WHAT STUDENTS NEED TO KNOW AND UNDERSTAND ABOUT CHANCE

By Leah O'Neill

Introduction

The following sections contain information about what your students need to understand about chance, what happens when they do not understand, how to recognise this, and what to do about it. Young students will have begun to form their own understandings of chance by the time they come to school. These are based on life experiences and the language and attitudes expressed at home in situations where the outcome is uncertain. These understandings are subjective and sometimes inaccurate.

Study of chance in Mathematics is focussed on helping students to predict how likely it is that an event will occur. Students need to be able to:

1. recognise situations in which there is uncertainty and use the language of chance
2. identify all of the possible events, options or outcomes
3. make judgements about the likelihood of events occurring and order events from the least likely to the most likely
4. make predictions or decisions based on the above

Recognise chance situations and use the language of chance

Through experiences that illustrate the concept of uncertainty, students come to recognise that there are many situations that involve an element of chance.

Common difficulties or misconceptions:

- It may be difficult for young students to recognise and distinguish between events that are subject to chance and those that are certain. They often tend to classify events that are likely as "certain" and those that are unlikely as "impossible" even though something could happen to change the outcome.
  - Events that are certain include those that will happen and those that definitely will not.
  - Impossible events are just as predictable as things that must happen and therefore, neither are affected by chance.
  - Events that are uncertain are the ones that involve chance.

Strategies to help develop understanding:

- Students' use of the language of chance should be clarified, refined and extended. A continuum of everyday terms which describe values of likelihood including: 'possible', 'impossible', 'likely', 'unlikely', 'certain', 'fair', 'not fair', 'always' and 'lucky' should be modelled and practised by students in context.
- When learning the language of chance, particular attention needs to be paid to binary pairs including: possible/impossible and certain/uncertain. These pairs describe different aspects of chance and must, therefore, be discussed separately at first. (Remember that events that are certain to **not** happen are impossible while events that are certain to happen are possible.)

Identify all of the possible events, options or outcomes

Strategies to help develop understanding:

- Listing of all possible events or outcomes identifies the sample space. Ordinary events in students' lives can be used to introduce this concept (e.g. "If you throw this bean bag at the target, what are the things that could happen?")
- More formal activities may include area models, such as spinners, and set models, such as coloured marbles in a bag.
  - Young students will find area models easier to interpret than situations involving set models. For example, students will be able to work out the sample space for a spinner with three different coloured areas more easily than a bag with three different coloured marbles.
  - Spinners with coloured areas that are not joined e.g. the red areas are separated by other colours are more difficult area models to interpret.

Make judgements about the likelihood of events occurring and order events

Common difficulties or misconceptions:

- The language of likelihood may be difficult for young students to understand due to the indistinct nature of these terms. They may not be able to easily distinguish between 'likely', 'highly likely', 'unlikely' and 'impossible'.

Strategies to help develop understanding:

- The language of likelihood can be developed through comparison of two everyday events to examine the relative likelihood of them occurring. These events should have obvious differences in their likelihood. Later more events with more similar likelihoods can be ordered by likelihood.
- Discussion of events that are equally likely to occur can be introduced in situations where there is no particular reason that one event is more likely to happen than another. This concept can be quite difficult to illustrate using a chance experiment as it is unlikely that the results of such experiments will yield data that is even. Usually, large numbers of trials would be needed. Understanding that each trial is independent of the one that went before is necessary to understand why this occurs. That is, each time a spinner with equal areas of red and yellow is spun, there is equally likely a chance of spinning red as there is of spinning yellow so it is entirely possible that nine out of ten spins will be yellow.
- In later years, probability uses numbers to measure the likelihood of events occurring. Events are placed on a scale from 0 (not possible) to 1 (must happen). This should only be introduced after students are able to understand likelihood (more, less or equally likely to occur). This is also true for fractional representations (e.g. "I have a one in five (1/5) chance of spinning red.") Informal discussions and introduction of the language is appropriate in the early years.

Make predictions or decisions based on an understanding of chance

Strategies to help develop understanding:

- Using the understandings they have developed about chance, students begin to be able to make predictions about how likely an event is.
- Once students have made a prediction, they should carry out simple chance experiments, recording and analysing the data. In the early years, ensure that experiments with obvious differences in the likelihood of outcomes are introduced first.
- Through the use of data, students may begin to recognise trends and make predictions or decisions based on them.

WHAT STUDENTS NEED TO KNOW AND UNDERSTAND ABOUT DATA

Introduction

The following sections contain information about what your students need to understand about data, what happens when they do not understand, how to recognise this, and what to do about it.
Young students learn about data as they:

1. Collect and organise data
2. Summarise and present information that will help them to answer questions that are of personal interest.

This information can then be:

3. Interpreted and analysed in order to draw conclusions that explain variations in their data.

Collecting and organising data

Concepts students need to understand:

- Data can be collected or found for the purpose of answering questions. It can be collected through:
  - Primary data collection methods which include counting, measuring, designing and asking questions of others and making observations
  - Secondary data collection methods where data is obtained by accessing the results of others' data collections
- Data needs to be classified or organised in a way that best fits the question to be answered.
- Data can be organised in different ways for different purposes. When data is reorganised into different classifications, it can change the conclusions we make or suggest new questions. Sometimes it may be difficult to make decisions about which category a piece of information fits into. Decisions about ambiguous data need to be made and applied consistently.
- When data is collected, it needs to be accurate and consistent. This can be achieved by ensuring that:
  - What is being observed and recorded is clear to everyone collecting the data.
  - The organisation applied to the data is explicit.
  - If the data is collected over time, it must always be done in the same way.
  - Survey questions are carefully worded so that they elicit responses that are not biased or influenced by them.
- Decisions need to be made about the population size when collecting data.

Strategies to help develop understanding:

- Students need help to identify and clearly articulate the question they want to answer.
- Students need help to organise data in a way that best fits the question to be answered by:
  - Trialling questions or categories to check that they provide relevant information.
  - Anticipating the types of responses or observations that will be collected to ensure that templates used for recording the data are appropriate.
- Students need help to decide on the population of people that their question applies to. If they want to draw conclusions about a very large group or one that would take a very long time to observe (e.g. all children at the school, or the number and types of vehicles that use the road beside the school) they may need to use a sample of the whole population. In this case, students would be making the assumption that what is recorded about the sample group will be representative of the whole population.
- A range of data collection methods should be introduced with attention to methods that will ensure accuracy and consistency.

Summarising and presenting data

When students summarise and present data, they need to take into account the purpose for displaying it and the audience for whom it is intended.

Concepts students need to understand:

- Data can be summarised and/or presented in a number of ways depending on need. These presentations are used to clearly illustrate the data they have gathered and assist with its interpretation. Presentation of data can take the form of diagrams, tables, plots and graphs with varying degrees of detail.
- Data can be summarised to make it easier to show trends or compare results. Young students typically focus on individual pieces of information within the data and may have difficulty seeing the data collection as a whole. Questions that ask them to quantify the numbers within a category or compare categories may be challenging.

Strategies to help develop understanding:

- To summarise and present data, young students use:
  - Lists or tables, beginning with simple recordings of collected data. As they gain experience in recording data, students develop organised lists in which patterns within the data are more visible. Later, students use tables to organise data into clearly defined categories or groups.
  - Picture or bar graphs which develop from:
    (i) A simple arrangement of objects or pictures which are lined up evenly along a baseline in order to compare the number in each category.
    (ii) More sophisticated graphs in which objects are replaced by symbols and recorded in written form. As students' understanding develops, symbols can be used to indicate more than one item or object within the graph.
- Students can be encouraged to make tallies of data within categories and then use numbers to represent the tally in a list or table. By doing this, students come to understand that while detail about individual pieces of data may be lost, a better overall picture is gained.

Interpreting data

When students interpret data, they report on their findings and draw conclusions in response to the question they were investigating.

Common difficulties or misconceptions:

- When young students interpret their own data, it is often difficult for them to see the data as separate from their own personal knowledge and may be influenced by experiences and/or personal preferences.

Strategies to help develop understanding:

- When young students interpret their own data, they should be encouraged to comment only on what the data tells them. They will begin by simply reporting the results of their data collections. As they become more experienced, students should be encouraged to:
  - Make comparisons between the categories in their data using numerical terms
  - Combine information to make general statements about trends
  - Make inferences based on the information they have gathered
- To assist students to separate personal knowledge from the data, experience in interpreting secondary data (data from other sources) is helpful. Students will need assistance to develop:
  - The ability to comprehend what the list, table or graph is describing
  - The reading techniques required to comprehend displays of data. For instance, tables and other data displays need to be read flexibly rather than from left to right as in a story book.
  - An understanding of the conventions used when displaying data. This includes, understanding how the cells within a table are organised and labelled and how to tell what the two axes on a graph refer to.
- Students should be helped to evaluate the quality of the data, its organisation and the way in which it is displayed.