Big Balloon Blow-Up ¦ Data Science Resource Teaching Guide

About this resource

This interdisciplinary data science resource has been designed as an extension activity for pupils that have completed the *Project Science* investigation the Big Balloon Blow-Up.

The resource includes an interactive video, where pupils are introduced to the *Data Science Lifecycle* and taken through the use of carbon dioxide sensor to collect data and answer the question *Do yeast need sugar to grow?*

This resource gives pupils the opportunity to develop their data literacy skills through a real-world experiment. They will use skills that span the curricular areas of technology, mathematics, literacy and science to problem-solve and answer the question using real data.

Click to access interactive video

Level	Scotland Curriculum for Excellence Second/Third level; England, Wales, NI KS2/3; Upper primary/lower secondary
Duration	Approximately 45 minute lesson
Curriculum links **(Scotland only)**	**Technologies (Second and Third Level)** I can extend and enhance my knowledge of digital technologies to collect, analyse ideas, relevant information and organise these in an appropriate way. **TCH 2-01a** I can explore and use the features of a range of digital technologies, integrated software and online resources to determine the most appropriate to solve problems. **TCH 3-01a** **Mathematics (Second and Third Level)** Having discussed the variety of ways and range of media used to present data, I can interpret and draw conclusions from the information displayed, recognising that the presentation may be misleading. **MNU 2-20a** I have carried out investigations and surveys, devising and using a variety of methods to gather information and have worked with others to collate, organise and communicate the results in an appropriate way. **MNU 2-20b** *

I can display data in a clear way using a suitable scale, by choosing appropriately from an extended range of tables, charts, diagrams and graphs, making effective use of technology. **MTH 2-21a / MTH 3-21a** *

I can work collaboratively, making appropriate use of technology, to source information presented in a range of ways, interpret what it conveys and discuss whether I believe the information to be robust, vague or misleading. **MNU 3-20a** *
When analysing information or collecting data of my own, I can use my understanding of how bias may arise and how sample size can affect precision, to ensure that the data allows for fair conclusions to be drawn. **MTH 3-20b** *

Science (Second and Third Level)
I have contributed to investigations into the role of microorganisms in producing and breaking down some materials. **SCN 2-13a**

I can explain some of the processes which contribute to climate change and discuss the possible impact of atmospheric change on the survival of living things. **SCN 3-05b** *

I have contributed to investigations into the different types of microorganisms and can explain how their growth can be controlled. **SCN 3-13b** *

* Through carrying out the Big Balloon-Blow Up investigation

Literacy (Second and Third Level)
When I engage with others, I can respond in ways appropriate to my role, show that I value others' contributions and use these to build on thinking. **LIT 2-02a**

As I listen or watch, I can identify and discuss the purpose, main ideas and supporting detail contained within the text, and use this information for different purposes. **LIT 2-04a**

I can show my understanding of what I listen to or watch by responding to literal, inferential, evaluative and other types of questions, and by asking different kinds of questions of my own. **LIT 2-07a**

When I engage with others, I can make a relevant contribution, encourage others to contribute and acknowledge that they have the right to hold a different opinion. I can respond in ways appropriate to my role and use contributions to reflect on, clarify or adapt thinking. **LIT 3-02a**

As I listen or watch, I can identify and give an accurate account of the purpose and main concerns of the text, and can make inferences from key statements **LIT 3-04a**

About Data Science

The Data Education in Schools programme is part of a wider initiative called the DDI [Data Driven Innovation] Skills Gateway. The aim of the gateway is to create a data literate workforce across Edinburgh and South East Scotland City Region with education opportunities for schools, colleges, universities and those already in employment.
Data Education in Schools

Data literacy is the ability to collect, analyse, interpret and communicate with data. It is important because as it gets easier to collect large amounts of data, this data is used to make decisions in our everyday lives. Being data literate empowers us to ask the right questions of data, build knowledge, make decisions and communicate meaning to others.

Data is a powerful tool that can inform, engage and create new opportunities; it helps us make connections that lead to new insights and improvements.

As more organisations become *data-driven*, being data literate improves employability skills. It is estimated that 90% of jobs already require digital skills (DDI, 2021).

The *Data Education in Schools* programme at the University of Edinburgh is supporting teachers and learners to develop their data literacy skills, in the Edinburgh and South East Scotland City Region. Their work includes development and delivery of professional learning, creation of classroom resources and the creation of an online knowledge-sharing community. To find out more click here

The *Data Science Life-Cycle*, also known as PPDAC which stands for Problem, Plan, Data, Analysis and Conclusion, is a method used to teach data literacy.

The *Data Science Life Cycle* is introduced to pupils in this resource, revealing each stage of the cycle using real-world data collected from their Big Balloon Blow-Up investigations and using a carbon dioxide sensor. To find out more about the Data Science Life Cycle/PPDAC click here.

Data Science Life Cycle or PPDAC
Image from Data Education in Schools

We have suggested some discussion points, classroom activities and provided extra context in the following notes, which should be used along with the classroom video.

ESTABLISHING KNOWLEDGE *What is data?* (20s)

You may wish to do this activity before playing the video, alternatively start the video and pause at 20 seconds.

On the board write *What is data?* As a class, ask pupils to brainstorm what this word means to them.

All suggestions are valid; this activity is useful for establishing prior knowledge and revealing misunderstandings.

Once finished, continue playing the video.

ACTIVE RECALL *How did you use data? What data did you collect?* (56s)

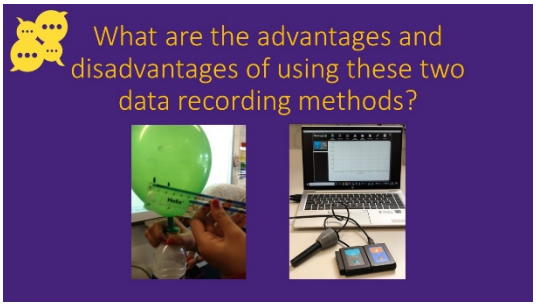
Working in small groups, pupils recall the investigation they did in class.

To facilitate this, you may wish to show some pictures that you took, or hold up some of the experimental equipment.

The data in this investigation is the numerical information that the pupils collected.

How did you use data? The data they collected (distance between dots on the balloons) was used to answer their question (Do yeast need sugar to grow?).

What data did you collect? They measured the distance between the two dots on the balloon. This data was used to indicate how much carbon dioxide was in the balloons and therefore indicated if the yeast were growing or not.



PLAN *What are the advantages and disadvantages of using these two data recording methods?* (2m 15s)

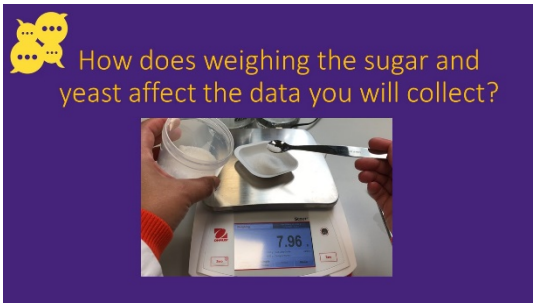
Hand out post-it notes to each group and ask them to write as many *advantages* and *disadvantages* as possible. They should only write one per post-it note.

On the board draw a Carroll diagram like the one below, invite pupils to place their post-it notes in the table. Summarise their thoughts to the class.

Here are some possible answers.

	Advantages	**Disadvantages**
Balloon	Cheap Easy to source the equipment Answered the question	Difficult to measure distance with a ruler Doesn't tell us the amount of carbon dioxide directly Difficult to set up Messy

	Everyone in the class got to have a turn	
Sensor	Data is collected by computer so we don't need to write it down More accurate readings Tells us the exact amount of carbon dioxide	Expensive Only one per class Less fun as less hands-on Computer does most of the work



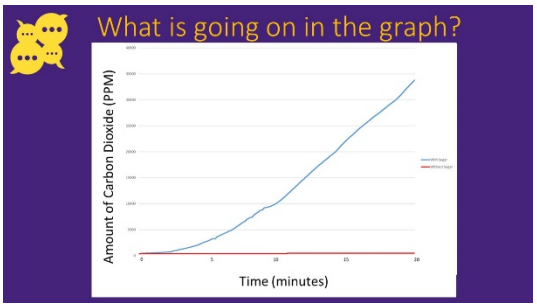
PLAN *How does weighing the sugar and yeast affect the data you will collect?* (3m 52s)

Ask the pupils to Think-Pair-Share this question.

Example answer:

Weighing the yeast means that the data will be more accurate as we have put exactly the same amount of yeast in each bottle.

Weighing the yeast and sugar means that we can repeat the experiment with exactly the same amounts. Repeating an experiment makes our data more reliable. We can take averages of the data from different experiments to be more confident in the data we collect (representative sample).



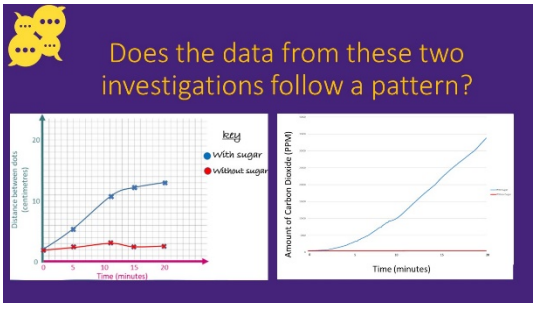
ANALYSIS *What is going on in the graph?* (7m 30s)

Working with a partner, ask pupils to describe what they see. Encourage them to use numerical values in their answers.

Example answer:

The graph shows that the bottle without sugar (red line) does not go up, it stays at 0 PPM (parts per million) of carbon dioxide from 0 minutes to 20 minutes.

The bottle with sugar (blue line) shows an increase in the amount of carbon dioxide after 2-3 minutes. After 20 minutes the amount of carbon dioxide is almost 35,000 PPM.

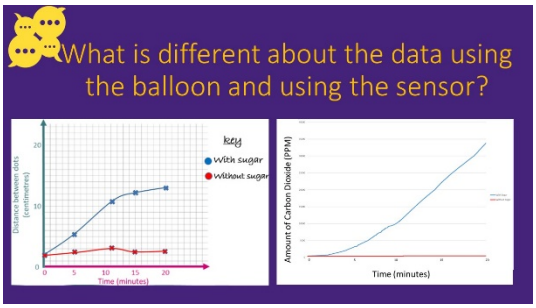


ANALYSIS Looking for patterns in data (7m 45s)

Ask the pupils if the data from the two investigations follows a pattern.

A pattern is "a particular way in which something is done, is organized, or happens" (Cambridge Dictionary). Displaying our data using graphs, we can see the patterns much more easily than just looking at the numbers (numerical data).

The data from both investigations do follow the same pattern. The red line stays in a low flat shape over time,



whereas the blue line shows an upward curve or line (trend) over time.

ANALYSIS *Comparing graphs* (8m 6s)

As a class, ask the pupils to think about the two graphs and the data that was used to make them.

You may wish to use a graphic organiser such as a Venn diagram to explore similarities and differences.

Similarities:

- Both are line graphs
- Both have time along the horizontal axis
- Both show the blue line going up/increasing
- Both show the red line staying low/the same
- Both graphs are measuring a change over time

Differences:

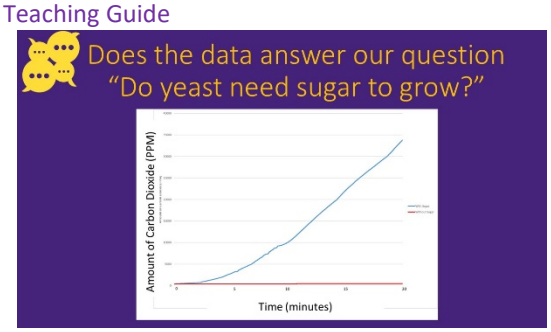
- The data in graph 1 was collected using a ruler and balloon, the data in graph 2 was collected using an electronic sensor
- The vertical axis in graph 1 shows *distance between dots (cm)*, the data in graph 2 shows the *amount of carbon dioxide (PPM – parts per million)*
- The data in graph 1 was collected every 5 minutes, the data in graph two was collected 10 times per second (every 0.1 seconds)
- The blue line in graph 1 levels off at 15 minutes, the blue line in graph 2 is still increasing at 15 to 20 minutes

Extension Question:

Why is the blue line in graph 2 increasing while the blue line in graph 1 is levelling out?

There are several possible reasons for this.

- If there was less sugar put in the bottle that produced the data in graph 1, then the yeast would run out of sugar sooner and would not be able to make as much carbon dioxide
- The balloon is not as sensitive as the sensor
- Carbon dioxide might have started to leak out of the balloon
- The balloon might not have expanded enough to show the increase in carbon dioxide
- The balloon might not be able to expand/get bigger any more than this
- The water temperature may have cooled below 30°C in the bottle that produces the data used in graph 1 (which means the yeast will stop growing)

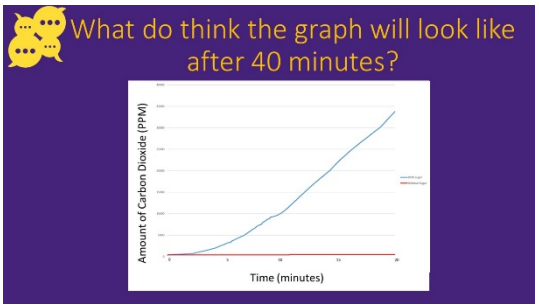


CONCLUSION Using the data to answer the question (8m 30s)

The data does show that yeast need sugar to grow.

When yeast grows it makes carbon dioxide gas. In the bottle with sugar (blue line), the amount of carbon dioxide increases over time.

The data shows that when there is no sugar mixed with the yeast (red line), carbon dioxide is not made by the yeast, indicating that the yeast is not growing.



CONCLUSION Using the data to make predictions (8m 47s)

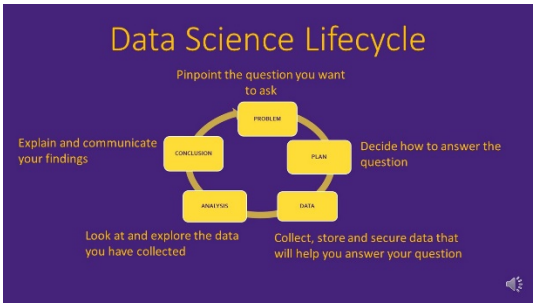
In the bottle without sugar, the yeast will not grow, so we expect the red line to remain at the same level (around 0PPM) after 40 minutes.

In the bottle with sugar, the yeast will continue to grow until they run out of sugar. When they run out of sugar they will stop growing and stop producing carbon dioxide. We would expect to see the blue line levelling off at 40 minutes, with the amount of carbon dioxide staying at around 40,000 – 50,000PPM.

Extension question:

If we repeated the experiment with half the amount of sugar in the bottle "with sugar" what would you expect the graph to look like?

The graph would show an increase in carbon dioxide, but then level out sooner (at a lower level of carbon dioxide) than the graph that is shown here.



Data Science Lifecycle (9m 2s)

A summary of the *Data Science Life-Cycle*, the framework used in this investigation.

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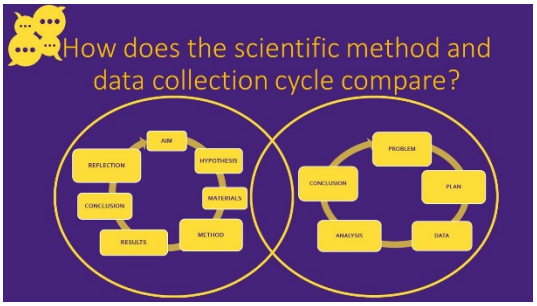

Data Science Lifecycle & Scientific Method (10m 3s)

In groups, place two hoops on the floor, or draw chalk circles if you have hard flooring in the classroom.

Give scrap paper to the pupils and ask them to complete the Venn-diagram.

Students own answers

Data Education in Schools. (n.d.). Data Education in Schools. [online] Available at: https://dataschools.education/ [Accessed 2 Nov. 2021].

DDI. (n.d.). *For people | What We Do*. [online] Available at: https://ddi.ac.uk/what-we-do/people/ [Accessed 2 Nov. 2021].