Using M&Ms to develop statistical literacy

Statistical thinking will one day be as necessary for efficient citizenship as the ability to read and write.
H. G. Wells


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provide practical ideas for exploring data with children.

Statistical literacy is defined as "the ability to read and interpret data: the ability to use statistics as evidence in arguments. Statistical literacy is a competency: the ability to think critically about statistics" (Schield, p. 2). For almost ten years mathematics educators such as Watson have argued the need for a statistically literate population (Watson, 1997). In fact it was Watson who alerted the authors to Wells' statement. Often, however, statistical literacy is seen as the domain of secondary schools and tertiary institutions. However when a definition of statistical literacy is considered it can be seen that all students can manage a level of statistical literacy.

When this notion was raised with a group of early years teachers the authors were questioned as to whether young children can understand statistics. For many, the view of statistics was one of boring figures that may be quoted and misquoted. The authors set out to try to help young children explore data. Along the way both the children and the authors learned a great deal. What follows is an account of several teaching episodes revolving around the idea of using M&Ms to inspire children working in Chance and Data. It is certainly not intended that students would be involved in all that is described in a single lesson. The work samples do, however, suggest that children can be involved in interpreting data at an earlier age than is generally expected — especially that which they have collected themselves.

Getting started

The starting point for this series of activities was a look at the M&Ms website. This was found using a Google search and entering m&m. The general site shows a world map (http://www.mms.com); from there we clicked on "United States", then "About M&Ms" and had a quick look at "History of M&Ms Brand", and "Interactive Timeline" from 1941 to present. This provides a nice link to the Time section of the curriculum. From there, we went back to "Products", and "Milk Chocolate". This gave a list of the six colours and the percentages of each in a pack sold in the United States (see Figure 1). Our suggestion is to have the students copy this, then use the "Back" arrow to return to the general site and choose "Australia and New Zealand". Now have them go to "Products", and "Milk Chocolate" in the Australian site and look at the percentages for each colour (which are different to the USA distribution; see Figure 2). You could discuss why this may be so. One interesting thing to note is that the distribution in Australia provides percentages that are much easier to work with than the American site.

Figure 1. USA site.

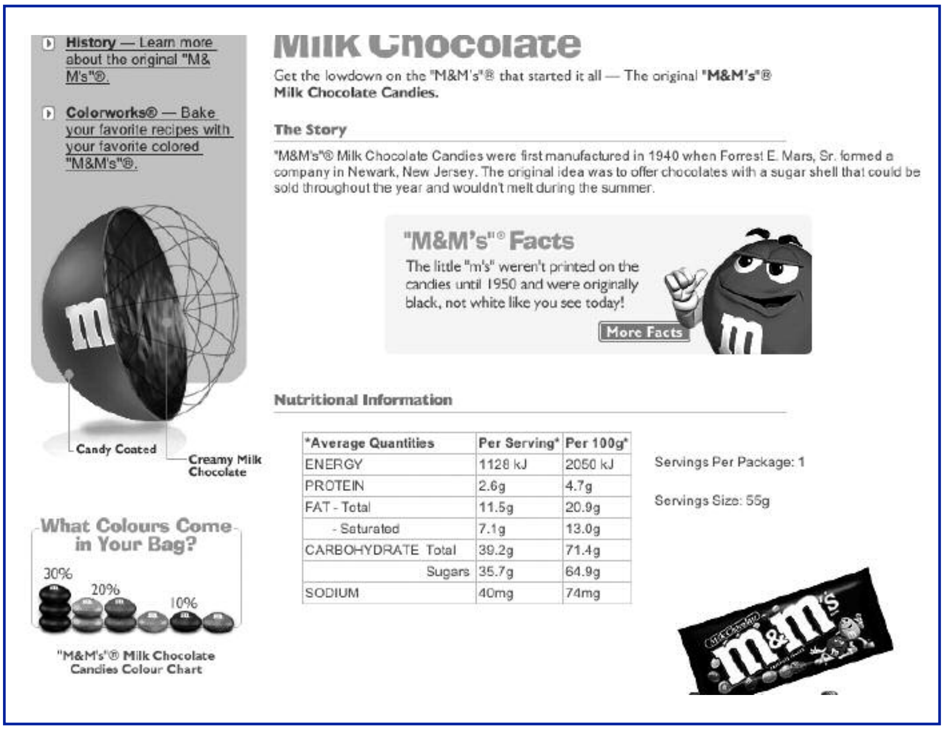


Figure 2. Australian site.

Activities

Averages

Discussion of the price of the purchases could then take place. If packs were bought from different shops or supermarkets, the price may vary. We found they ranged from $1.12 to $1.90 per 55-gram pack.

Collecting data

Distribute the 55-gram bags, one per group of 4. Ask the students not to open them at this stage. Ask them to write down an estimate of how many M&Ms they think their bag contains. Then provide them with the information that each M&M weighs approximately 1 gram, and allow the students to adjust their estimates if desired. Tell them that there were 58 in our original bag, but ask them to imagine that there were exactly 50 in their bag. Now ask them to write down an estimate of how many of each colour they would expect to find. Give out a brown paper bag for each group and ask them to open the pack and pour the contents into the bag. Then give them the chance to count the lollies but put them straight back into the paper bag. An interesting discussion can take place about the variation in the number of M&Ms in each pack. The number of M&Ms in the packets we used ranged from 57 to 63.

To get each bag to contain exactly 50 (an easy number to work with), students randomly dip into the bag and take out the surplus sweets. We allowed the students to share these out in their group and eat them. This removed them from the tables so they would not get mixed in with the other 50; also it tends to mean that they are then willing to continue with the rest of the activities resisting the urge to eat the remaining M&Ms. [Note: Teachers will need to take into account any food allergies]. Of course, you can put the spares aside to eat later, or the teacher can collect them if desired. Now they can take the remaining 50 out, group them according to colour and compare the results with their predictions. These can also be compared with the percentages given on the Australian website.

Summarising and representing the data

We now have generated some data that can be used to provide various graphical representations of the M&Ms. Ask children to place them in rows on 15 mm squared paper according to colour (see Appendix 1). This generates a "concrete" graph of the colours. They can then move them to one side and either draw a representation of each (a pictogram/ pictograph), or colour in one square for each colour (a bar graph). Another option is to colour in the circles on the M&M Pictograph paper (Appendix 2). They should discuss what is needed to turn this into an acceptable bar graph, and put in the missing title and axis labels.

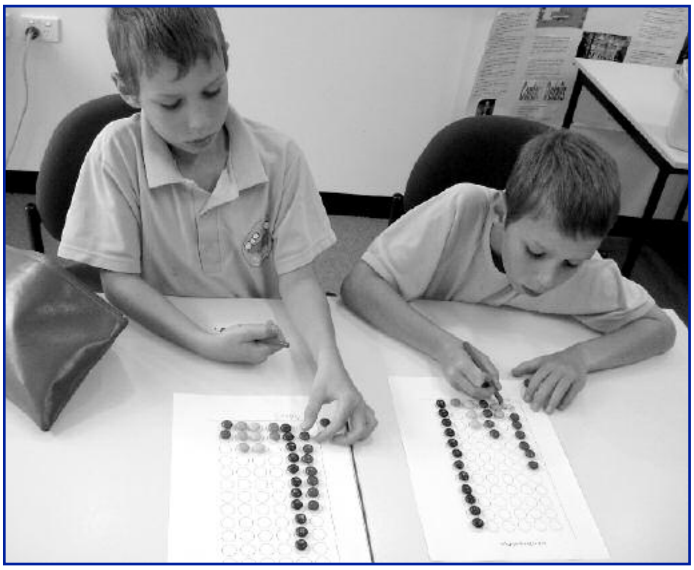


Figure 3. From concrete graph to pictograph.

Discussion on other types of graphs can come from this activity.

- What is the difference between a bar graph and a histogram? (For a discussion of the difference see Bana, Marshall and Swan, 2005, p. 81.)
- Why didn't we use a line graph? (The data is not discrete.)
- What other type of graph could be useful for this type of data? (Pie/circle graphs.)
- What do we need to do to produce a pie graph? (If constructed in the usual way: compasses, protractors, complex calculations of percentages of each colour compared to the whole population of M&Ms, and calculations of degrees of the circle would be required.)

Figure 4. M&Ms in a circle.

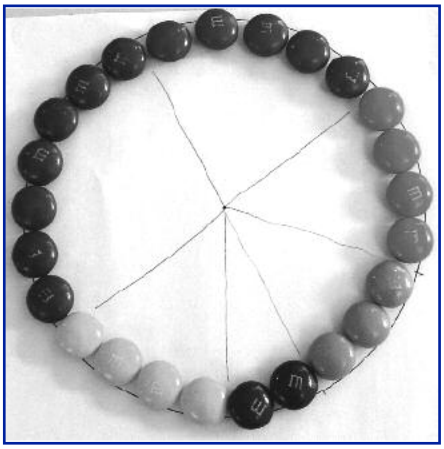


Figure 5. Becoming a pie graph.

Making a pie graph

Here is an easier way to produce a pie graph. To make numbers easier to handle, each group puts all 50 sweets back in the paper bag, and randomly draws out 25 to go into a second paper bag. Alternatively students could halve the number of each colour, thus splitting the 50 into two equal groups of 25. There should now be a bag of 25 M&Ms for each pair of students. Students are then given a template of a circle (diameter 12 cm, and marked in the centre, see Appendix 3). Each pair places their 25 M&Ms around the circumference of the circle according to colour, making sure that they are evenly spaced, but touching each other. If there are gaps between the sweets, they need to be moved just inside the outline, so that they are touching. The children can then draw the segment for each colour by drawing a line from the centre to the outside of each colour group, as shown in Figures 4 and 5. Ask the students how they could work out the percentage of each colour. It is a simple matter of multiplying their number by 4, as there are 4 × 25s in 100. Students then need to be reminded about completing the graph by giving it a title and labelling the segments.

An alternative approach to producing a pie graph is discussed in Lovitt and Clarke (1988, pp. 144–145) using paper strips.

For this activity, a strip of 25 squares is made by cutting and taping the M&M Bar Graph paper used previously, with a small allowance at each end for overlapping. The 25 M&Ms are placed in colour groups along the strip.

These are coloured accordingly. A paper clip is then used to form the strip into a circle. By placing this onto blank paper and tracing around the circle, marking in the various colour segments and labelling the parts, a circle graph is produced (see Figures 6–9).

Analysing the data/writing about the graphs

It is important that the production of the graph is not the endpoint of the exercise, but a stimulus for discussion about what can be interpreted from the data as presented. Little is to be gained from simply collecting data. This analysis of the data fits the model proposed by Green & Graham (1994): Pose a question; collect the data; summarise the data and analyse the data. Most Australian curricula tend to follow a similar fourstep process.

Students should be encouraged to at least discuss what the data indicates. Asking children to write about the data after it has been summarised or graphed will help them reflect on the trends and will also provide valuable insight to the teacher as to the interpretation of the data. Consider, for example, the very literal descriptions of the data provided by two seven-year olds. Note one student makes more comparative statements than

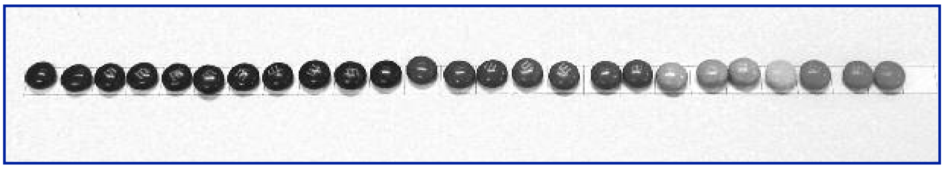


Figure 6. M&Ms on strip of squares.

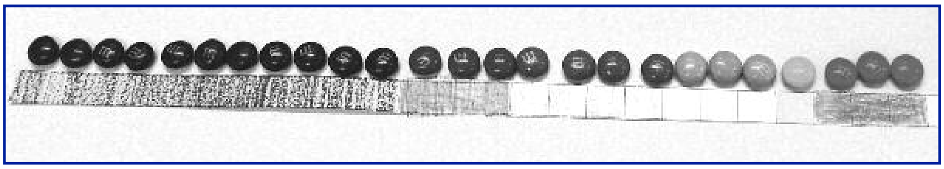


Figure 7. Coloured strip of squares.

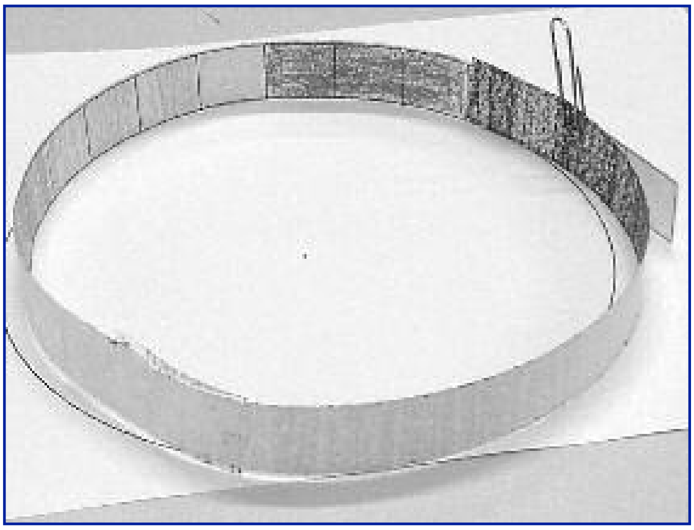


Figure 8. Made into a circle.

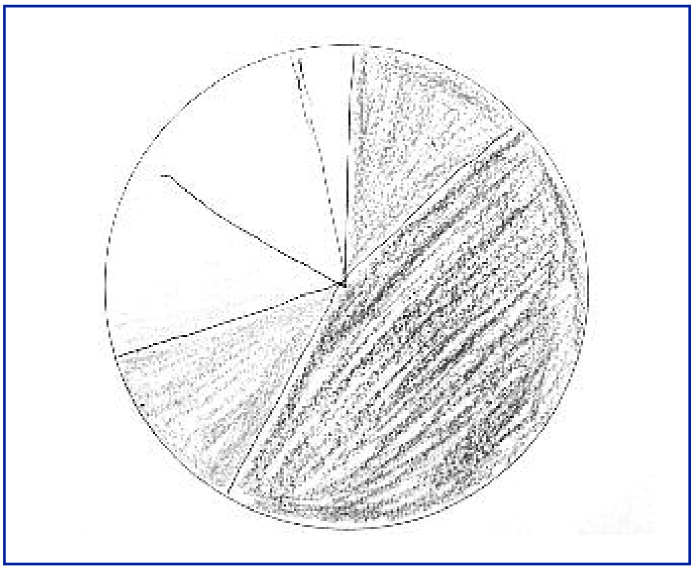


Figure 9. Pie graph.

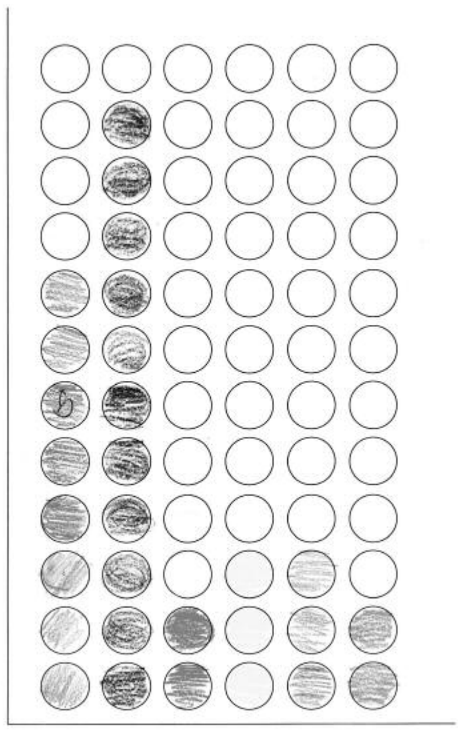


Figure 10. Adrian's pictograph.

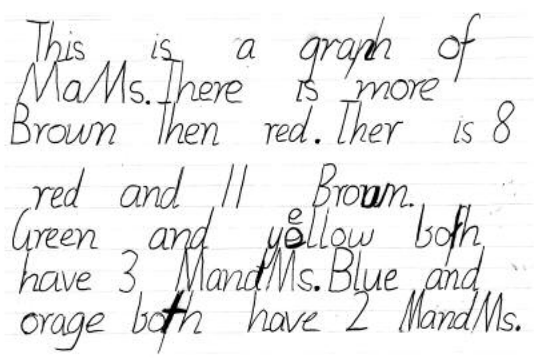


Figure 11. Adrian's description.

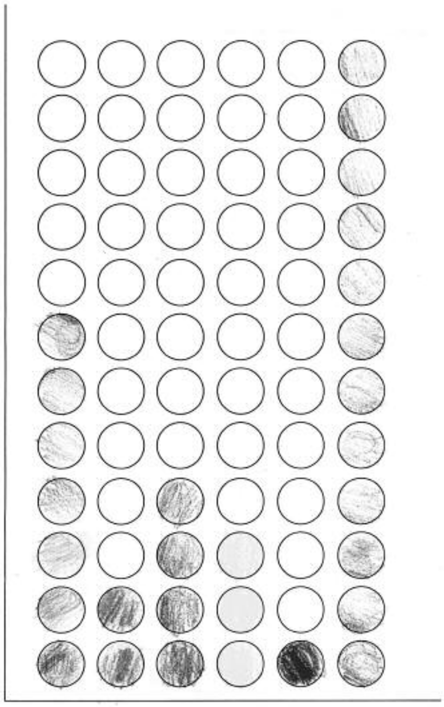
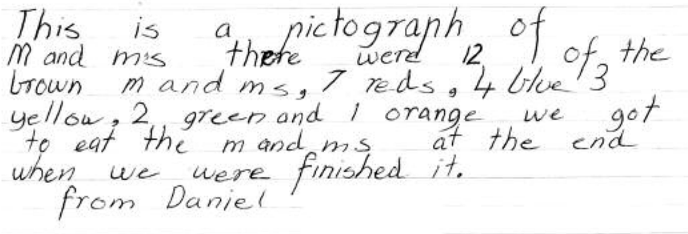


Figure 12. Daniel's pictograph.



This is a pictograph of
M and ms there were 12 of the
brown m and ms, 7 reds, 4 blue 3
yellow, 2 green and 1 orange we got
to eat the m and ms at the end
when we were finished it.
from Daniel

Figure 13. Daniel's description.

the other and one simply reports the facts.

Alternatively students can be asked to write a series of questions pertaining to their graph and exchange their work with other students. In this case, some probing questions can be encouraged, rather than only simple ones such as, "How many yellow M&Ms in our packet?".

Without this stage, lessons such as these described might be "fun" or enjoyable but whether children learn anything is unclear. Some children may simply hone their colouring skills as they mark a circle or square for each M&M.

Sampling

Take 10 M&Ms in colour proportions that are the same as those on the Australian website: 30% brown; 20% yellow; 20% red; 10% orange; 10% blue; 10% green. Put them in the paper bag. One student takes one from the bag, and the partner records its colour by completing a tally. They then replace it and continue for a total of 10 "draws". This is a simulation of the machine that fills the bags with 50 sweets, loaded with the thousands of M&M that are in the published colour proportions. At this stage, children can discuss the results of their short run. Are the results as would be expected? The students then continue for 40 more "draws", making a total of 50 "draws" per pair of students. Discussion would follow this activity about the results of their simulation:

- Are the results what the students expected?
- Are the results of their short runs different to the results of their long runs?
- If you total the colour draws for each pair of students after their 50 draws, what are the results?
- Are they the same or similar to the published proportions? Why or why not?
- This can lead to the Working Mathematically "What if…" questions such as, "What if there were 20 in the correct colour proportions in the bag?" "What if there were 100?" "What if we continued the simulations for 100 draws?".

Producing graphs with the aid of technology

Many children are introduced to using computer programs such as Excel to produce graphs. This is an important skill, but it is the authors' belief that children need to have had the experience of manually producing graphs in their different forms before moving to technology to do it for them. Children need an understanding of the different types of graphs, and the suitability of each of them for the different types of data they collect. It is easy to produce a graph via the computer, but too often children use an inappropriate graph because they lack the statistical literacy to do otherwise.

The graphs outlined in this article could easily have been produced using a spreadsheet chart function. There is no doubt that technology is having an impact on the teaching of mathematics and should also have an impact on the way we develop data sense. The authors, however, feel that children need experience in collecting primary data and making some decisions about the appropriate graph to use, the scale and the way the graph should be labelled. Many of these aspects of graphing are incorporated almost seamlessly and need to be made explicit to children. Regardless of how the graph is produced, young children should be encouraged to collect primary data, rather than published or secondary data, and then to write about the graph.

Conclusion

Learning to read and interpret data provided in various forms such as tables and graphs is fundamental to the development of statistical literacy. So often data is presented to us along with explanations. Data gathering and interpreting activities such as those outlined in this article are designed to allow children not only to collect data but sort and organise data and then interpret data. The ability to analyse and interpret data is crucial if we are to develop a statistically literate population.

References

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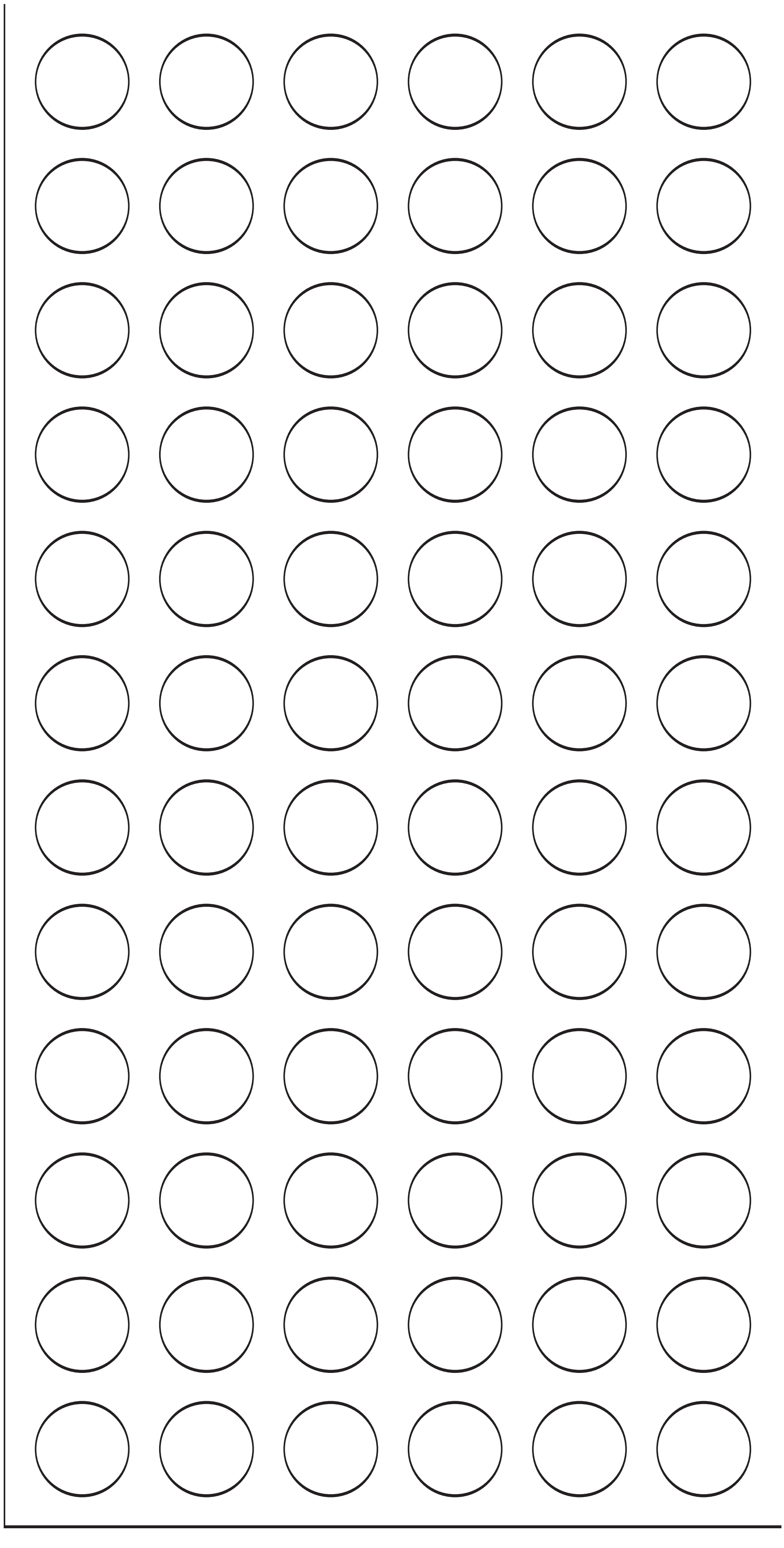
APMC

Appendix 1: 15 mm M&M bar graph paper

Appendix 2: M&M pictograph paper



Appendix 3: M&M pie graph paper