

Summary of learning goals

- This sequence is designed to develop students' concept of statistical variation. They perform experiments, draw graphs, compare results and analyse their findings.

Australian Curriculum: Mathematics (Year 3)

ACMMG061: Measure, order and compare objects using familiar metric units of length, mass and capacity.

ACMSP069: Collect data, organise into categories and create displays using lists, tables, picture graphs and simple column graphs, with and without the use of digital technologies.

ACMSP070: Interpret and compare data displays.

Summary of lessons

Who is this sequence for?

- Students will need some experience with data collection, creating simple column graphs and conducting experiments.

Lesson 1: Making Licorice

Students observe variation in machine-made and handmade products, then make licorice sticks by hand and using the Play-Doh Fun Factory®. They record and compare the attributes of both types of licorice sticks by plotting their findings and comparing the shapes of the two plots.

Lesson 2: Are Machines Better?

Students are challenged to use the Play-Doh Fun Factory® to produce identical licorice sticks. They experiment with strategies to restrict variation and consider the importance of maintaining consistency.

Reflection on this sequence

Rationale

This sequence focuses on developing the fundamental understanding of variation in data through a meaningful context.

Students learn about variation by making licorice sticks with a machine and then by hand. They record their results and display their data using dot plots. By comparing the shapes of the two dot plots, students can appreciate that variation is natural. They then experiment with strategies to restrict variation when making their licorice sticks.

The focus on variability is what distinguishes statistics from mathematics.



reSolve mathematics is purposeful

- The lesson builds students' understanding of data variation.
- The context of a licorice factory is both intriguing and easily imagined by students.



reSolve tasks are inclusive and challenging

- The collaborative, hands-on nature of this task provides access for all students.
- Students are asked to make inferences and draw conclusions of varying complexity based on the data presented.



reSolve classrooms have a knowledge-building culture

- The task is completed as a class, allowing students to learn from others' contributions. This allows students to build on the collective knowledge of the class while also extending their individual understanding.

Acknowledgements

This sequence is based on the following article:

Watson J, Skalicky J, Fitzallen N, Wright S, 2009, 'Licorice production and manufacturing: All-sorts of practical applications for statistics', *Australian Primary Mathematics Classroom*, 14(3), 4–13.

Making Licorice

Y3

About this lesson

Students observe variation in machine-made and handmade products, then make licorice sticks by hand and using the Play-Doh Fun Factory[®]. They record and compare the attributes of both types of licorice sticks by plotting their findings and comparing the shapes of the two plots.

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Mathematical purpose

- To explore concepts of statistical variation and hypothesis testing.

Learning intention

- To find the differences between 'licorice sticks' made by hand and those made by a machine.



Time

A lesson of approximately 1 hour.



Vocabulary

- attribute
- consistent
- mass
- process
- variation



Resources

- Play-Doh Fun Factory[®] extruders
 - ◊ We recommend having 5–10 in the classroom. These can be purchased for about \$10 from department stores that stock Play-Doh[®] products.
- electronic scales
- two versions of the same product, one handmade and one machine-made (e.g. cookies, clothes, toys)
- sticky notes (two different colours)
- Student Sheet 1 – Comparing Dot Plots (one per student)

What's the difference?



Resources: Show students a handmade product and its machine-made equivalent.

As a class, describe the attributes of each product and observe the ways in which they differ. For example, using cookies you might notice that the shape and size of the machine-made cookies demonstrate less **variation** than the handmade cookies. Ask students to suggest some reasons why there is less variation in the machine-made products.

- Pose the questions:**
- *What are some products that you might expect to be **identical** when they are made by a machine?*
 - *What are some products that you might expect not to be identical when made by a machine?*
 - *Is there anything you can think of that could be identical when made by hand?*

Making licorice sticks



Resources: Ask if students are familiar with licorice sticks and show them photos of licorice being made in a factory.

The photo *1a Licorice Factory* is from the Junee Licorice & Chocolate Factory in New South Wales.

- Pose the questions:**
- *In what ways would you expect the licorice sticks made this way to look? Would you expect them to be all the same?*
 - *What about handmade licorice sticks? What difference would you expect?*



Resources: Divide students into groups and give each group a Fun Factory® set and playdough.

Give students a few minutes to experiment with making licorice sticks by hand and with the Fun Factory®. Make a list of all the **attributes** of the licorice sticks: mass, length, diameter, shape, etc.

Explain that students will be making and comparing handmade and factory-made licorice sticks.

Pose the question: *Which process will make more consistent products? How can we test this?*

As a class, agree on a set diameter and length for your licorice sticks. We recommend 1.5 cm diameter and 8 cm length, as this is easy to do with the Fun Factory®. Students will be making licorice sticks with these attributes by hand and using the Fun Factory®, then comparing the mass of each stick.



Teacher notes:

- In this lesson, the diameter and length of the sticks are set and the mass varies. In Lesson 2: Are Machines Better? students have a set mass of playdough and measure the variation in the lengths of the sticks.
- If you are doing only Lesson 1, you may prefer to set the mass of each stick to 10 g and have students measure the variation in length instead.

Have students make the same number of licorice sticks by hand and with the Fun Factory®. Three of each is a good starting point. Have students record the mass of each licorice stick on a separate sticky note, using one colour for factory-made sticks and another colour for handmade sticks. Each student should have at least six sticky notes to contribute to the dataset.

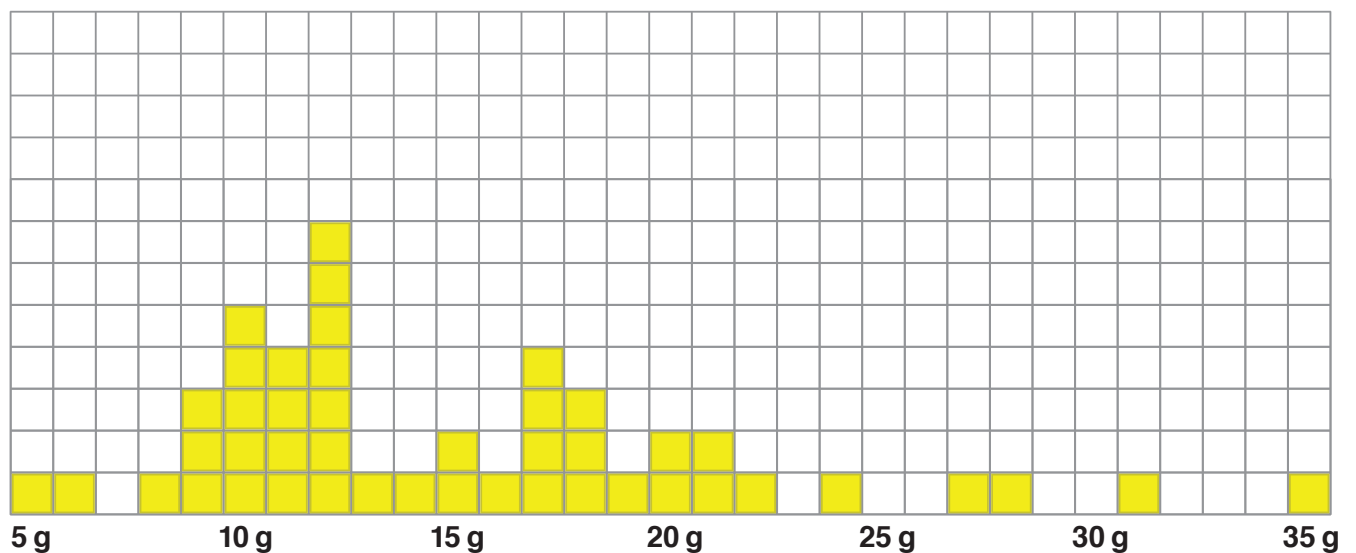
Some questions:

- How much difference can 1 g make to the shape/size of a licorice stick?
- Which set of sticks look as if they have less variation? Which set of sticks is quicker to make?

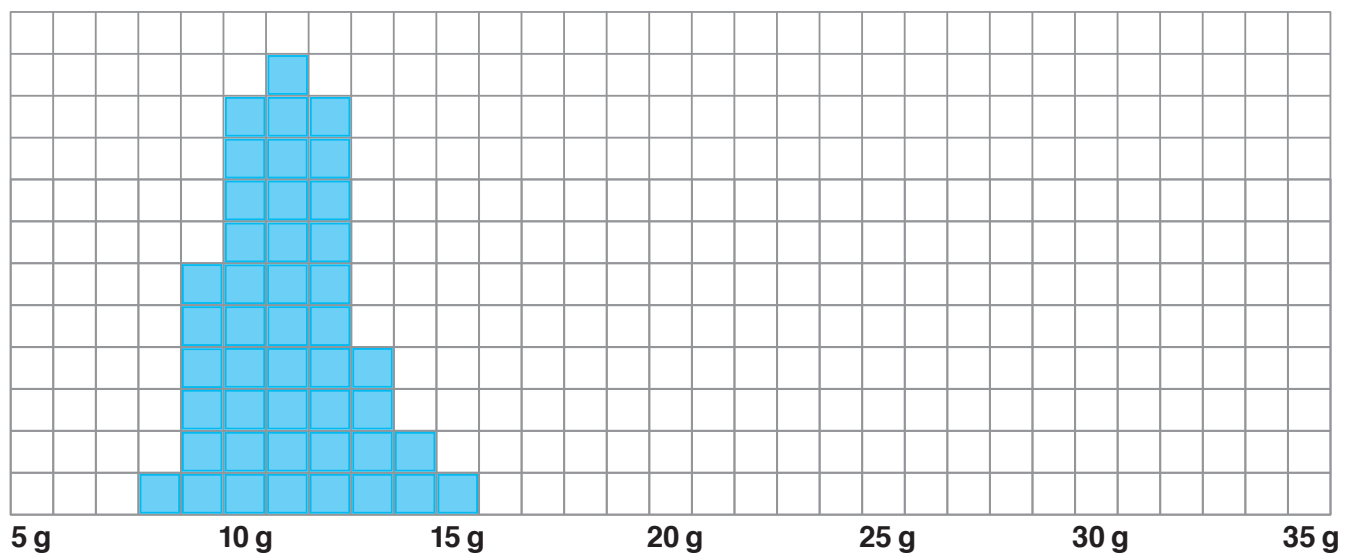
Create two class dot plots: one for handmade licorice and one for the machine-made. As a class, decide on a scale for the x-axis. This scale must be used on both graphs so that the data can be easily compared.

Have the students place their sticky notes indicating the mass of their handmade licorice in the appropriate place on the handmade dot plot. Repeat for the mass of machine-made licorice.

Dot plot of handmade licorice



Dot plot of machine-made licorice



Reflection

Students will find that there is greater variation in the handmade licorice and less variation in the machine-made licorice. This is evident in the spread of the data and the shape that it makes on the plot.



Resources: Provide students with Student Sheet 1 – Comparing Dot Plots.

Ask students to write a description of the shape of the two plots and to compare how the plots are similar and different.

As a class, discuss the spread of the data in the two graphs:

- *What is the difference in spread between the two groups?*
- *Which plot is more consistent?*
- *Is there less variation in handmade or machine-made licorice?*
- *Would we expect the same plot if we made another collection of handmade and machine-made licorice?*
- *Which method is better at making licorice sticks?*
- *What does 'better' mean in this context?*

Where to next?

Lesson 2: Are Machines Better? explores the levels of variation found in machine-made products. Students experiment with different strategies to restrict variation, and find that even with strategies in place, products will not be completely identical.

Comparing Dot Plots

Name: _____

Describe the shape of the two dot plots.

In what ways are the two dot plots similar and in what ways are they different?

Which is *better* at making licorice sticks: machines or people?

Why do you think machines or people are better?

Are Machines Better?

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About this lesson

Students are challenged to use the Play-Doh Fun Factory[®] to produce identical licorice sticks. They experiment with strategies to restrict variation and consider the importance of maintaining consistency.

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Mathematical purpose

- To further develop the concept of variation and how variation can be minimised.

Learning intention

- To find out how we can make all of our licorice sticks identical.



Time

A lesson of approximately
1 hour.



Vocabulary

- consistency
- efficient
- variation



Resources

- Play-Doh Fun Factory[®] extruders
 - ◊ We recommend having 5–10 in the classroom. These can be purchased for about \$10 from department stores that stock Play-Doh[®] products.
- electronic scales
- sticky notes (two different colours)

Reviewing Lesson 1

Look back at the two graphs constructed in Lesson 1: Making Licorice. Ask students to consider:

- *Why do handmade products have more **variation** than machine-made products?*
- *What sort of **variation** would you expect from machine-made products, if any?*

Explain that the goal of this lesson is to find out what sorts of variation there can be in machine-made products, and to discover what might **cause** variation in machine-made products.



Resources: Divide students into groups of two or three and give each group playdough, a Fun Factory® and access to an electronic scale.

Making more licorice sticks

Set students the challenge of manufacturing a set of **identical** licorice sticks using the Fun Factory®. Briefly experiment to agree on the mass of playdough you will insert into the Fun Factory® to make each stick (10 g works well), and have each group measure out at least 10 lumps of playdough at the agreed mass.

To make each stick, have students put in one lump of playdough and make a stick. Without cleaning out the Fun Factory®, place another lump of playdough into the Fun Factory® and make another stick. Have students continue this process until they have made at least four sticks of licorice each.

Ask students to measure the length of each stick to the nearest centimetre and record this measurement on a sticky note. Ask students to then weigh each stick and record this on a different-coloured sticky note.

Do we have variation?

Construct two more class dot plots: one for the length of the sticks and one for mass. Decide on a scale for each dot plot. Have students post their data onto the dot plots.

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Teacher note:

- As these graphs use different scales, it is important for students to realise that they cannot be compared. This is in contrast to the two dot plots constructed in Lesson 1, which were directly compared. The two separate graphs show different sorts of variation that can be seen.

Prompt students:

- *Describe the shape of each graph. In what ways are they similar and in what ways are they different?*
- *What sort of shape would the graph make if every licorice stick was identical? What if every licorice stick was different?*
- *Everyone put the exact same mass of playdough into the Fun Factory®. How did we end up with so many different results?*

Write a list of factors that might be involved; for example:

◇ *How hard/fast did you push the lever?*

◇ *What was the shape of the playdough when you put it into the Fun Factory®?*

◇ *Did you use the plastic knife or your hands to remove each stick from the Fun Factory®?*

- *Which group was closest to making all their licorice sticks identical? Can they tell us **how**?*
- *Cleaning out the Fun Factory® between each licorice stick means that there will be less variation in the mass of each stick. But is it an **efficient** strategy? Why/why not?*
 - ◇ Factors to take into consideration include time and wastage, etc.