How Risky is Life?
Lesson 1: Perceptions of Risk

Australian Curriculum: Mathematics (Year 9 and 10)

ACMNA208: Solve problems involving direct proportion. (Year 9)

ACMSP226: Calculate relative frequencies from given or collected data to estimate probabilities of events involving 'and' or 'or' (Year 9)

Lesson abstract

Students consider how statistical representations (such as a description of a typical Australian) can be considered as mathematical models of reality. They begin to build other such models through discussion of dangers that may worry them, and they analyse risk as a combination of probability of occurrence and hazard. They then focus on potentially fatal hazards, and rank the causes of unexpected death, estimating numbers of Australians who will die in a year from each cause. They express the number of people in various ways in proportion to the population.

Mathematical purpose (for students)

There are two dimensions of risk: probability of occurrence and the extent of the hazard.

Mathematical purpose (for teachers)

Statistics and probability have important roles to play in developing mathematical models that can provide insight into real contexts. Probabilities and statistical measures and their representations can be considered as the mathematical models that can provide insight into the complexity of the real world.

Students learn that risk has two dimensions: probability and 'hazard' (the seriousness of the event), and express probabilities in the most accessible form – as numbers in a population. The aim is to elicit students' prior perceptions of the risks in everyday life to be compared with reality in the next lesson. This involves thinking in orders of magnitude, and handling large and/or very small numbers.

Lesson Length: 45 minutes approximately

Vocabulary Encountered

- risk
- hazard
- order of magnitude

Lesson Materials

- Slide show *ST7_Risk_1a_Perception_Of_Risk.pptx*
- Student Sheet 1 - Some Causes of Unexpected Death (one per group)
- Enlarged copy of Student Sheet 1 to make cards for class display, with 'washing line' and pegs (optional)
- Poster materials - paper, pens, glue, scissors etc.

We value your feedback after these lessons via https://www.surveymonkey.com/r/J8GPD7Z

Mathematics by Inquiry is an initiative of, and funded by, the Australian Government Department of Education and Training

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Lesson structure

- Descriptive modelling (Whole-class discussion – 10 minutes)
- Brainstorming risks (Collaborative small-group work – 5-10 minutes)
- Comparing different risks of life or death (Collaborative small-group work - 15 minutes)
- Sharing perceptions (Whole-class discussion - 10 minutes)

Descriptive Modelling

Show the slide: ***The typical Australian***.

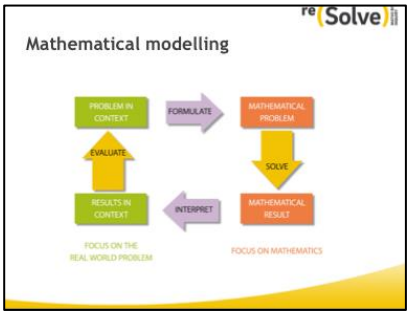
First, students have a brief opportunity to think about how the use of data and derived statistics relate to mathematical modelling. The intention is not to go into detail, but rather to emphasise that a lot of detailed data about all Australian citizens has been condensed into some summary measures that give an idea of a 'typical' Australian. However, in reality, there is no such person. The 'typical' Australian is a mathematical model of data!

Present students with some summary data from the Australian Bureau of Statistics (link on slide - http://abs.gov.au/websitedbs/D3310114.nsf/home/2016+Census+National). It was derived from the 2016 census. Ask students, working in pairs, to think about how the "typical" Australian was determined, including:

- What data does the census collect?
- How would census data be used to find the 'typical' age?
- Which average might it be best to use for age? (ANS: possibly median)
- What does it mean to say that the 'typical' Australian is a female? What average (mean, mode, median) is best to use for this? (ANS: possibly mode)

Extending prompt

- How is it possible that the typical Australia was only one year younger (37) ten years ago?



Use the slide **Mathematical modelling** to discuss how the modelling process relates to the use of mathematics to find statistical measures (and representations) such as those used in finding the 'typical' Australian.

Indicate that in this case the problem context is the diversity of the characteristics of Australians including factors such as their gender, age, where they were born, their parents' ancestry and so on.

Statistical measures, such as averages, range, standard deviation etc. are calculated to give some measure of typicality.

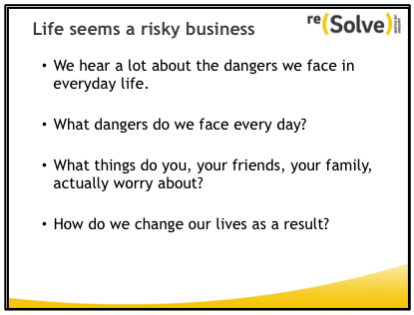
Explain that in this unit students will develop mathematical models to give insight into 'How risky is life?'. As we move through the unit we will see in more detail how our work fits the modelling process.

The overall challenge for the unit is to develop a poster to answer the question 'How risky is life?'. This task is introduced to students in later lessons of the unit: they may complete it at home or in class in a final lesson.

The rest of this lesson is spent thinking about the problem context - risks in life.

Brainstorming Risks

Students start by discussing the wide range of risks that they, their friends and family worry about – and how awareness of risk changes their lives.



Show the slide **Life seems a risky business**

Allocate students to groups of 3 or 4 students to consider these questions and to list their 'worries' in workbooks.

Collecting and sharing ideas

Collect ideas from the class and, with discussion, list the dangers on the board under three columns headed 'Serious', 'Very serious', 'Life or death'.
(Now or later, separate the two aspects of risk – (i) the probability of something happening, and (ii) the 'hazard' (how serious it is if it happens).

Expected responses

If students' ideas lack variety, show the slide **Press clippings** to stimulate discussion.

The slide **Examples of Worries** are typical products of a lively discussion. Show this slide if you think the class needs to broaden the range of dangers they are considering.

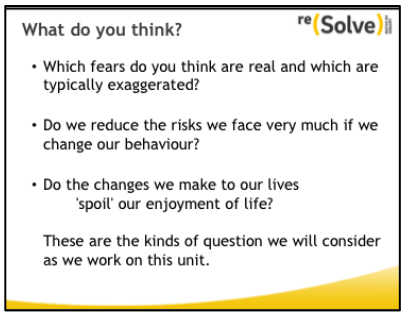
How does risk influence our lives?

Have students to write down some ways in which fear (or knowledge of risk) affects people's everyday lives. Collect class responses and organise them as far as possible under major dangers (e.g. road accidents, health) and students' suggested responses to these dangers, as illustrated below.

Dangers	Responses to danger
Road accidents	I'm not allowed to ride a bike to school. We must wear bike helmets.
Assault	My parents won't let me go to many places on my own. My gran is afraid of being mugged so she won't go out.
Diseases	My dad is giving up smoking. People must practise 'safe sex'. We must 'cover up' in the sun. We have to eat fresh vegetables instead of junk food. My mum goes to the gym once a week.
Drowning	We learn to swim so that we are less likely to drown. We swim between the flags.
Terrorism	My uncle refuses to fly anywhere. We didn't dare go into the city after the terrorist attack.

Conclude this part of the lesson using the questions on the slide **What do you think?** to stimulate a brief discussion about how we tend to behave in response to different risks we experience in our lives. The two aspects of risk (probability of happening and the hazard) may naturally arise.

Explain that in this unit we will use mathematics to gain a better understanding of how we perhaps should react to various fears that we may have.



Ranking different risks of death

Risk is a huge subject. Therefore, this section narrows the focus to unexpected 'life or death' risks so that the 'hazard' being considered is always the same. We will only consider risks of *death from unnatural causes* (i.e. not illness or old age).

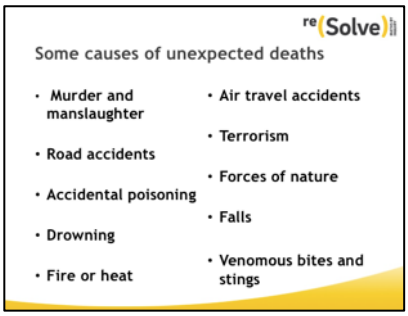
Start by explaining that risk has two aspects:

- Probability: How likely is it to happen? *Missing a bus is more likely than being struck by lightning*
- Hazard: How bad is it if it does? *Missing a bus is much less serious.*

Note how the lists of students' worries were classified by hazard (serious – very serious – life or death).

In this unit, we will be focusing on the worst kind of hazard: unexpected death from 'unnatural causes' and compare the risks.

Show slide: **Some causes of unexpected deaths** and give each group Student Sheet 1 - Some Causes of Unexpected Death, poster paper, scissors and glue. Students cut the sheet into cards that can be sorted.



Ask groups to sort the cards with the most common cause of unexpected death at the top and the least common at the bottom. They can use the extra blank cards to write in other important causes they may think of.

Students now make rough estimates of how big each risk is. Ask groups to write on each card their rough estimate of the number of people in Australia who die each year from that cause. Emphasise that only very rough estimates are expected. We are mainly interested in estimating the order of magnitude of the various risks (1 in 10 or 1 on 100 or 1 in 1000 etc.).

When the students in a group have agreed on the order and estimated the numbers, they should paste the cards down the centre of the poster, and get ready to justify their estimates.

Enabling prompts

- Have any of these ever happened to someone you know, or someone you have heard of?
- The total number of people in Australia is about 25 million.
- Remember to estimate deaths in just one average year – not when something unusual happens.
- Would this happen to one person in 100 in an average year? One in 1000? One in a million? You do not have to be exact.

Order of magnitude (optional)

You may like to introduce the terminology 'order of magnitude' –a semi-quantitative measure where numbers within a factor of 10 (usually) are *the same order of magnitude*. So 31 and 76 are the same order of magnitude; 544 is in the hundreds so much larger and we say it is of a different order of magnitude, and 8317 is another order of magnitude higher again. Order of magnitude is NOT calculated precisely.

Sharing Perceptions

Bring students' thinking together by asking them to present their rankings and estimated numbers of people dying each year. This may be done as a normal class discussion or, in a livelier way, using large versions of the cards (you can make these by enlarging the cards on student sheet and using a 'washing line' across the room/board. Ask one group to peg the cards in order on the line. Successive groups can then modify this order, explaining why they think their order is preferable.

In either of these modes, the discussion focuses on comparing the estimates of risks by the groups.

Enabling prompts

- You say that the number of people dying because of a plane crash is greater than that of dying in a road accident. Why is that? Is it because more people die when it does happen?
  Which is greater: the risk of dying if you are in a plane crash OR the risk of dying if you are in a car crash? (ANS: the plane crash).
  Which is greater: the risk of being in a plane crash of any sort or the risk of being in a car crash of any sort? (ANS: the car crash)
- You say that the number of people being murdered is greater than the number dying from an accidental fall. Why is that? Is it because there is more murder reported in the newspapers?

Ask students to calculate the *proportions* of the total population that die from each cause, according to their estimates.

Extending prompts

- How would you calculate 50 people as a proportion of the total Australian population?
  Is that more or less than one in a million?
  - There are about 25 million people in Australia. One in a million would be 25 people. So 50 people would be 2 in a million.
  - Alternatively, 25,000,000 ÷ 50 = 500,000. So it's one person in 500,000 each year.
  - 50 people in Australia as a percent is (50 ÷ 25000000) x 100% =0.0002%

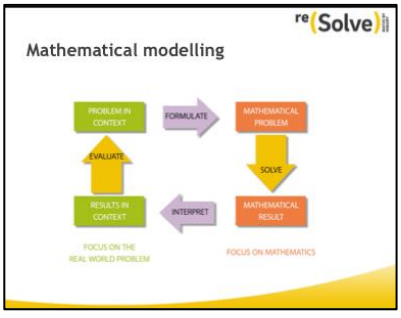
Suggest that looking at the spread of views on the different risks need to learn more about the facts and that we'll move to that in the next lesson.

You may want to end this section of the lesson on a reassuring note by telling students that in the next lesson we will probably find that life is a lot less risky than they may think.

Data-driven modelling

Return briefly to relate the work to processes of mathematical modelling as set out in the modelling diagram.

Show the slide Mathematical modelling and point out that we have **defined** a problem context of interest (risk of human activities) and **simplified** it by focusing on a specific set of risks – deaths from unnatural causes. We have begun to **formulate** the model mathematically – identifying possible causes and their occurrence as variables, and estimating numbers.



For next lesson, ask students to gather newspaper clippings or screenshots of news stories that refer to risks that are currently topical.

Some Unexpected Causes of Death

Murder and Manslaughter	**Air travel accidents**
Road accidents	**Terrorism**
Accidental poisoning	**Forces of nature** (Storms etc.)
Drowning	**Falls**
Fire or heat	**Venomous bites and stings**

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