

Unit Overview: How Risky is Life?

Summary of learning goals

This unit provides insight into something that affects, and can impoverish, people's lives, liberties and happiness - the mismatch between real and perceived risk. Students explore the risks of dying unexpectedly from various causes. They start from their own fears and, by comparing them with Australian Bureau of Statistics data, they recognize that these are often unfounded and sometimes driven by the media. Students learn how to calculate the risks involved for various activities and how these are related to the base risk of death for people of different ages and genders. The emphasis is on order-of-magnitude comparisons, reflecting the various kinds of variation in risk level between individuals and over time.

In working through this unit students will see how mathematical modelling is applied to understand a data-driven context such as risk. They will learn to:

- **Define** a problem situation of interest (in this case, risk).
- Focus down to some specific questions (initially, risks of death from unnatural causes).
- **Formulate** the questions in precise mathematical and statistical terms.
- **Solve** (answer the questions) by collecting appropriate data, then represent it in ways that help reveal its meaning.
- **Interpret** data, drawing inferences about the questions of interest.
- **Evaluate** and critique the approach, the data and the inferences, and consider whether more detailed questions should be asked (in this case, about age and gender).
- **Communicate** their reasoning clearly.

Throughout, the goals are to develop students' ability to work and think independently, and to learn that:

- Life is risky but, in our society, not very risky.
- Mathematical thinking is essential for getting risks in perspective, as a first lesson in accepting that small risks are an inevitable part of life - and that it is orders of magnitude, rather than precise numbers, that are significant.

Australian Curriculum: Mathematics (Years 9 and 10)

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

ACMNA210: Express numbers in scientific notation (Year 9)

ACMSP283: Compare data displays using mean, median and range to describe and interpret numerical data sets in terms of location (centre) and spread (Year 9)

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

ACMSP228: Identify everyday questions and issues involving at least one numerical and at least one categorical variable, and collect data directly and from secondary sources (Year 9)

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ACMSP228: Identify everyday questions and issues involving at least one numerical and at least one categorical variable, and collect data directly and from secondary sources (Year 9)

ACMSP252: Investigate and describe bivariate numerical data where the independent variable is time. (Year 10)

ACMSP253: Evaluate statistical reports in the media and other places by linking claims to displays, statistics and representative data. (Year 10)

Summary of lessons

Who is this unit for?

This unit is for students who have some knowledge of proportional reasoning, probability and reading charts and tables. All these skills can be further developed and stretched in the unit by working with the life statistics provided. The life and death context illustrates mathematical and statistical concepts vividly, assisting students to develop a more firmly grounded capacity to interpret probabilities and evaluate statistical claims.

It is preferable that students have learned about the purpose and phases of mathematical modelling before embarking on this unit, by having studied at least one reSolve *Mathematical Modelling* unit or the lesson *ST7_Modelling_QuickStartLesson.pdf* packaged with this unit. However, with only slight adjustment, this unit can also be taught without the explicit focus on mathematical modelling.

Lesson 1: Perceptions of risk

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 worry them, and they analyse risk as a combination of probability of occurrence and hazard (the seriousness of the event). 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.

Lesson 2: Sudden death - the data

Students are given the official numbers of people who died in 2015 from selected ‘unnatural’ causes. They compare them with their perceptions, going on to calculate the risk of dying from these causes in various ways numerically and represent them visually. It emerges that unexpected deaths are very unlikely in Australia.

Lesson 3: The bigger picture

This lesson focuses on the ‘base’ probability of dying in a year, the total risk of death broken down only by age and gender. This is dominated by illness-related deaths, which are strongly age-dependent. The overall picture is built up from further data on various causes of death in various age bands. Students read and interpret graphs and tables, and express risk in multiple ways (probability, proportion, percent). They use data to evaluate statements.

Lesson 4: Phoney figures?

This lesson first relates the analysis from previous lessons to the modelling process and diagram. Students then move on to a series of exercises in critiquing the interpretation and evaluation of data, done mainly in think-pair-share groups. The aim is to practise looking at data sensibly, seeing the story presented in a direct reading of the data but then looking through it make more sophisticated interpretations.

Lesson 5: How risky for me?

This lesson explores variation and prediction. Students use a computer simulation to explore the random variation that may be expected in the data, getting a feel for whether reported changes (e.g. in number of drownings) are significant, or likely to have happened by chance. The unit closes by reflecting on the extent to which overall probabilities apply to individuals. Finally, students summarise their mathematical understanding of risk on a poster.

Reflection on this sequence

Rationale

This unit demonstrates mathematical and statistical modelling in a data-driven context. It introduces concepts of descriptive modelling, with a focus on the analysis and interpretation of data and evaluation of the inferences drawn from it. By modelling the risk of dying in the coming year and interpreting the relative probability of various causes of death - unnatural and natural - students learn about the limits and dangers of anecdotes and impressions, the attributes of reliable data, and expected degrees of random variation.

They go through the steps of the modelling cycle. First identifying that perceptions of risk and real risk may not be the same, and that the differences need to be investigated. They use reliable data from the Australian Bureau of Statistics to examine deaths from accidental causes, and in subsequent modelling cycles, this model of risk in life is improved to include all causes of death and how the risks relate to age and gender. There is a strong emphasis on sensible interpretation of probabilities, and of sensibly drawing inferences from data, consistent with the mathematical modelling emphasis on the way that mathematics can help to answer questions that really relate to people's lives. As a final product, students prepare a poster setting out clearly the mathematics behind why they should 'take the risk' of engaging in a pleasurable or worthwhile activity that they may initially have believed to be unacceptably risky.

The central idea is that mathematics provides an important way to understand the world and make decisions: it is a purposeful activity.

reSolve Mathematics is Purposeful

Problem Solving: Students undertake descriptive modelling in a data-driven context to answer questions about risk. The modelling includes simplifying the questions, formulating them mathematically, selecting data, representing and drawing inferences from it, critiquing such inferences (including by testing with a simulation), and reporting on the reasoning involved.

Reasoning: Students create arguments about probabilities and risks (distinguishing hazard from probability), evaluate media reports and use statistical knowledge to clarify situations. They read and 'read through' data displays to avoid simplistic interpretations. They use clear definitions for data collection and in arguments.

Fluency: Students express proportions and probabilities in multiple ways and read various data displays.

Understanding: Students gain practical understanding of the size of large and small numbers (populations, probabilities). They learn to use simulation to test whether reported effects are likely to indicate a real change or random fluctuations in an unchanged situation.

reSolve Tasks are Inclusive and Challenging

The work can be undertaken at various levels. At the lower level, students can concentrate on expressing proportions and probabilities in various ways and reading the straightforward aspects of the provided data. At a higher level, students can undertake sophisticated investigations into the definition of data categories, put data together to test hypotheses that explain the observed effects, and test by simulation whether conclusions are likely to be real or random effects.

reSolve Classrooms Have a Knowledge Building Culture

Students can work collaboratively through the steps of the modelling cycles as they investigate evidence about questions of immediate relevance to their lives. Students can contribute their different life experiences.

References

Australian Government Actuary, *Australian Life Tables*

http://www.aga.gov.au/publications/#life_tables

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abs.gov.au/websitedbs/D3310114.nsf/home/2016+Census+National

Australian Bureau of Statistics, *Causes of Death, Australia, 2015*

<http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/3303.0-2015-Main%20Features-Australia's%20leading%20causes%20of%20death,%202015-3>