Crime Scene Investigation in the

The strand unit of **Representing and Interpreting Data** (Primary School Mathematics Curriculum, 1999) sets out objectives which emphasise the need for children to experience genuine data investigations. Investigations may take the form of a project/problem to be addressed over a number of lessons. The investigation presented here (and used in Limerick City classes) uses the PPDAC cycle (see Intouch, March 2012) as an organising framework. The investigation requires pupils to explore the characteristics of a **distribution** (set) of data collected as part of an investigation.

Context: Crime Scene Investigators (C.S.I.)

Step 1: Problem (PPDAC)

Introduce the context by telling children 'Today we're going to investigate a crime scene'. The CSI theme tune may be played. Explain that an incident has happened in the school and that their class has been selected to help the Gardaí with their investigations. Present an image of the crime scene (e.g. school garden) (image 1a). Provide children with information regarding the crime (e.g. vandalism). Highlight that the only evidence found by the Gardaí crime investigation bureau was a shoe print (image 1b).

Image 1a Crime Scene: School Garden

Image 1b Evidence: Shoe print

Ask children how the available evidence may be used to capture the culprit. Children's suggestions may include: 'check everyone's shoes for a match/dirt/a pattern'. In response make children aware that such approaches could be unreliable as the suspect may have washed/changed their shoes. Guide children to the conclusion that we need to measure shoe size. State that all pupils in the class must prove their innocence before proceeding to investigate the crime.

Step 2: Plan (PPDAC)

Invite suggestions regarding how to rule themselves out as suspects. Responses may include: 'place shoes in actual shoe print'; 'measure shoe sizes'. Explain that statements alone are not conclusive scientific evidence and that the crime scene cannot be tampered with. Tell the children that each pupil is going to find the length of their shoe print as this is the procedure recommended by the Gardaí.

Step 3: Data (PPDAC)

Demonstrate tracing a shoe print on an A4 page (image 2a) and subsequently measuring the length of this shoe print (image 2b). Remind children of the importance of using the ruler/metre strip correctly (i.e. start at 0) as well as the appropriate unit of measure (cm).

Image 2a Tracing length of shoe print

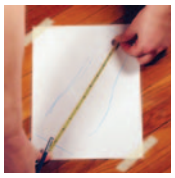

Image 2b Measuring length of print

Allow children to trace, measure and record their shoe length. Highlight that this data will be used to figure out the possible identity of the suspect.

Inform the class that the Gardaí have requested a **typical** shoe length for the class (one value that best represents the class' shoe length). Ask children to make **an individual prediction** of the typical shoe length of the class (based on their own shoe length measurement). Encourage children to take account of the various characteristics of the class e.g. different heights/ages; boys/girls. Ask a selection of children to report and justify their predictions e.g. '25-28cm because some people have bigger and smaller shoe sizes' (this child selected an interval). Building on this, ask children to work in groups to make a **group prediction** of the shoe length which best represents the class. Record each group's prediction. Groups will have various responses (individual values/intervals) and reasons for their predictions e.g. '26 as we added together our shoe lengths and divided by 4'.

Step 4: Analysis (PPDAC)

Following discussion of group predictions, tell children that you are going to investigate the characteristics of the classes' actual shoe size (i.e. the distribution). Introduce the line plot as a useful graph to represent data. Have the children identify the range of

classroom

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data values and present these values in order as the 'x axis' of the graph. To demonstrate making the graph, place an X above the particular number which represents your shoe length e.g. 30cm, and ask children what this means (answer: that the teacher has a shoe length of 30cm). Invite children to mark their individual shoe lengths on the graph. On completing the data representation stage (image 3), ask children to work in their groups to come up with 3 interesting things they notice about the data. This is facilitating them to begin to **read the data** and **read beyond the data** (see Intouch, March 2012).

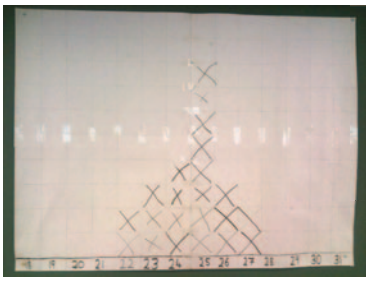

Image 3 Line Plot of Class' Shoe Length

Allow each group to report their findings. Children in our classrooms mentioned:

* 25cm is the most popular shoe length
* The graph goes from 22 to 27
* It looks like the Eiffel Tower

Children's observations should be used to guide the formal analysis of the **distribution** i.e. the arrangement of data values on the line plot. For example, children's references to the 'bump' facilitates introduction of the statistical term for the 'most popular/common' as the mode i.e. 25cm. Inform the class that the **range** (the interval from the lowest to the highest data value) of the data set is 22-27cm (and not 18-31cm as some children mistakenly think).

It will be necessary to explicitly address many features of the graph using both formal and informal language. Start by discussing the shape of the data. When considering the shape, refer to the location of the **cluster of data** (naturally occurring group of values from 22-27cm) as well as the fact that there are no **outliers** (unusual data value separated from the cluster) or **gaps** (holes) in this data set. Discuss what this means in the context of shoe size.

With older children, then move to identifying measures of central tendency. Children can find the **mean** shoe length. Remind children of the meaning and formula for the mean (see Intouch, April 2012) and encourage the use of calculators to identify the mean of the data. In this example (image 4) the mean is 25cm. Subsequently the **median** can be introduced as the exact middle value of the data set (where half of the data are above and half below this value). It is possible to describe the median using the body e.g. 'With my arms outstretched my head is the median i.e. there would be the same amount of data at either side of it'. Demonstrate the method of finding the median i.e. write the data in order and cross out pairs of data values starting at the ends in order to find the middle value.

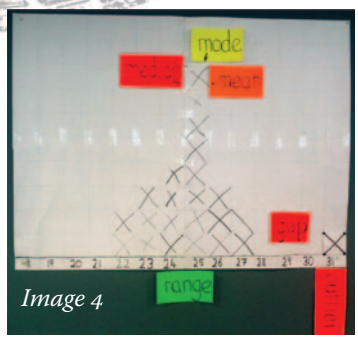

Image 4

In the case of an odd number of values, a single middle value (median) emerges. However, in this example (image 4) because there is an even number of values

~~22~~, ~~22~~, ~~23~~, ~~23~~, ~~23~~, ~~24~~, ~~24~~, ~~24~~, ~~24~~, ~~25~~, 25, 25, ~~25~~, ~~25~~, ~~25~~, ~~25~~, ~~25~~, ~~26~~, ~~26~~, ~~26~~, ~~27~~, ~~27~~

(22 pupils) there are two middle values of 25cm and 25cm. Therefore the median is 25cm (the midpoint between the two middle values). Explore what the median would be if the two middle value were 24 and 25 (answer: 24+ 25= 49 ÷ 2= 24.5cm).

Image 4 Labelling characteristics of the distribution

Use the line plot to highlight that the **mean**, **mode** and **median** of the data set are all 25cm because the distribution is almost symmetrical. Allow groups to compare their predictions with these findings. Lead the class to the conclusion that 25cm is the shoe length that best represents the class. If the mean, mode and median are different for your class, allow children to report/vote on the shoe size that best represents the class by considering all these values.

Pose questions that support children in **reading beyond the data**. Present questions such as 'What do you think a distribution for 2nd class shoe lengths would look like?'; 'Does this data represent all 5th classes?'; 'Who might have a shoe length of 31cm'. Explore the consequences of an outlier (e.g. 'x' over 31cm) being added to the line plot through questions such as 'Will the mode change?' (Answer: no); 'Will the mean change?', 'How?' (Answer: yes; it will be bigger); 'Will the median change?'; 'How?' (Answer: No, it will still be 25cm). It is possible to work through each of these investigations. Ask the pupils what else might change if you measure the shoe sizes of a different sample (Answer: possibly the shape, mean, median, mode).

Step 5: Conclusion (PPDAC)

You may then get a 'mock' phone call from the Gardaí telling you that the actual shoe length found in the garden was 28cm (Note: the crime scene shoe length should never be the same as one of the children's shoe length). Explore what this means in the context of the data collected from your class (Answer: all pupils in this class are innocent). Ask each group to provide suggestions as to the next steps in the investigation. Groups may recommend that the investigation focus on '4th and/or 6th class in this school'; '1st years in secondary schools'; 'the school staff'.

The children's suggestions could be the basis for follow-on work, where data regarding shoe length is examined from another sample e.g. school staff. This activity, in turn, will provide opportunities for children to make comparisons between the respective data sets. The 'typical' value will prove invaluable during such an activity, considering that the two data sets to be compared will be different sizes.

Mairéad Hourigan, Aisling Leavy *and* **Áine McMahon** *lecture in Mathematics Education in Mary Immaculate College.*

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