Children as Data Detectives

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Children as Data

Transforming the teaching of data

Is your experience of teaching data less than exciting? Do you think there is more to teaching data than making bar charts of children's favourite colours? And pictograms of modes of transport to school? Surely trend graphs can be used for reasons other than illustrating monthly rainfall? In this article we outline the latest exciting trends in teaching data handling.

Recent approaches to teaching data handling involve children carrying out real investigations with data using the PPDAC cycle.

What? The PPDAC cycle (Problem, Plan, Data, Analysis, Conclusion) is used in many countries to guide classroom-based statistical investigations.

How long? For 4-6 days, children take on the role of data detectives as they move through the PPDAC cycle.

Image 1: The PPDAC cycle (PDF version available on website)

Step 1: Problem (formulating a question)

The success of the PPDAC cycle in your classroom is largely dependent upon identification of a driving question that generates curiosity and motivates children to want to collect data. Arrange children into groups, and help each group identify a problem of interest and develop a statistical question arising from the problem. Younger children need more help; older children can generate their own questions. Then construct hypotheses about the outcome of the investigation. This step may take from 10-20 minutes of your class time.

Some interesting questions that primary children have investigated:

1. How many baby teeth have children in our class lost? (Senior infants)
2. What is our favourite superpower – invisibility, flying, telepathy, super strength? (2nd class)
3. Are rugby and soccer players different in size? (5th class)
4. Is the length of your forearm the same as the length of your foot? (5th class)

Step 2: Plan (planning the procedures used to collect the data)

Once the research question is identified, introduce children to common data collection methods and help each group identify the method that is best suited to their investigation. Younger children need more support in selecting an appropriate collection method. This step may take approximately 10-15 minutes of your class time. The most commonly used methods are

- Surveys (Question 2 above)
- Experiment / Measurement (Questions 1, 3 and 4 above)

Step 3: Data (the data collection process)

Prior to collecting data, help children decide on a way to record their data. Tally charts and tables are complementary representations that can be introduced as early as 1st class. Tally charts can easily transform into tables (see figure 1). Most data can be collected during the school day or as homework. Remember that internet searches are also useful tools for data collection in the senior classes (e.g to answer the question 'Are most children's book authors male or female?'). Data collection time will vary (from 0-3 maths classes) depending on the questions children have written.

What is out favourite superpower?		
Invisibility	𝍸 ||	7
Fly	𝍸 𝍸	10
Telepathy	|	1
Super strength	|||	3

Figure 1: Tally-chart and table of children's favourite superpowers

Step 4: Analysis (the summaries and analyses of the data)

This step is where most of the active teaching takes place and constitutes a large proportion of the teaching time (from 2-4 maths classes). Teaching focuses on:

a) Introducing different types of ***graphs***

b) Introducing children to ***statistical measures***

Introducing graphs

Different graphs present different 'pictures' of the data. Encourage each group to create many different graphs for their same set of data. One of the most versatile graphs is the line plot (see figure 2). It is easy to construct and is a natural precursor to the bar chart. Image 2 shows two line plots made by 5th class children being used to compare the heights of soccer and rugby players on the Irish teams.

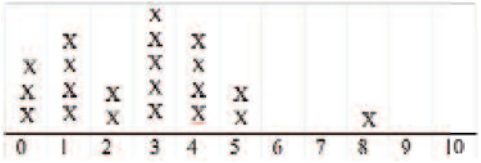

Figure 2: Number of baby teeth lost by senior infant children

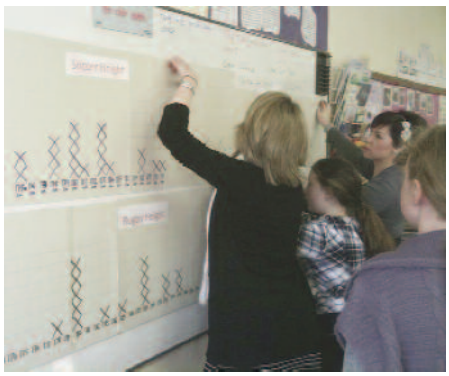

Image 2: Children and teachers using line plots to compare data

When constructing graphs try to focus less on the techniques of graph construction (computers do them now for most of us!) and more on ***graphical sense/literacy*** by focusing on:

1. ***Describing the shape of the data.*** Younger students might describe the shape of the 'missing teeth' data as a bump or clump (or even as rabbits ears in figure 2). Use a mixture of language e.g. 'Where is the bump? What does that mean?' while slowly changing the language to more sophisticated statistical language 'Where does most of the data lie?' 'Is the mode falling inside the bump/cluster?'
2. ***Using statistical language*** to describe features of the data e.g. in the missing teeth data there is a large spread/variability, data are skewed to the left and there is one outlier.

Detectives

3. Reasoning about which *graphs are appropriate* to display the data e.g. a pie chart might not be suitable for the missing teeth data as it will hide the gap of 6 and 7 missing teeth.
4. In the middle classes, focus on *landmarks* (see figure 3) in the data e.g. Clusters, gaps, outliers
5. In the senior classes, identify statistical measures on graphs e.g. where is the mode, median, mean? Also focus on what these measures indicate about the data e.g. what does the mean tell us about the data?

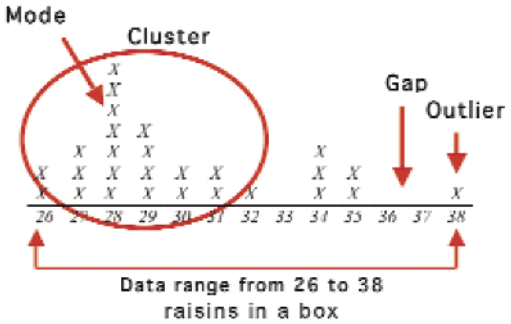

Figure 3: Exploring landmarks in the data

A good way to ensure increasing challenge for children when analysing graphs is to ask questions from each of the following three categories:

Category 1: Reading the data

These are the simplest type of question which requires the child to take information directly off the graph. For example, *How many of us would prefer to fly? What is the least/most baby teeth anyone has lost? What is the mode of the raisin data?*

Category 2: Reading between the data

These questions are more complex and require the child to interpret the graph. The answer will take one step to solve and usually involves the addition, subtraction or comparison of data. For example, *How many more children preferred to fly than be invisible? How many children had more than 30 raisins in their boxes of raisins? How many more raisins did the person with the most raisins have compared to the person with the least number of raisins?*

Category 3: Reading beyond the data

These questions require the student to extend, predict or infer from the data. While this reasoning is quite complex, and involves thinking about samples, when motivated by an interesting investigation children are quite good at making accurate predictions based on their sample. For example, *Do you think that the favourite superpower of teachers in the school is the same as our favourite superpower? Based on this data, if a new senior infant came into the class, how many baby teeth do you think he/she will have lost? How likely would it to be to find 50 (or 15/20/28/33 etc.) raisins in a box of raisins?*

Step 5: Conclusion (the conclusions about what has been learned)

Student's conclusions should relate back to their original question. They should ask 'Was our original hypothesis correct?' The conclusion should restate the questions, outline the data collection method, and describe the outcomes from the analysis. Consider having each group make a mini-presentation to the rest of their class, placing posters of children's work on display in the classroom/school or having children write a report (perhaps using computers) of the process and outcome of their investigation. Our experience in classrooms indicated that children enjoyed sharing their results and taking on the role of 'experts' (see image 3). At the same time, other class members were genuinely interested in asking questions about the work of other groups. Finally, encourage students to use some statistical language in their conclusion. Useful phrases include: Outlier, gaps, skew, these data suggest, probably, most, spread, shape, expected, unexpected, middle etc.

when motivated by an interesting investigation children are quite good at making accurate predictions

Image 3: Children presenting their work

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