

Data and Analysis

Professional Learning Resource for Information Handling

This resource is part of the suite of Numeracy Professional Learning Resources

For Scotland's learners, with Scotland's educators

Do luchd ionnsachaidh na h Alba, le luchd foghlaim Alba

Contents

03		Introduction
04		Early Level
11		First Level
16		Second Level
20		Third Level
24		Fourth Level
27		Appendix One

Introduction

This professional learning resource has been created to enable practitioners to reflect on their own knowledge and understanding, highlight areas which children find challenging and outline effective approaches to support future learning and teaching in Data and Analysis.

Data and Analysis is an essential aspect of everyday life. The ability to read and analyse data is an important life skill.

When planning learning experiences it is beneficial for practitioners to consider what opportunities there are both within numeracy and across the curriculum for delivering these experiences. Data analysis can be easily integrated into other subject areas across the curriculum allowing for an inter-disciplinary approach.

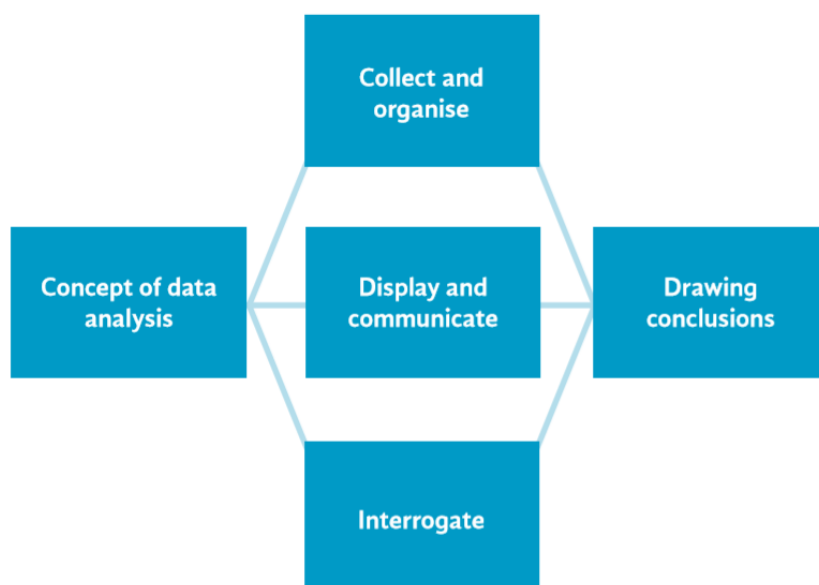
Opportunities to work outdoors can provide a broad range of data and analysis opportunities, some of which are included throughout.

Learners should be provided with opportunities to gather and record information and present it in meaningful ways. Data analysis develops crucial critical thinking skills, allows learners to identify patterns and trends and encourages them to make sense of information.

When planning opportunities for learners, it is essential to ensure a balance of activities are provided, including collecting, organising, representing, interpreting and discussing data.

There are a number of different ways of representing data. Progression through these methods will be demonstrated throughout, and examples of these can be found in Appendix One.

National Numeracy and Mathematics Progression Framework¹ Data and Analysis



¹ Further guidance on using the National Numeracy and Mathematics Progression Framework can be found by clicking [here](#).

Early Level

The table below includes the experiences and outcomes related to 'Data and Analysis' at early level. The experiences and outcomes should be used in the planning of learning, teaching and assessment. It is important to note that the benchmarks are designed to support teacher professional judgement in progress towards and achievement of a level. There are a range of different experiences that learners need to be exposed to before these can be achieved.

Experiences and Outcomes	Benchmarks
I can collect objects and ask questions to gather information, organising and displaying my findings in different ways. MNU 0-20a	<ul style="list-style-type: none">• Asks simple questions to collect data for a specific purpose.• Collects and organises objects for a specific purpose.• Applies counting skills to ask and answer questions and makes relevant choices and decisions based on the data.• Contributes to concrete or pictorial displays where one object or drawing represents one data value, using digital technologies as appropriate.• Uses knowledge of colour, shape, size and other properties to match and sort items in a variety of different ways.• Interprets simple graphs, charts and signs and demonstrates how they support planning, choices and decision making.
I can match objects, and sort using my own and others' criteria, sharing my ideas with others. MNU 0-20b	
I can use the signs and charts around me for information, helping me plan and make choices and decisions in my daily life. MNU 0-20c	

Careful consideration should be given to the **spaces, interactions** and **experiences** we provide.

Please see the 'Guidance Document' for additional information for learning and teaching approaches at early level.

Spaces

Rich, carefully considered learning spaces both outdoor and indoor can offer learners practical opportunities to develop their skills in interpretation and analysis of data. The choice of experiences on offer should reflect an environment of open-ended possibilities in which children can feel intrinsically motivated to explore and investigate data through play. Selecting appropriate and engaging resources can enhance interactions; leading to creativity, curiosity and deeper learning.

Open-ended materials offer the potential for creative explorations through child-initiated and adult initiated learning experiences. Spaces should be planned to provide a balance of opportunities for learners to play, explore, investigate and question. Practitioners should ensure that planning for learning is carefully balanced and is both responsive and intentional in design. These opportunities should enable learners to make sense of data in the world around them, whilst also ensuring learners needs are being met through their engagement with all experiences and outcomes presented within early level.

There are many different ways of permeating opportunities for development of data skills across the learning spaces. Some examples of how to do this are provided below.

Provide access to a wide variety of different materials and objects.

buttons	marbles/beads	feathers	flowers	leaves
sticks	shapes	socks	money	stones
dice	toy cars	toy animals	toy food	coins

Provide a variety of tubs, containers and hoops.

Display a range of charts and signs outdoors and indoors.

Provide blank/empty charts.

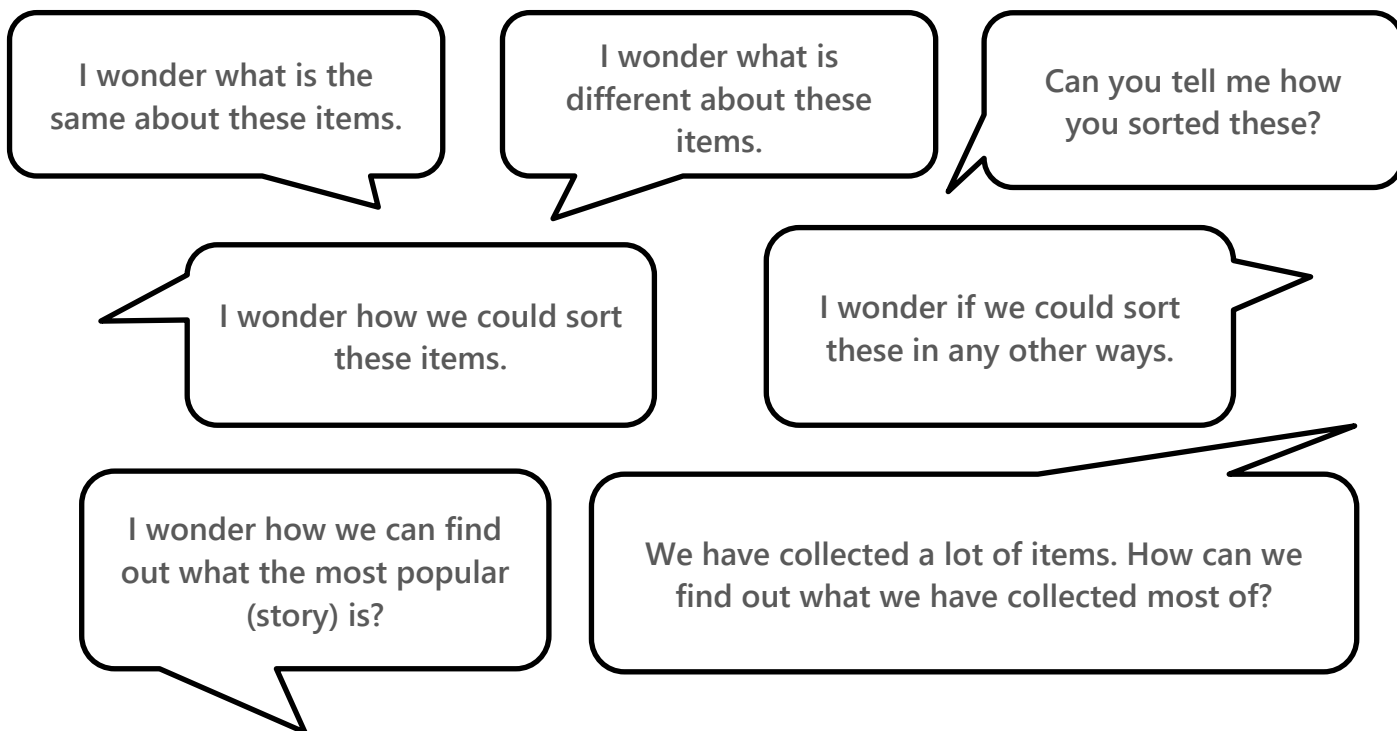
Provide clipboards and writing tools.

Clearly label storage boxes and shelves.

Interactions – One of the roles of the Adult/ Practitioner

One of the roles of the practitioner is to determine what the child could learn through their own interests using high quality interactions. Practitioners should support learners to extend their data and analysis skills and understanding through encouragement of creativity and curiosity. Careful observation is an important assessment tool, as is knowing when to stand back and give learners time to investigate by themselves. It is important to notice when learners are more receptive to further support from the adult and address any misconceptions that may cause challenges at later stages.

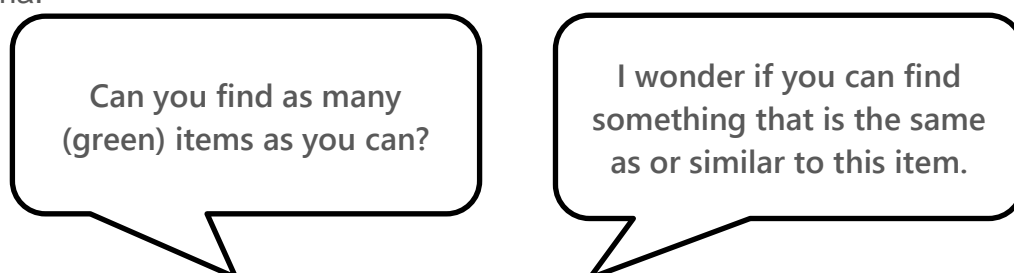
Language can be used as a powerful vehicle for teaching and learning in data and analysis. When interacting with learners, practitioners can model the use of relevant vocabulary in meaningful contexts. This allows learners to make links between the spoken word and the associated learning. Using language in the correct context regularly will support learners' understanding.



Experiences and Routines

Experiences of everyday activities are important, both indoor and outdoor.

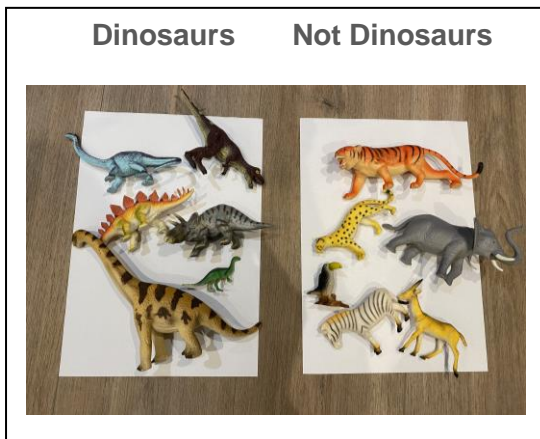
Learners should be provided with lots of practical opportunities at early level to match items to set criteria.



Opportunities to collect and sort real objects into categories is important. Providing materials which are relevant and real will be more meaningful. Examples of potential materials can be found on page five of this document. Learners should be encouraged to decide which objects they would like to sort and sort the objects using their own criteria, explaining their choices. They may choose attributes, such as, colour, size, shape, pattern, length and texture or they may have other ideas about how to categorise the items. The key is that they make the decision and can explain their choices. It is important that learners develop an understanding that there are different ways of categorising some objects.

Sorting items could be carried out using a variety of approaches for example; using hoops and containers or marking off sections of the floor/playground using tape or chalk.

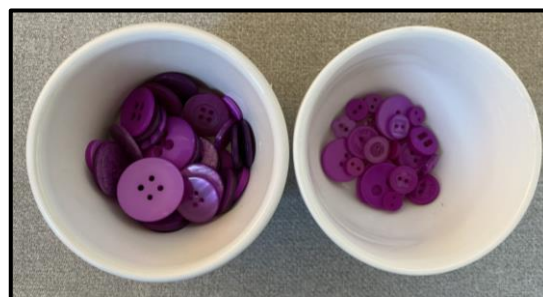
Initially they may sort by one property.



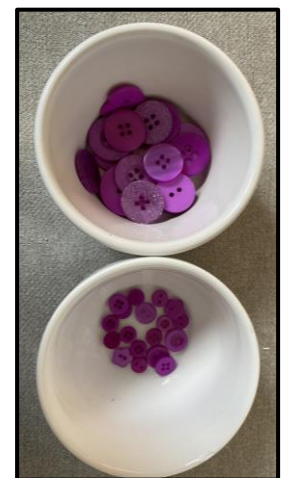
This can then progress to learners sorting by more than one attribute.



Sorted by colour.



Sorted by colour and number of holes.

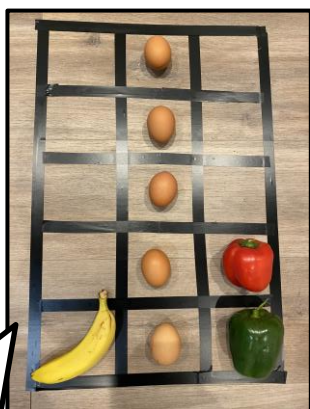


Sorted by size and colour.

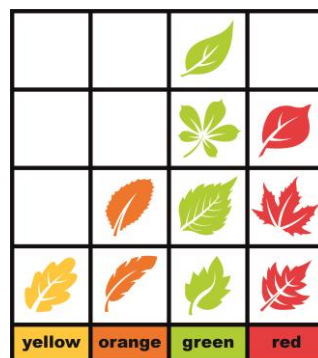
Collecting, organising and displaying

Learners can then progress to using simple graphs and charts such as pictograms or bar charts using concrete or pictorial objects for a specific purpose. Again, learners should make choices about what they collect and how they display it. This could be within a role play situation, for example if there is a 'shop' area, they could carry out a stock take.

Examples of this could include collecting information about the colours of objects, types of food in the play shop, sizes or shapes of objects. Blank bar charts or pictograms can be provided for learners to physically place the objects on and make comparisons.



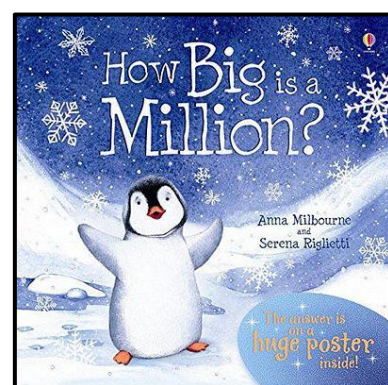
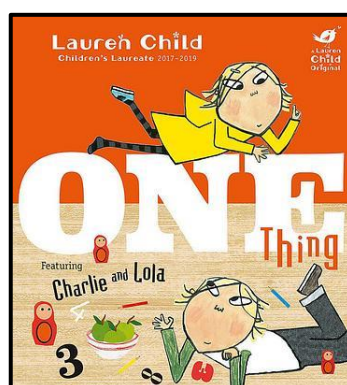
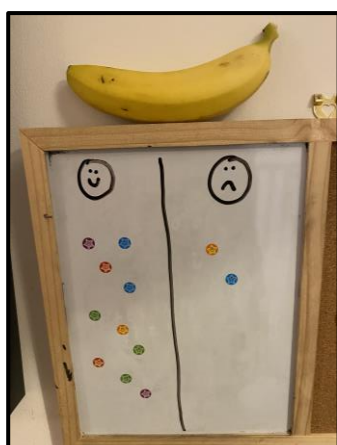
I wonder how many more peppers are needed to have the same amount as the eggs.



I wonder how many leaves we collected altogether.

Learners may need support in deciding what they would like to investigate, how they are going to find that information out and how they will organise their results, but it is important to be led by their interests as much as possible.

Simple charts and diagrams could be introduced through 'Question of the day' or 'week.' These could be displayed and learners can stick their photograph, a sticker or a peg on the answer that suits them best. Learners can be encouraged to create their own questions to collect information about. Charts should be kept simple initially and become progressively more challenging.²



Which story will we read later today?

Learners place a counter in a tub next to their choice.

² Images of books have been taken from <https://www.scottishbooktrust.com/book-lists/books-about-numbers>

Using signs and charts

The setting should be a numeracy rich environment with displays and signs which encourage the children to use their skills as they play and make decisions about their day.

Learners should be provided with lots of opportunities to investigate the area around them, both within the playroom or classroom and the wider environment. They should become skilled in looking for signs, labels, charts and visual prompts in these areas and be provided with opportunities for rich dialogue regarding their purposes.



Can anyone spot any signs?



I wonder what would happen if that sign was not there.

There are many digital games and applications which can reinforce the concept of data and analysis, some of these can be found on interactive board software already in classrooms and many free online resources are also available. One example may be through the lunch ordering system.

I wonder what the most popular lunch choice is today.

How many more people bring a packed lunch than go home for lunch?

Points to consider

- Learners require lots of concrete materials to manipulate and should create their own criteria and use the criteria of others.
- A variety of materials should be provided for sorting.
- Learning will be more deeply embedded where links are made to real life situations.

Links to other curricular areas

Number and number processes

- Counting on and back.
- Exploring quantities.

Estimation

- Developing a sense of size.

Measurement

- Comparing sizes and amounts.

Properties of 2D shape/3D objects

- Investigating and sorting.

Literacy

- Sorting objects by initial sounds.

Science

- Using senses to explore the world around them, exploring materials.

Social Studies

- Describing and recording the weather in relation to season.

Reflective Questions

- **How often do we provide opportunities for learners to choose the materials they sort?**
- **How often do we provide opportunities for learners to choose how they categorise items?**
- **In what ways do we use the outdoors to support learning in this area?**
- **How well do we encourage the learners to make and use signs and labels in their play?**

First Level

The table below includes the experiences and outcomes related to 'Data and Analysis' at first level. The experiences and outcomes should be used in the planning of learning, teaching and assessment. It is important to note that the benchmarks are designed to support teacher professional judgement in progress towards and achievement of a level. There are a range of different experiences that learners need to be exposed to before these can be achieved.

Experiences and Outcomes	Benchmarks
<p>I have explored a variety of ways in which data is presented and can ask and answer questions about the information it contains.</p> <p style="text-align: right;">MNU 1-20a</p> <p>I have used a range of ways to collect information and can sort it in a logical, organised and imaginative way using my own and others' criteria.</p> <p style="text-align: right;">MNU 1-20b</p> <p><i>Using technology and other methods, I can display data simply, clearly and accurately by creating tables, charts and diagrams, using simple labelling and scale.</i></p> <p style="text-align: right;">MTH 1-21a</p>	<ul style="list-style-type: none">• Asks and answers questions to extract key information from a variety of data sets including charts, diagrams, bar graphs and tables.• Selects and uses the most appropriate way to gather and sort data for a given purpose, for example, a survey, questionnaire or group tallies.

Effective Learning and Teaching Approaches


Data presentation



At this level learners should be presented with data in the following ways:

- Venn diagrams
- Tables
- Carroll diagrams
- Bar charts
- Pictographs
- Pie charts

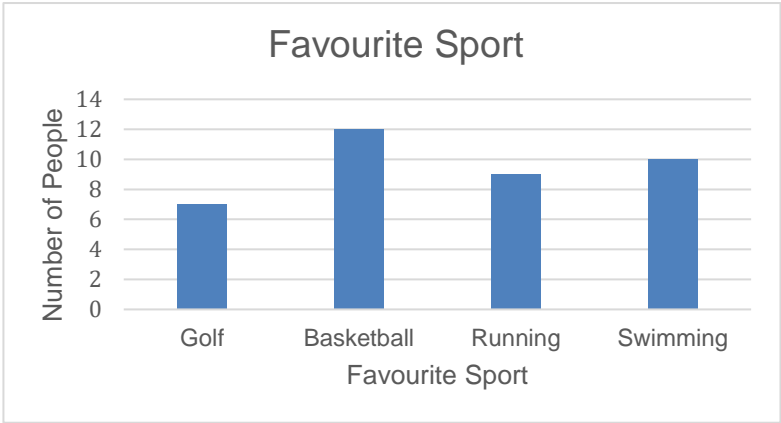
Examples of these can be found in Appendix One and practitioners are encouraged to use concrete, pictorial and digital formats.

Features of correct data representation should be discussed such as title, key and labelling of scales. When using bar graphs, learners should initially be exposed to graphs where the scale represents one and then progress to graphs where the scale represents two, five and ten. If they have a good grasp of this, they can then be exposed to graphs of varying scales. At this stage, pictograms where one picture represents more than one response should be introduced.

 Could represent 2 or more people.

 If one of these represents 10 then  represents 5 people.

Learners should also use bar charts where the totals represented are in between the numbers marked on the scales.



Learners should be provided with opportunities to explore the different ways data is presented and to ask and answer questions about the information contained. Questions should be a variety of one-step, multi-step and learner generated questions.

One-step question	How many liked swimming best?
Multi-step question	What is the difference between the most popular and the least popular?
Multi-step question	How many liked a sport that uses a ball best?

It is also useful to discuss common errors and misconceptions that arise in representation of data to learners, encouraging them to highlight and discuss errors.

Discussion around the parts of graphs and displays:

- title
 - key
 - axes
 - scales
- and why they are needed will develop a deeper understanding.

Collecting, sorting and organising data

In addition to investigating different methods of data presentation, learners should be provided with opportunities to investigate different ways of collecting information. This could involve learners creating questionnaires, making decisions about the criteria they use and using written and digital methods to collect data.

Some ideas for types of data to collect are suggested below, however learners should also be involved in decisions about the type of information they would like to collect, this will make it more relevant and interesting.

Observations
<ul style="list-style-type: none">• traffic surveys• objects found in school grounds; trees, wildlife, flowers

Surveys
<ul style="list-style-type: none">• favourites; sport, food, music, colour• characteristics; eye/hair colour, shoe size<ul style="list-style-type: none">• method of travel to school• after school clubs attended• preferred choice for class topic

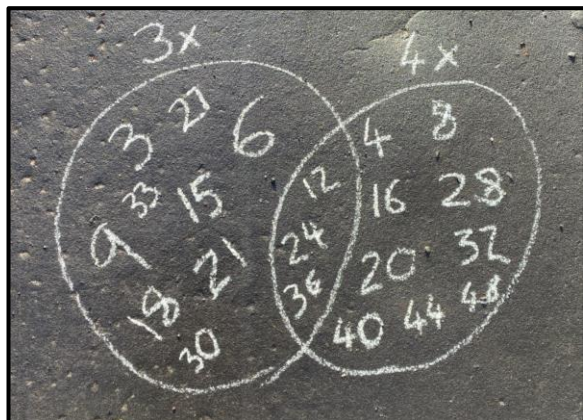
Initially learners can be provided with templates to collect data using different formats and then should progress to making decisions about the best way to collect their own data. It is important to support learners in finding an organised system for collecting data. The teacher should model how this can be done to begin with. Digital methods of collecting data could also be used, for example using Microsoft or Google Forms.

Chance and uncertainty can be taught alongside this as a means of creating data from probability experiments and analysing the results. Formal tally marks should also be introduced at this stage. It is worth discussing why limited choices should be provided when creating a survey.

Number on dice	Number of rolls	Total
1		12
2		10
3		15
4		13
5		15
6		14

Once learners have collected data, they need to decide how to organise it. They should be provided with opportunities to discuss and experiment with different methods of organising the data collected using the methods of presentation mentioned earlier in this document.

Outdoors can provide many opportunities to develop skills in data and analysis. An example of a Venn and a Carroll diagram are provided below.



Key questions to support learning may include:

- Who will we ask? How many people will we ask? When will we ask?
- What is the total number of people surveyed?
- What is the best way to collect this information?
- What is the best way to organise this information? Why?
- How many are represented by each section (bar graphs)? Why might this graph count in ones and this one in twos? What does it mean if the chart is in between the numbered labels on the graph?
- What further questions can we explore based on the information?

Points to consider

- Ensure that learners are aware of the title, key and axes by explicitly pointing them out and discussing their purpose.
- Learners should be exposed to different types of scale and lots of discussion around these should be facilitated.
- Ensure that pictures are the same size and that bars are the same width in material provided to learners in order to avoid confusion.

Links to other curricular areas

Money

- Using data and analysis to calculate profits.

Ideas of chance and uncertainty

- Interpreting data and making predictions of the likelihood of events occurring.

Measurement

- Recording findings from experiments.

Properties of 2D shape/3D objects

- Investigating and sorting using venn and carroll diagrams.

Science

- Recording observations, displaying results of experiments, living things, inheritance.

Social Studies

- Enterprising surveys, local services, natural environment, weather, climate and population data.

Health & Wellbeing

- Planning for choices and change – making decisions about school events such as trips, healthy eating campaigns, charity campaigns.

Reflective Questions

- **How well do we provide a balance of concrete materials and pictorial representations in this area?**
- **How often and in what way do we use the outdoors to support learning in this area?**
- **In what ways do we use digital technology to enhance learning in this area?**
- **How often do we provide opportunities for learners to make decisions about the type of data to collect?**
- **How well do we use interdisciplinary learning in this area?**

Second Level

The table below includes the experiences and outcomes related to 'Data and Analysis' at second level. The experiences and outcomes should be used in the planning of learning, teaching and assessment. It is important to note that the benchmarks are designed to support teacher professional judgement in progress towards and achievement of a level. There are a range of different experiences that learners need to be exposed to before these can be achieved.

Experiences and Outcomes	Benchmarks
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	<ul style="list-style-type: none">• Devises ways of collecting data in the most suitable way for the given task.• Collects, organises and displays data accurately in a variety of ways including through the use of digital technologies, for example, creating surveys, tables, bar graphs, line graphs, frequency tables, simple pie charts and spreadsheets.
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	<ul style="list-style-type: none">• Analyses, interprets and draws conclusions from a variety of data.• Draws conclusions about the reliability of data taking into account, for example, the author, the audience, the scale and sample size used.

Effective Learning and Teaching Approaches

Data presentation

At this level learners should continue to be presented with data as detailed in previous levels and should also be presented with data displayed in:

- Line graphs
- Pie charts

Examples of these can be found in Appendix One.

Learners should continue to be exposed to data presented in a variety of ways and should be encouraged to ask and answer questions about the information contained.

Scales on graphs should be varied and could now include appropriate fractions, decimal fractions or percentages. Questions should be designed to encourage learners to answer questions in the context of the data provided and to discuss possible explanations.

Examples

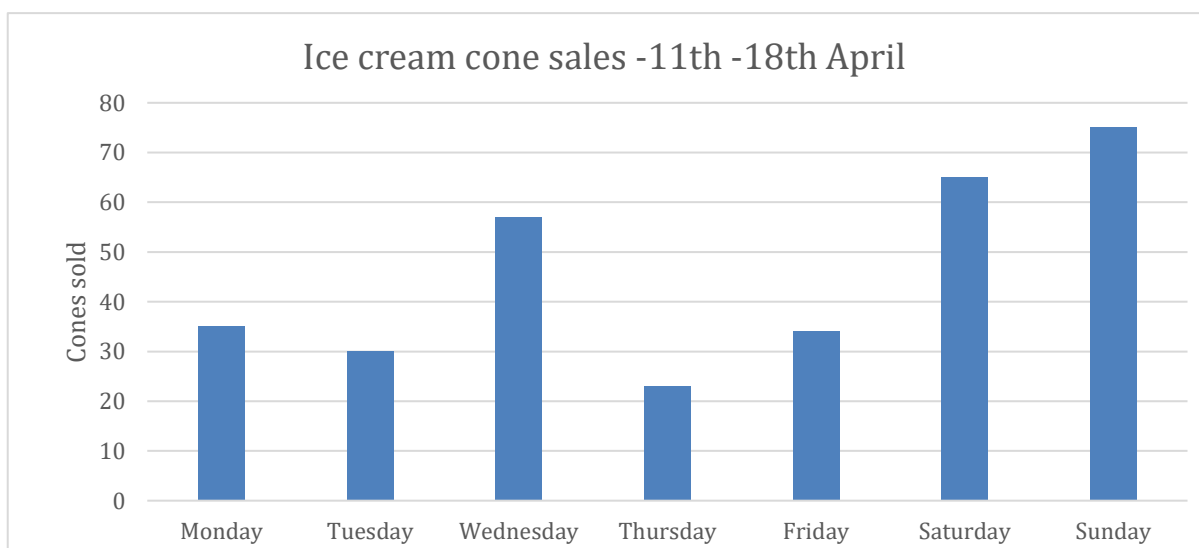
The table below gives details of the cost of a family holiday:

	Holiday cost (7 days)	Holiday cost (14 days)
Adult	£573	£756
Child (5 to 16 years old)	£345	£467
Infant (Under 5 years old)	£20	£20

- Calculate the total cost for a family of two adults, a 10-year-old child and a 2-year-old child to go on holiday for:
 - One week
 - Two weeks
- Compare the costs and comment on your findings.
- What other things should be considered when deciding whether a two-week or a one-week holiday is best value? [For example, daily costs such as food, car hire, entertainment.]

This graph shows the number of ice cream cones sold in a local café in a particular week in April. Questions could be posed about the most sales, least sales and the differences between sales on particular days but it is also important to allow learners to think about the reasons behind the data. Learners could be asked to consider:

- Why might the sales have been higher on Wednesday than any other weekday?
- Why are Saturday and Sunday sales higher than other days?
- Why might Sunday have had the highest sales?



Learners should be encouraged to discuss and explore the variety of possible stories behind the data which is presented.

When introducing line graphs, it is important to discuss when this is the most appropriate format to use. Line graphs show how one thing varies by comparison to another. They are particularly useful at showing a change over time.

Learners should be given the opportunity to read and interpret a variety of line graphs in pictorial and digital formats.

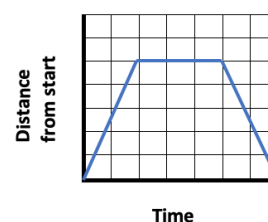
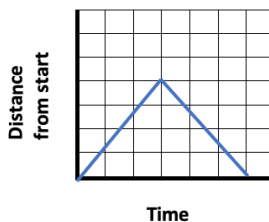
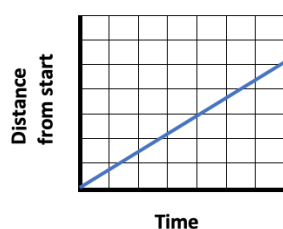
Learners should also be introduced to graphs where the vertical axis does not start at zero and be given the opportunity to discuss when this is useful and when it can be misleading.

Once learners demonstrate confidence in interpreting line graphs with a single line, graphs with multiple lines can be introduced.

Learners should be given opportunities to interpret the story told by line graphs. This could be done by choosing which graph best fits a given scenario and why. An example of this is below.

Match each description to one of the graphs below.

- a) A car travels away from home at a steady speed
- b) A man walks to the post box to post a letter at a steady speed and returns home at the same speed.
- c) A boy walks to school, stays for the school day and then walks home.



Collecting, sorting and organising data

Learners should be provided with opportunities to collect and organise their own data by creating surveys, questionnaires or by recording measurements. It is important to discuss the type of data, which is to be collected, how this could be recorded and the best way to display it.

Learners should start with the question which they want an answer to and then to think carefully about what information they require and how they will collect and record this information. The use of open and closed questions in questionnaires should be discussed and learners should be given the opportunity to design questions which will enable them to collect their data efficiently.

Having collected their data learners should then choose the most appropriate method of presentation. Learners could be given the same information presented in different ways and asked which presentation method they would choose giving justification for their decisions. This can provide a good opportunity to discuss the use of line graphs to display time series data such as the temperature over a period of a school day or the height of a sunflower over a period of time.

By considering the number of responses or measurements they have taken and who was asked or has responded to a question, learners can begin to explore how this will affect the reliability of their data and the conclusions which can be drawn from it. For example, if the question was 'What is your favourite sport?' and only members of the football team answered the question what impact this might have on the data collected. This can then lead to discussion of how data is collected in the wider world.

Points to consider

- Learners may require support to correctly interpret scales.
- A variety of data should be used to ensure learners develop skills in interpreting different types of displays.
- By examining a wide variety of graphs in everyday use, for example in newspapers and online articles, learners can begin to develop an understanding of how graphs can be misleading.

Links to other curricular areas

Number and number processes

- Solving problems involving whole number and decimal fractions.

Fractions and decimal fractions

- Carrying out calculations.

Estimation and rounding

- Estimating and deciding if answer is reasonable.

Measurement

- Common units of measure to record information.

Science

- Recording observations, displaying results of experiments.

Social Studies

- Traffic, community and political surveys, natural environment, weather/climate, tourism, market research.

Health and Wellbeing

- School events, trip choices, healthy eating, exercise choices.

Reflective Questions

- **In what ways do we use digital technology to enhance learning in this area?**
- **How often do we provide opportunities for learners to make decisions about the type of data to collect and how to present it?**
- **How often do we discuss the reliability of data which we provide for learners?**
- **Do our learners clearly communicate their solutions in the context of the question?**
- **How often do we ask questions which require learners to think about the 'story' behind what the data is telling them?**

Third Level

The table below includes the experiences and outcomes related to 'Data and Analysis' at third level. The experiences and outcomes should be used in the planning of learning, teaching and assessment. It is important to note that the benchmarks are designed to support teacher professional judgement in progress towards and achievement of a level. There are a range of different experiences that learners need to be exposed to before these can be achieved.

Experiences and Outcomes	Benchmarks
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	<ul style="list-style-type: none">• Sources information or collects data making use of digital technology where appropriate.• Interprets data sourced or given.• Describes trends in data using appropriate language, for example, increasing trend.• Determines if information is robust, vague or misleading by considering, for example, the validity of the source, scale used, sample size, method of presentation and appropriateness of how the sample was selected.

Effective Learning and Teaching Approaches

Data presentation

At this level learners should continue to be presented with data as detailed in previous levels and should also be presented with data displayed in:

- Comparative bar graphs
- Comparative line graphs

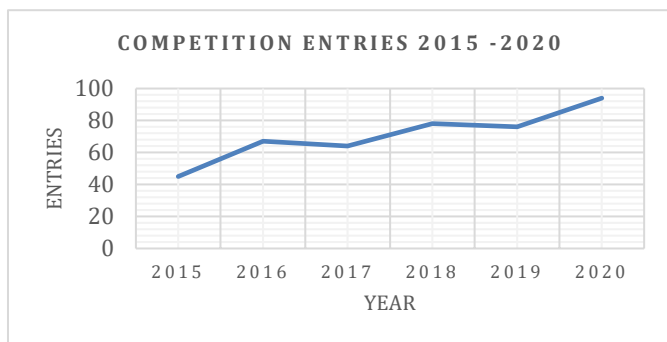
Examples of these can be found in Appendix One.

Learners should continue to be exposed to data presented in a variety of ways. Examples of graphs and charts should be sourced from relevant real-life contexts whenever possible.

At this level learners should be given the opportunity to interpret pie charts to support percentage calculations in context and to use proportions of 360 degrees to interpret information.

Learners should be introduced to comparative bar and line graphs to enable them to begin to develop appropriate mathematical language to compare data sets. Learners should be given the opportunity to tackle a variety of questions which give them further practice, selecting and communicating processes and explaining their thinking.

Learners should be introduced to the appropriate mathematical language to describe trends in data, such as an increasing or a decreasing trend, and this should then be related to the context of the question.



Competition entries show an increasing trend between 2015 and 2020.

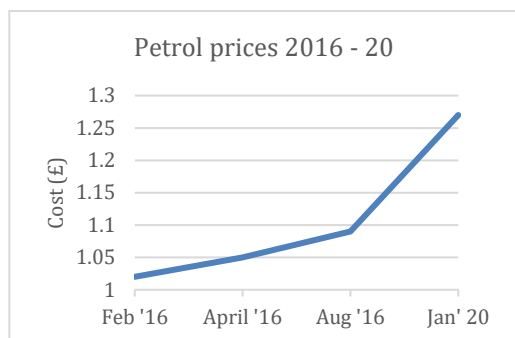
Graphs and charts are used widely in the media and there are many examples of misleading use. Examples should be collected which illustrate the impact of:

- sample size
- sample selection
- method of presentation
- scale
- wording of survey questions.

It is essential at this stage that learners are encouraged to discuss whether information is robust, vague or misleading and can interpret information presented to draw fair conclusions. Examples can be sources from the media which demonstrate how data can be misrepresented.

Learners could be shown some examples of misleading graphs and asked, 'Can anyone notice any problems with the way this has been presented?'

Examples

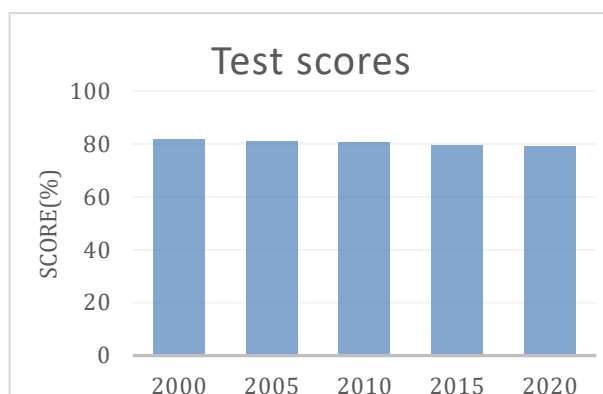
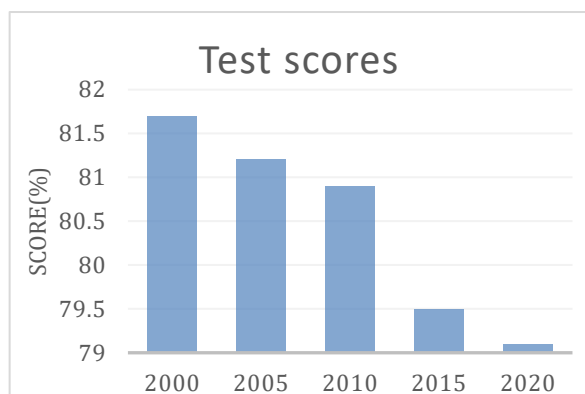


Learners may need prompts.

Look at the horizontal scale.

Look at the vertical scales.

Both of these graphs are displaying the same data.



Points to consider

- Learners may take time to develop the comparative language needed to compare data sets. A significant amount of modelling and discussion may be required.
- The small print of advertisements is a rich source of examples of data sets that may or may not support robust conclusions.
- Learners may need guidance in gauging the reliability of sources of data, particularly online sources.

Links to other curricular areas

Number and number processes

- Using a variety of methods to solve problems in context, clearly communicating processes and solutions.

Fractions and decimal fractions

- Carrying out calculations and making comparisons and choices in real life situations.
- Applying proportionality when interpreting a pie chart.

Estimation and rounding

- Rounding to an appropriate degree of accuracy, having taken account of the context.

Science

- Recording, displaying and reporting on results of experiments, interpreting scientific data displayed in graphs charts and tables.

Social Studies

- Reviewing basic sources of evidence such as newspapers or surveys used in arguments about current affairs to form a valid opinion.

Health and Wellbeing

- Reviewing statistics to make informed decisions.

Reflective Questions

- **In what contexts do learners have the opportunity to discuss real life data in our department?**
- **How can we link with other curriculum areas within the school when planning for data analysis learning? How can we support this planning?**
- **How often and in what ways do we allow learners to investigate the validity of the source, scale used, sample size, method of presentation and appropriateness of how the sample was selected?**

Fourth Level

The table below includes the experiences and outcomes related to 'Data and Analysis' at fourth level. The experiences and outcomes should be used in the planning of learning, teaching and assessment. It is important to note that the benchmarks are designed to support teacher professional judgement in progress towards and achievement of a level. There are a range of different experiences that learners need to be exposed to before these can be achieved.

Experiences and Outcomes	Benchmarks
I can evaluate and interpret raw and graphical data using a variety of methods, comment on relationships I observe within the data and communicate my findings to others. MNU 4-20a	<ul style="list-style-type: none">• Interprets raw and graphical data.• Uses statistical language, for example, correlations, to describe identified relationships.

Effective Learning and Teaching Approaches

An ability to interpret and analyse data is an essential skill for life and work and practitioners are encouraged to make links across the curriculum.

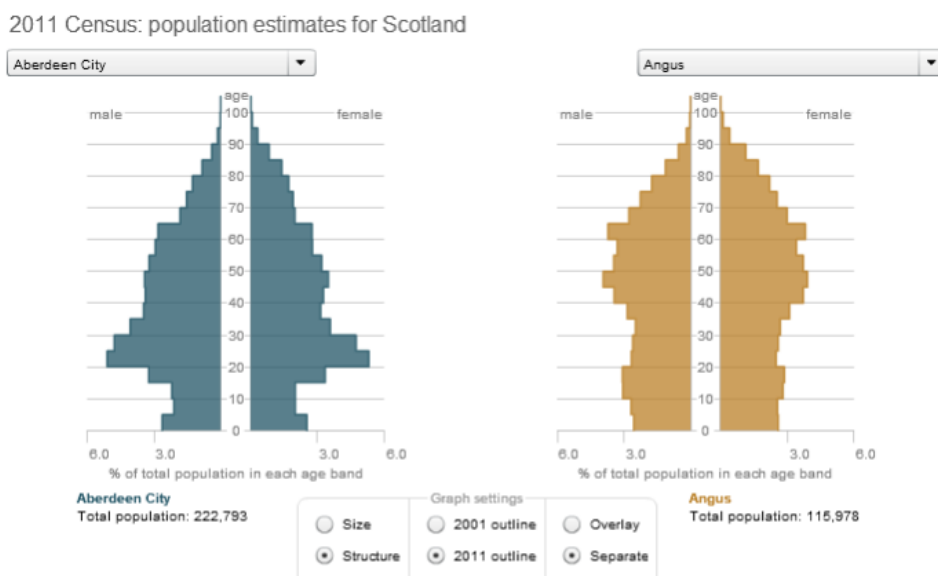
Learners should be given the opportunity to work with a variety of raw and graphical data. Many interesting sources of data can be accessed online. Examples of freely available data include most streamed Spotify songs, top 100 Rotten Tomatoes movie reviews, Scottish census data and NHS data.

Data presentation

At this level learners should continue to be presented with data as detailed in previous levels and should also be presented with data displayed in:

- Stem and leaf diagrams
- Scatter graphs

Learners can also be exposed to a number of less familiar styles of graphs and charts, for example, population pyramids.



Learners could benefit from opportunities to explore digital tools such as excel and R Studio when analysing and displaying data.

Learners should be encouraged to clearly articulate the conclusions that can be drawn from analysis and communicate their findings using appropriate mathematical language. It is important that when working with data, emphasis is given to the understanding of what the data represents and the communication of this within the context of the question. This is an essential skill for life and is reflected in senior phase qualifications. Mention continues to be made in Scottish Qualification Authority course reports that candidates are often unable to make valid comments when comparing data sets.

Points to consider

- Learners should be given the opportunity to explore scenarios where two quantities which have a statistical correlation are not linked in any way. The phrase “correlation does not imply causation” can be investigated and plenty of interesting examples found.
- Data collected in other subject areas might provide rich opportunities for analysis.
- Further and higher education partners and local employers might rely heavily on data science and could provide additional input to lessons.

Links to other curricular areas

Number and number processes

- Carry out the necessary calculations to solve problems in unfamiliar contexts.

Fractions, decimal fractions and percentages

- Carry out calculations and use solutions to make comparisons, decisions and choices.

Estimation and rounding

- Choosing the correct degree of accuracy to make real-life calculations.

Time

- Interpret information from a graph and use the link between speed, distance and time to carry out related calculations.

Social Subjects

- Analysis of current and historical data to support learning.

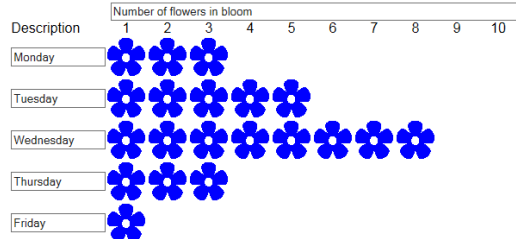
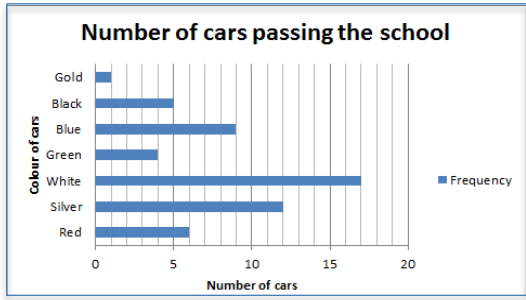
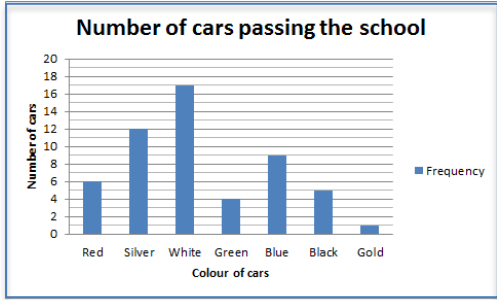
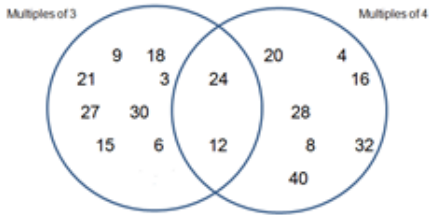
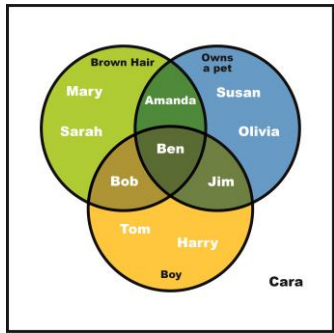
Sciences

- Analysis of experimental data.

Reflective Questions

- **How often are learners exposed to real life data? Where is this data sourced from?**
- **What cross curricular links are in place to enrich learning relating to data analysis? How could we improve links across curriculum areas?**
- **In what ways do learners have the opportunity to present conclusions and communicate finding based on their interrogation of data?**
- **How do we encourage learners to make use of digital tools to analyse and present data?**

Appendix One

Method of displaying data	Illustrations	Information																																
Pictogram/pictograph		<p>A pictogram or pictograph is a way of showing data using images. It can be represented horizontally or vertically</p> <p>Learners can create pictograms/pictographs using physical objects or pictures of objects.</p> <p>Pictures can also represent a value more than one.</p>																																
Bar chart/ bar graph	<div><table border="1"><caption>Number of cars passing the school (Horizontal Bar Chart)</caption><thead><tr><th>Colour of cars</th><th>Frequency</th></tr></thead><tbody><tr><td>Gold</td><td>1</td></tr><tr><td>Black</td><td>5</td></tr><tr><td>Blue</td><td>9</td></tr><tr><td>Green</td><td>4</td></tr><tr><td>White</td><td>17</td></tr><tr><td>Silver</td><td>12</td></tr><tr><td>Red</td><td>6</td></tr></tbody></table></div> <div><table border="1"><caption>Number of cars passing the school (Vertical Bar Chart)</caption><thead><tr><th>Colour of cars</th><th>Frequency</th></tr></thead><tbody><tr><td>Red</td><td>6</td></tr><tr><td>Silver</td><td>12</td></tr><tr><td>White</td><td>17</td></tr><tr><td>Green</td><td>4</td></tr><tr><td>Blue</td><td>9</td></tr><tr><td>Black</td><td>5</td></tr><tr><td>Gold</td><td>1</td></tr></tbody></table></div>	Colour of cars	Frequency	Gold	1	Black	5	Blue	9	Green	4	White	17	Silver	12	Red	6	Colour of cars	Frequency	Red	6	Silver	12	White	17	Green	4	Blue	9	Black	5	Gold	1	<p>A bar graph (also bar chart) is a graphical display of data using bars of different heights. They can be displayed horizontally or vertically.</p>
Colour of cars	Frequency																																	
Gold	1																																	
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Venn Diagram	<div><table border="1"><caption>Venn Diagram: Multiples of 3 and 4</caption><thead><tr><th>Set</th><th>Elements</th></tr></thead><tbody><tr><td>Multiples of 3</td><td>9, 18, 21, 3, 27, 30, 15, 6</td></tr><tr><td>Multiples of 4</td><td>20, 4, 16, 28, 8, 32, 40</td></tr><tr><td>Intersection</td><td>24, 12</td></tr></tbody></table></div> <div><table border="1"><caption>Venn Diagram: Brown Hair and Owns a pet</caption><thead><tr><th>Set</th><th>Elements</th></tr></thead><tbody><tr><td>Brown Hair</td><td>Mary, Sarah, Ben, Bob, Tom, Boy</td></tr><tr><td>Owns a pet</td><td>Susan, Olivia, Ben, Jim, Harry, Cara</td></tr><tr><td>Intersection</td><td>Ben</td></tr></tbody></table></div>	Set	Elements	Multiples of 3	9, 18, 21, 3, 27, 30, 15, 6	Multiples of 4	20, 4, 16, 28, 8, 32, 40	Intersection	24, 12	Set	Elements	Brown Hair	Mary, Sarah, Ben, Bob, Tom, Boy	Owns a pet	Susan, Olivia, Ben, Jim, Harry, Cara	Intersection	Ben	<p>A diagram that shows all possible logical relations between a collection of sets of data.</p>																
Set	Elements																																	
Multiples of 3	9, 18, 21, 3, 27, 30, 15, 6																																	
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Carroll diagram	<table><tr><td></td><th>Can Fly</th><th>Cannot fly</th></tr><tr><th>Mammal</th><td>Bat</td><td>Elephant Horse</td></tr><tr><th>Bird</th><td>Pigeon Eagle</td><td>Ostrich Penguin</td></tr></table>		Can Fly	Cannot fly	Mammal	Bat	Elephant Horse	Bird	Pigeon Eagle	Ostrich Penguin	A two-way table used for grouping items according to characteristics.																		
	Can Fly	Cannot fly																											
Mammal	Bat	Elephant Horse																											
Bird	Pigeon Eagle	Ostrich Penguin																											
Frequency Table	<table><tr><th colspan="3">Number of cars passing the school</th></tr><tr><th>Colour</th><th>Tally Marks</th><th>Frequency</th></tr><tr><td>Red</td><td> </td><td>6</td></tr><tr><td>Silver</td><td> </td><td>12</td></tr><tr><td>White</td><td> </td><td>17</td></tr><tr><td>Green</td><td> </td><td>4</td></tr><tr><td>Blue</td><td> </td><td>9</td></tr><tr><td>Black</td><td> </td><td>5</td></tr><tr><td>Gold</td><td> </td><td>1</td></tr></table>	Number of cars passing the school			Colour	Tally Marks	Frequency	Red		6	Silver		12	White		17	Green		4	Blue		9	Black		5	Gold		1	A table used to show the frequency of each item. The tally marks column gives a visual representation of the number of times an item appears in a set, tally marks are bundled in groups of five.
Number of cars passing the school																													
Colour	Tally Marks	Frequency																											
Red		6																											
Silver		12																											
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Pie chart	<div><p>FAVOURITE PETS</p><table><thead><tr><th>Pet</th><th>Percentage</th></tr></thead><tbody><tr><td>Cat</td><td>28%</td></tr><tr><td>Dog</td><td>40%</td></tr><tr><td>Bird</td><td>16%</td></tr><tr><td>Fish</td><td>10%</td></tr><tr><td>Rabbit</td><td>4%</td></tr><tr><td>Other</td><td>2%</td></tr></tbody></table></div>	Pet	Percentage	Cat	28%	Dog	40%	Bird	16%	Fish	10%	Rabbit	4%	Other	2%	A chart which uses ‘pie slices’ to show relative sizes of data. As there are 360° in a circle each section in the pie chart will be a proportion of 360°. The sections of the chart can be recorded in percentages, e.g. half of the pie represented 50% of the data collected													
Pet	Percentage																												
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Line graph	<div><p>Bird Watching</p><table><thead><tr><th>Day</th><th>Number of birds</th></tr></thead><tbody><tr><td>Monday</td><td>5</td></tr><tr><td>Tuesday</td><td>6</td></tr><tr><td>Wednesday</td><td>15</td></tr><tr><td>Thursday</td><td>4</td></tr><tr><td>Friday</td><td>1</td></tr><tr><td>Saturday</td><td>11</td></tr><tr><td>Sunday</td><td>6</td></tr></tbody></table></div>	Day	Number of birds	Monday	5	Tuesday	6	Wednesday	15	Thursday	4	Friday	1	Saturday	11	Sunday	6	A graph that shows information that is connected in some way – such as a change over a period of time.											
Day	Number of birds																												
Monday	5																												
Tuesday	6																												
Wednesday	15																												
Thursday	4																												
Friday	1																												
Saturday	11																												
Sunday	6																												

Stem and leaf diagrams	<div><p>Data set: 11, 12, 13, 14, 18, 23, 24, 27,27,31,34,36,42</p><p>Stem and Leaf Diagram:</p><table><tr><th>Stem</th><th>Leaf</th></tr><tr><td>1</td><td>1 2 3 3 4 8</td></tr><tr><td>2</td><td>3 4 7 7</td></tr><tr><td>3</td><td>1 4 6</td></tr><tr><td>4</td><td>2</td></tr></table><p>Key 1 2 Means 12</p></div>	Stem	Leaf	1	1 2 3 3 4 8	2	3 4 7 7	3	1 4 6	4	2	<p>A table where each data value is split into a “stem” (the leading digit(s)) and “leaves” (usually the last digit)</p> <p>For example, “32” is split into “3” (stem) and “2” (leaf).</p> <p>The “stem” values are listed down, and the “leaf” values are listed next to them.</p>																									
Stem	Leaf																																				
1	1 2 3 3 4 8																																				
2	3 4 7 7																																				
3	1 4 6																																				
4	2																																				
Comparative bar graphs	<div><div><p>Age profile of concert goers</p><table border="1"><caption>Age profile of concert goers (Clustered)</caption><thead><tr><th>Age(years)</th><th>Concert A</th><th>Concert B</th></tr></thead><tbody><tr><td>Under 15</td><td>5200</td><td>2100</td></tr><tr><td>15-18</td><td>1300</td><td>2500</td></tr><tr><td>19-24</td><td>1800</td><td>2200</td></tr><tr><td>Over 24</td><td>1700</td><td>3200</td></tr></tbody></table></div><div><p>Age profile of concert goers</p><table border="1"><caption>Age profile of concert goers (Stacked)</caption><thead><tr><th>Age(years)</th><th>Concert A</th><th>Concert B</th><th>Total</th></tr></thead><tbody><tr><td>Under 15</td><td>5200</td><td>2100</td><td>7300</td></tr><tr><td>15-18</td><td>1300</td><td>2500</td><td>3800</td></tr><tr><td>19-24</td><td>1800</td><td>2200</td><td>4000</td></tr><tr><td>Over 24</td><td>1700</td><td>3200</td><td>4900</td></tr></tbody></table></div></div>	Age(years)	Concert A	Concert B	Under 15	5200	2100	15-18	1300	2500	19-24	1800	2200	Over 24	1700	3200	Age(years)	Concert A	Concert B	Total	Under 15	5200	2100	7300	15-18	1300	2500	3800	19-24	1800	2200	4000	Over 24	1700	3200	4900	<p>A comparative graph is used to compare two (or more) sets of data on the same axis. Bar graphs can either be clustered or stacked.</p>
Age(years)	Concert A	Concert B																																			
Under 15	5200	2100																																			
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Comparative line graphs	<div><p>Tuck shop sales</p><table border="1"><caption>Tuck shop sales</caption><thead><tr><th>Days of the week</th><th>Piece of fruit</th><th>Chocolate bar</th></tr></thead><tbody><tr><td>Monday</td><td>22</td><td>12</td></tr><tr><td>Tuesday</td><td>30</td><td>45</td></tr><tr><td>Wednesday</td><td>42</td><td>32</td></tr><tr><td>Thursday</td><td>35</td><td>30</td></tr><tr><td>Friday</td><td>12</td><td>50</td></tr></tbody></table></div>	Days of the week	Piece of fruit	Chocolate bar	Monday	22	12	Tuesday	30	45	Wednesday	42	32	Thursday	35	30	Friday	12	50	<p>A comparative line graph is used to compare two (or more) sets of data on the same axis.</p>																	
Days of the week	Piece of fruit	Chocolate bar																																			
Monday	22	12																																			
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Histogram	<div><p>Bus wait time</p><table border="1"><caption>Bus wait time</caption><thead><tr><th>Time in Minutes</th><th>Number of passengers</th></tr></thead><tbody><tr><td>0 < x ≤ 5</td><td>4</td></tr><tr><td>5 < x ≤ 10</td><td>10</td></tr><tr><td>10 < x ≤ 15</td><td>24</td></tr><tr><td>15 < x ≤ 20</td><td>20</td></tr><tr><td>20 < x ≤ 25</td><td>6</td></tr></tbody></table></div>	Time in Minutes	Number of passengers	0 < x ≤ 5	4	5 < x ≤ 10	10	10 < x ≤ 15	24	15 < x ≤ 20	20	20 < x ≤ 25	6	<p>A graphical display where continuous data is grouped into intervals such as $0 < x \leq 5$, $5 < x \leq 10$, The frequencies for each interval are then plotted using bars.</p>																							
Time in Minutes	Number of passengers																																				
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