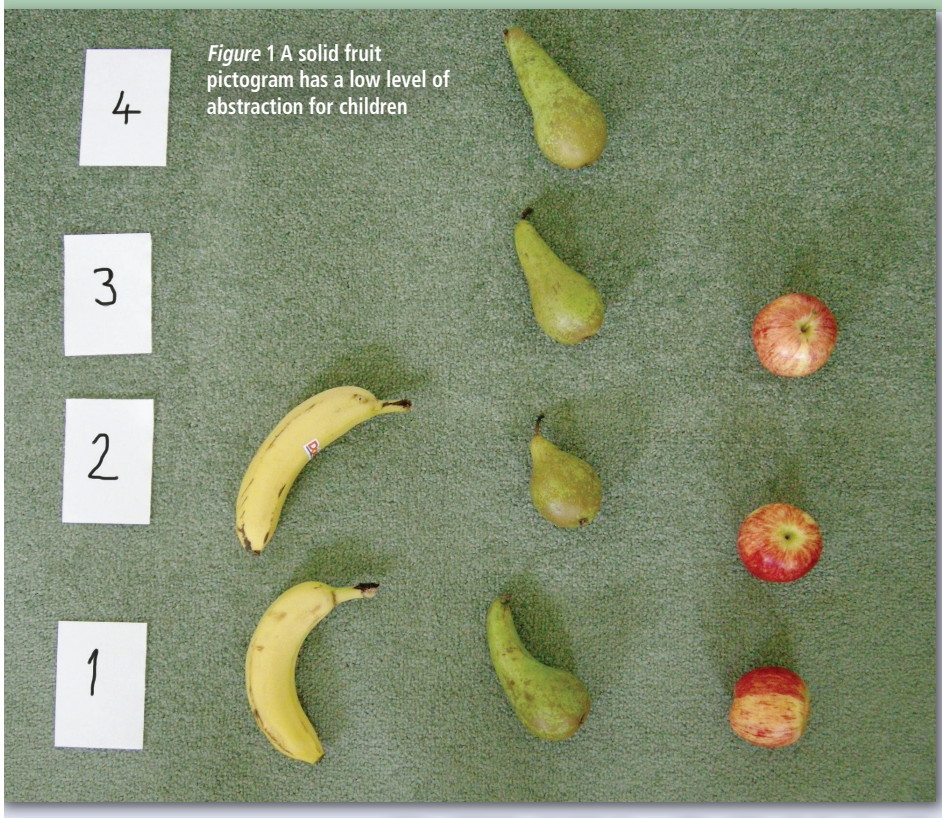

Figure 1 A solid fruit pictogram has a low level of abstraction for children

Pattern Seeking

Science & mathematics

DEVELOPING CREATIVITY AND ABSTRACTION IN REPRESENTING DATA

*There are many ways to represent data. **Andy South** shares some ideas for doing this and shows how they all relate to the use of symbols, size, colour and position*

Key words:
Enquiry skills
Cross curricular

The world has entered the 'Information Age' with unprecedented access to data and information. The livelihoods and leisure time of adults are increasingly dependent upon their ability to access and interpret information. Graphic designers, IT wizards and scientists are addressing the problem of how to represent data in simple, accessible and visual ways such that it becomes useful information. We now see more data graphics in our newspapers and on television about everything from sport to climate change to election results. Children will need to develop the skills to interpret information presented in a diversity of ways.

Abstraction

Creating charts and graphs is all about visual abstraction: the process of representing aspects of the data with imagery that can be interpreted by the reader. Children may need help making the link between the 'real' and the image.

This abstraction can be achieved using symbols, size, colour and position. Where the representation is close to what we are representing, abstraction is relatively low; for example, using colours to represent favourite colours or pictures to represent favourite fruit. Abstraction is higher when the size or position of the symbols is used to represent quantities; for example, bars on a chart or points on a graph. These abstractions are not obvious to all children and need to be taught.

Data can be represented using solid objects, paper and computer graphics. To help children develop the skills to understand such abstractions we can challenge them to create and interpret representations in a diversity of ways.

Solid representations

At the lowest level of abstraction, children can use real objects to create a solid pictogram. Because the children are using

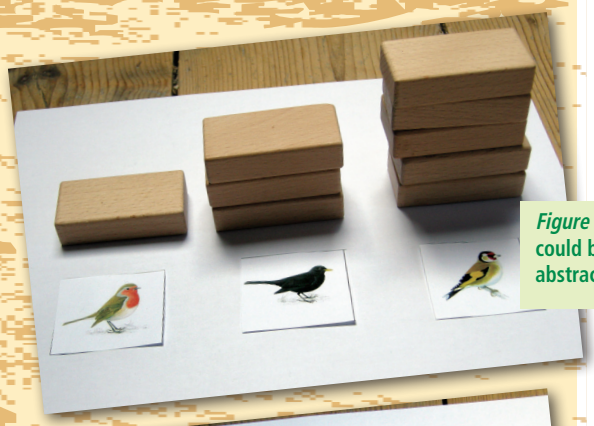

Figure 2 A 3D representation could be the next level of abstraction

Figure 3 Using piles of beans to represent bird observations

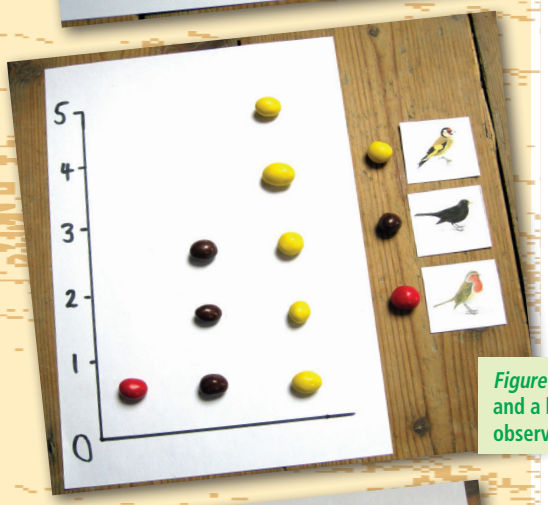

Figure 4 Using coloured sweets and a key in a graph of bird observations

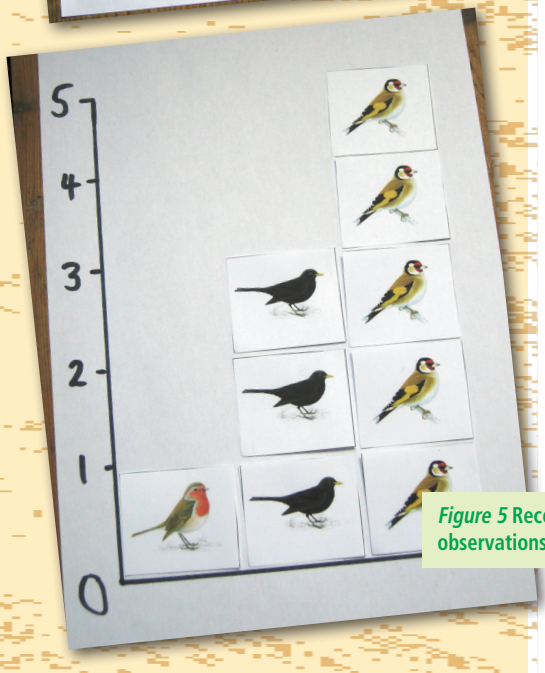

Figure 5 Recording the bird observations as a pictogram

the items themselves to create a chart they can concentrate on the positioning of the objects, which is the abstraction that helps represent the data. You could do this with fruit, different-flavoured crisp packets or Smarties. In each case, have a range of items from which children can choose their favourites and use the items themselves to create a pictogram column. You will need enough of each choice for most of the class just in case they all choose the same! Then, after they have chosen, model how they can add their choice to the correct column (Figure 1).

You can increase the abstraction by using different objects to represent the data; for example, record the numbers of different species of bird seen, create axes on a piece of paper, and use pictures of the birds to label columns. The birds aren't 'real', but the children can count out blocks equivalent to the number of each species. Encourage them to position these blocks in the correct columns and they can create a 3D block chart (Figure 2).

If greater numbers of birds were seen you could use smaller objects to represent them, such as beans (Figure 3). Because the beans are placed in piles it is less easy to see exactly how many of each bird they saw. You could ask children how they might want to change this design.

To encourage the use of colour, you could use coloured blocks, counters or even sweets, with different colours representing different species (Figure 4).

In each case, ask the children what the representations show, how they know that and which are their favourites. Encourage them to come up with their own options. Notice how different combinations of symbols, size, positioning and colour help us to identify what the representations show.

Another option is to use the children themselves as the data points. You can create a large pictogram or block chart in which each child stands in a particular column along an *x*-axis. In this case the abstraction is that the children themselves are representing the data by their position. Use a line on the ground in the hall or playground as the *x*-axis and put out labels for categories on pieces of paper along it. This is particularly useful for survey-type investigations, such as favourite animals or birthday months. You could link it into a science investigation, where the children could indicate their prediction beforehand by where they stand, as well as their results afterwards. Take a picture from above and then use it on the whiteboard as a reminder and to compare with more conventional paper charts. In our example of bird observations you could even make bird masks for the children representing the different species seen, thus making the representation less abstract for them.

Paper representations

More conventional paper representations also involve different levels of abstraction. Pictograms are a good first step, being less abstract than bar or block charts (Figure 5).

One way of encouraging children to see how symbols on paper can represent data is to get them to draw around and cut out items to record. I set a year 2 class (ages 6–7) the challenge of discovering what was the most common hand size in the class. The children each cut around and measured an outline of their hand. Then, on a large piece of squared paper with an *x*-axis of numbers in whole centimetres, each child added their hand cut-out to the class pictogram. This provided a good focus for class discussion about what the data showed (which hand sizes were the most common, which were the largest and smallest). By

thinking ahead I had asked the boys to cut their hands out in one colour and the girls in another so we could also comment on whether girls or boys had bigger hands (Figure 6).

To make the step from pictograms to bar charts the children were set the task of creating their own bar charts of the class pictogram. Axis templates can help with this abstraction before moving to blank graph paper and giving children the freedom to develop their own creative charts.

Computer representations

Computer representations have the advantage that they can be very quick to create and modify and it is relatively easy to produce very professional looking outputs. The *TES* provides a good collection of activities on data handling (see *Resources*), including tools for creating pictograms of eye colour, snacks and traffic surveys. It divides the resources by age group and includes activities for interpreting graphs as well as creating them. A bar graph generator is provided by Utah State University (see *Resources*). Its strength is that it has few options to set. It allows you to select the number of bars (up to 12) and the height of the *y*-axis (up to 20) and to fill in a label for each column. Bars can be filled by clicking on blocks.

With a few more options, the ITP data handling application (see *Resources*) provides a good introduction to elementary charting. It is easy to input and modify data and plot either a bar or pie chart. It is relatively inflexible in terms of colours and layouts, which for elementary users will be an advantage: not so much to 'play with' and get distracted by (Figure 7)! The ability to switch between bar and pie charts for the same data is a useful feature, as we can ask children about how they know what the pie chart shows and probe for understanding about the role of colour and the size of segments in representing the data.

A further step, with more options, is provided by graphing sites from NCES in the US (see *Resources*). They have a simple (classic) graph generator, where you can choose bar, pie or line charts, that takes you step-by-step through choices, or a more complex version where many options can be set by accessing different tabs (Figure 8).

A new site targeted at adults (chartle.net, see *Resources*) provides even more options, some of which are straightforward enough to be used by older primary children. Similarly, the flexibility of Microsoft *Excel* can make it more difficult for children to get a simple expected result, but once they do it opens up a range of possibilities. The difficulty for the teacher can be in making sure that they have a very straightforward set of instructions to follow that work on the particular version of *Excel* being used, and that they can work out what to do when things go slightly wrong! I found with a class of 7- and 8-year-olds that some children shown how to use *Excel* were very excited to use it on computers at home and bring in their own creations in the following days.

A different way of using size to represent quantities can be demonstrated using *Wordle* (see *Resources*). This is a beautifully simple website that allows you to paste text into a box, and then with one click it will produce a colourful 'word cloud' in which the size of the word is an indication of how frequently it appeared in your text (Figure 9). It is then easy to modify default values specifying fonts, colours and whether common words are ignored. It can be used on fiction texts in literacy lessons and children can produce a visual representation of their own text, explaining how the size of the word relates to how many times they used it. For our example of bird observations, I simply typed each bird name into a word document once for each time it was seen (e.g. blackbird, blackbird, blackbird) and pasted it into the *Wordle* site. You could then ask children to explain how they know that more blackbirds than robins were seen.

All these ideas help children

Figure 6 A pictogram of children's hands showing the most common size

Figure 7 The ITP data handling application

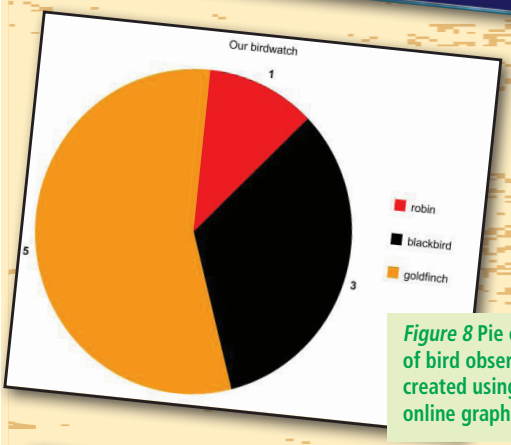

Figure 8 Pie chart of bird observations created using NCES online graph generator

Figure 9 A Wordle 'word cloud' to represent bird observations

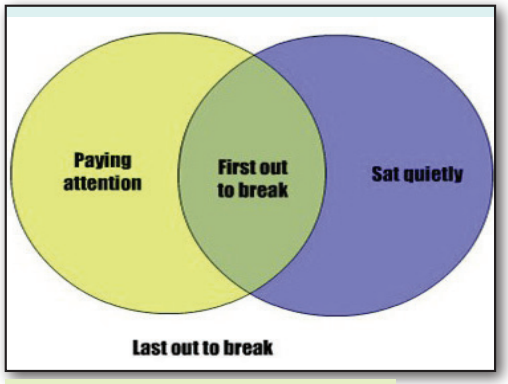

Figure 10 Using unusual charts to challenge children's interpretation skills

to engage with different ways of displaying scientific information. They encourage children to think about how position, size and colour can be used to represent data. Such skills will be very useful in aiding their presentation and interpretation of scientific and other information, both later in school and outside of it. I would encourage you to challenge your children's creativity in developing ways to display data and then challenge their understanding by asking them to explain what their creations show.

Finally, if you want to make some different charts to challenge their skills of interpretation you could try the *graphjam* website (see *Resources*). Here users create charts (some of which are not suitable for primary children) to represent unusual things such as music lyrics. I have used it to create a Venn diagram indicating how children can ensure they are the first out at break time (Figure 10)!

Resources

TES Data handling: **www.tes.co.uk/article.aspx?storycode=6073977**

Utah State University entry-level on-line bar graph generator: **nlvm.usu.edu/en/nav/frames_asid_190_g_1_t_1.html**

ITP Data handling: **webarchive.nationalarchives.gov.uk/20110202093118/http:/nationalstrategies.standards.dcsf.gov.uk/node/47751**

NCES graphing: **nces.ed.gov/nceskids/graphing/classic**

nces.ed.gov/nceskids/createagraph/default.aspx

Chartle: **www.chartle.net/create**

Wordle: **www.wordle.net/**

Graphjam: **app.cheezburger.com/FlashBuilder/GraphJam**

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