols to describe this theorem statement.* | |
| **Literacy Process** | Understand |
| **Numeracy in Mathematics Content Domain** | JC: 2.1 and LC: 2.1 |
| **MQI Content Domain** | Linking Between Representations |
| **Literacy Form Domain** | Spoken Language/ Printed Text |
| **Source** | Author’s own |

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| ***B5****:* ***Symmetry***  *Your students have been working on symmetry. They were given the task below requiring them to decide the number of lines of symmetry for three different shapes.*  *Aoife and Ruairi’s answers are shown in the table.*   1. *Correct the answers of each student by checking correct or incorrect.* 2. *Evaluate Aoife and Ruairi’s knowledge of symmetry in the boxes provided below*      |  |  |  |  | | --- | --- | --- | --- | |  | | **Students and their answers about the number of the lines of symmetry** | | | **Shape** | **Shape name** | **Aoife** | **Ruairí** | |  | Regular hexagon | **6**  **🞏Correct**  **🞏Incorrect** | **12**  **🞏Correct**  **🞏Incorrect** | |  | Regular pentagon | **5**  **🞏Correct**  **🞏Incorrect** | **10**  **🞏Correct**  **🞏Incorrect** | |  | Rhombus | **4**  **🞏Correct**  **🞏Incorrect** | **2**  **🞏Correct**  **🞏Incorrect** | | **Aoife’s Knowledge of Symmetry** |  | | | | **Ruairi’s Knowledge of Symmetry** |  | | | | |
| **Literacy Process** | 1. Understand (b) Critically Appreciate |
| **Numeracy in Mathematics Content Domain** | JC: 2.1 and LC: 2.1 |
| **MQI Content Domain** | Mathematical Sense-Making |
| **Literacy Form Domain** | Printed Text |
| **Source** | IEA (2009) TEDS-M 2008, p. 22 |

C: Patterns & Sequences/Algebra & Functions

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| ***C1****:* ***Linear Pattern***  *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.*  *T: Why is the 39th car yellow?*  *S: 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.* | |
| **Literacy Process** | 1. Understand (b) Critically Appreciate |
| **Numeracy in Mathematics Content Domain** | JC:3.1/4.1/4.2/5.2 and LC:3.1/4.1/5.1 |
| **MQI Content Domain** | Remediation of Student Errors and Difficulties |
| **Literacy Form Domain** | Spoken Language |
| **Source** | Zazkis, R. (2016) ‘ Dialogues on number theory’, |

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| ***C2****:* ***Exponential Equation***  *Watch the clip from the American sitcom ‘Parks and Recreation’ and answer the following question:*  *How many games did they play to reach $6,400?*  <http://blog.mrmeyer.com/2009/what-can-you-do-with-this-the-6400-question/>, | |
| **Literacy Process** | Critically Appreciate |
| **Numeracy in Mathematics Content Domain** | JC: 4.2/5.2 and LC:5.1 |
| **MQI Content Domain** | Patterns and Generalisations |
| **Literacy Form Domain** | Broadcast Media |
| **Source** | Meyer, D. (2009)*What can you do with this the 6400 question* |

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| ***C3: 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.* | |
| **Literacy Process** | 1. Understand (b) Use |
| **Numeracy in Mathematics Content Domain** | JC: 4.6 and LC: 4.2 |
| **MQI Content Domain** | Mathematical Explanations |
| **Literacy Form Domain** | Spoken Language/ Printed Text |
| **Source** | PMDT (2016), Workshop 10 |

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| ***C4: Ratios/Rates and Proportions***  *Miss Murphy’s students were comparing different rectangles and decided to find the ratio of height to width.  They wondered, though, if it would matter whether they measured the rectangles using centimetres or measured the rectangles using inches.*  *Students offered other examples to consider.*  *For each situation below:*   1. *decide whether it is a valid contribution for which different ways of measuring produce the same or different ratio by ticking the box correct or incorrect.* 2. *provide an explanation for your answer*  |  |  |  | | --- | --- | --- | | **Student Contribution** |  | **Provide an explanation for your answer** | | *a)the ratio of two people’s heights measured in (1) feet, or (2) metres* | **🞏Correct**  **🞏Incorrect** |  | | *b) the noontime temperatures yesterday and today, measured in (1) Fahrenheit, or (2) Centigrade* | **🞏Correct**  **🞏Incorrect** |  | | *c) the speeds of two airplanes, measured in (1) metres per second, or (2) Km per hour* | **🞏Correct**  **🞏Incorrect** |  | | *d) the growths of two bank accounts measured in (1) annual percentage increase, or (2) end-of-year-balance minus beginning-of-year balance* | **🞏Correct**  **🞏Incorrect** |  | | |
| **Literacy Process** | 1. Use (b) Critically appreciate |
| **Numeracy in Mathematics Content Domain** | JC: 3.1/4.4 and LC: 3.1/3.3/4.1/5.2 |
| **MQI Content Domain** | Teacher uses Student Mathematical Contributions |
| **Literacy Form Domain** | Printed Text |
| **Source** | LMTP(2008), p.25 |

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| ***C5: Simultaneous Equations***  *The following problems appear in a mathematics textbook for Junior Certificate:*  *Problem 1: Seán, Mark and Joe collect football stickers. They have 198 of them altogether. Seán has 6 times as many football stickers as Mark and Joe has 2 times as many football stickers as Mark. How many football stickers does each boy have?*  *Problem 2: Leah, Niamh and Máiread have €198 euro altogether. Leah has 6 times as much money as Niamh and three times as much as Máiread. How much money does each girl have?*   1. *Solve each problem.* 2. *Typically Problem 2 is more difficult than Problem 1 for Junior Certificate Students. Give one reason that might account for the difference in difficulty level.* | |
| **Literacy Process** | 1. Use (b) Critically appreciate |
| **Numeracy in Mathematics Content Domain** | JC: 4.3/4.4/4.8 and LC: 4.1/4.2 |
| **MQI Content Domain** | Mathematical Sense-Making |
| **Literacy Form Domain** | Printed Text |
| **Source** | IEA (2009) TEDS-M 2008, p. 4-5 |

D: Data/Probability & Statistics

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| ***D1. Reading Graphs***   1. *Represent this data numerically.* 2. *Comment on the reasonableness of the reporter’s statement using mathematical evidence to support your answer*. | |
| **Literacy Process** | 1. Understand (b) Use |
| **Numeracy in Mathematics Content Domain** | JC: 1.6/3.1 and LC: 1.6/3.1 |
| **MQI Content Domain** | Linking Between Representations |
| **Literacy Form Domain** | Broadcast Media |
| **Source** | Shiel, G. et al (2007), p.13 |

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| ***D2: 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:*   |  |  |  | | --- | --- | --- | | Step 1 | Step 2 | Step 3 | | Katie:  Joe:  Lucy: |  |  |   *Evaluate this student’s method and final answer:* | |
| **Literacy Process** | Critically Appreciate |
| **Numeracy in Mathematics Content Domain** | Data JC: 1.1/3.1 and LC: 1.1/3.1 |
| **MQI Content Domain** | Remediation of Student Errors and Difficulties |
| **Literacy Form Domain** | Printed Text |
| **Source** | SEC (2013), LCOL, P2, Question 1, p.3 |

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| ***D3: Number Systems and Probability Concepts***  *Students are given the following problem:*  *John chooses an arbitrary natural number, squares it, and takes the last digit of the square. What is the probability that this digit is 1?*  *Following are the responses of three students:*   |  |  |  | | --- | --- | --- | | **Student A** | **Student B** | **Student C** | | There are 10 digits altogether. Each of them has an equal chance to be the last digit. Therefore the answer is 1/10=10%. | The last digit of a square depends only on the square of the last digit of the number chosen. The last digits of squares of the first 10 natural numbers are 1, 4, 9, 6, 5, 6, 9, 4, 1, 0. Since there are two 1’s in this sequence, the answer is 2/10=20%. | This probability cannot be determined, since there are infinitely many natural numbers and we cannot check all possibilities. |  1. Which of the three responses is most appropriate:   **🞏 Student A**  **🞏 Student B**  **🞏 Student C**   1. Describe misconceptions the other two students have. | |
| **Literacy Process** | 1. Understand (b) Use |
| **Numeracy in Mathematics Content Domain** | JC: 1.2/3.1 and LC: 1.2/3.1 |
| **MQI Content Domain** | Remediation of Student Errors and Difficulties |
| **Literacy Form Domain** | Printed Text |
| **Source** | Schmidt, W (2006), MT21, p. 28 |

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| ***D4****.* ***Graphs and Frequency***  *The following graph gives information about the adult female literacy rates in Central*  *and South American countries.*    *Suppose you ask your students to tell you how many countries are represented in the*  *graph. One student says, “There are 7 countries represented.” In your opinion, what was the student thinking in order to arrive at that conclusion?* | |
| **Literacy Process** | 1. Understand (b) Use |
| **Numeracy in Mathematics Content Domain** | JC: 1.6/3.1 and LC: 1.6/3.1 |
| **MQI Content Domain** | Remediation of Student Errors and Difficulties |
| **Literacy Form Domain** | Spoken Language/Printed Text |
| **Source** | IEA (2009) TEDS-M 2008, p. 19 |

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| ***D5****.* ***Statistics and Probability in the Media***  *As a post graduate who has studied probability and statistics modules, you are asked for your advice on which newspaper report best represents the findings of these UCC researchers. Which, if any, would you chose? Give reasons based on the mathematical evidence in the reports.*   |  | | --- | | **Report 1**  **Children born by C-section have 23% increased risk of developing autism**  A new study has found that children born by Caesarean sections have a 23% increased risk of developing autism. However it also cautioned that the overall risk of Autism Spectrum Disorder (ASD) – though elevated – remains small and that more research is needed to further explore the risk. The research, led by Eileen Curran of University College Cork is to be published in the forthcoming issue of the Journal of Child Psychology and Psychiatry.  Professor Louise Kenny, one of the authors and a practicing obstetrician said:  Parents should be reassured that the overall risk of a child developing ASD is very small and that Caesarean section is largely a very safe procedure and when medically indicated, it can be lifesaving.  The study says it is unclear what is driving the association.  It says that further investigation is needed to understand the interrelationship between environmental factors, such as mode of delivery, and genetic factors with regards to the causes of ASD.  Lead author, Eileen Curran, said, “Given the accelerating rate of Caesarean section globally, this finding warrants further research of a more robust quality using larger populations to adjust for important potential confounders and explore potential causal mechanisms.”  The study examined the published literature on observational studies in various countries including the United States, Australia, Canada and Sweden that investigated the effects of delivery by Caesarean section on ASD.  Researchers also reviewed literature on delivery by Caesarean section and attention deficit and hyperactivity disorder (ADHD). However, only two studies were included, and findings were unclear. (Russell, 2014) | | **Report 2**  **The Search for Answers on Autism Must Go On**  Around one in 100 people has some form of the disorder, ranging from the mild to severe. It can affect a person's learning ability, communications, social interaction and behaviour.  This latest study led by UCC researchers suggests that babies born surgically through Caesarean section could be at a higher risk of autism spectrum disorder.  The notion is not new and it has considerable limitations which the authors themselves acknowledge. Their tone is not over-exuberant but correctly restrained.  Firstly, it is a review of studies already undertaken globally examining this area. Although the UCC researchers selected studies, each of them has their own limitations.  Also these are observational studies which do not prove cause and effect.  Around one in four babies in Ireland is delivered through Caesarean section, many of them in emergency life-saving situations. The rate is around 30pc in some hospitals.  It is valid to examine if there is any association between the rise in these deliveries and the increase in the disorder  The connection between the two may be difficult to grasp. The UCC study points out that babies born through Caesarean may have a form of bacteria in the gut that affects the rest of the body including the brain.  People will find the other suggestion, that a baby surgically delivered at 37-39 weeks may have lost out on vital brain development, more persuasive.  The weakness of the research is that few studies showed if the caesareans were planned or emergency. The reason for an emergency procedure may already be due to developmental problems in the womb.  The findings also imply that Caesarean section is associated with milder forms of autism, although this has not been confirmed.  The need to put these studies in perspective was underlined by the global scare which arose in 1998. Dr Andrew Wakefield, a UK medic, said, in the Lancet, that autism was linked to the MMR vaccine.  It was later proved wrong but led to more than a decade of many parents not giving children the measles jab. Some of the deaths from measles in Ireland during that time could be linked back to the fear the study provoked.  The UCC researchers are making no such bold claims but calling for more investigation.  However, a side effect of this research should prompt the officials currently conducting a review of our maternity services here to get more information on the reasons why so many Caesarean sections are done here (O’Regan, 2014). | | |
| **Literacy Process** | Critically Appreciate |
| **Numeracy in Mathematics Content Domain** | JC: 1.2/ 1.5/1.7 and LC: 1.2/1.3/ 1.5/1.7 |
| **MQI Content Domain** | Mathematical Sense-Making |
| **Literacy Form Domain** | Broadcast Media |
| **Source** | Russell, C. (2014), The Journal  O’ Regan, E. (2014), The Irish Independent |

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