CURRICULUM LEVEL 5 STATISTICAL INFERENCE

Teacher guide.

Resources to support statistical thinking and report writing. Featuring two road safety contexts: *How far until it stops?* and *Driven to distraction!*

RESOURCES AND ROAD SAFETY CONTEXTS

Statistical enquiry tasks	Datasets	Teaching resources
How far until it stops? Context: vehicle stopping distances in wet and dry conditions and at different speeds. Download task ***Driven to distraction!*** Context: driver distraction and driver fatigue. Download task Note: Direct links in this guide go to associated files on the Education Portal. However, if you have downloaded the CL 5 bundle you already have all these files. Download the complete Curriculum Level 5 bundle here: Mathematics and Statistics (Education Portal)	***How far until it stops?*** 3 continuous and 2 categorical variables with 60 records. Download csv file ***Driven to distraction!*** 3 continuous and 2 categorical variables with 60 records. Download csv file	• How far until it stops? Activity 1 Understanding the context and variables ppt • How far until it stops? Activity 4A Writing analysis statements ppt • How far until it stops? Activity 5A Writing a Conclusion ppt • Driven to distraction! Activity 1 Understanding the context and variables ppt • Driven to distraction! Activity 2A Writing questions ppt • Driven to distraction! Activity 4A Writing analysis statements ppt • HookED SOLO Hexagons Stopping Distances • HookED SOLOHexagons distraction and fatigue

THE NEW ZEALAND CURRICULUM CONNECTIONS

Mathematics and Statistics Achievement Objective at Level 5

In a range of meaningful contexts, students will be engaged in thinking mathematically and statistically. They will solve problems and model situations that require them to:

Plan and conduct surveys and experiments using the statistical enquiry cycle:

- determining appropriate variables and measures
- considering sources of variation
- gathering and cleaning data
- using multiple displays, and re-categorising data to find patterns, variations, relationships, and trends in multivariate data sets
- comparing sample distributions visually, using measures of centre, spread, and proportion
- presenting a report of findings.

(Highlighted statements are the ones covered by these resources)

Key Competencies

The following key competencies are foregrounded:

Participating and contributing

This competency is about being actively involved in communities. Communities include family, whānau, and school and those based, for example, on a common interest or culture. They may be drawn together for purposes such as learning, work, celebration, or recreation. They may be local, national, or global. This competency includes a capacity to contribute appropriately as a group member, to make connections with others, and to create opportunities for others in the group.

Students who participate and contribute in communities have a sense of belonging and the confidence to participate within new contexts. They understand the importance of balancing rights, roles, and responsibilities and of contributing to the quality and sustainability of social, cultural, physical, and economic environments.

Using language, symbols, and texts

Using language, symbols, and texts is about working with and making meaning of the codes in which knowledge is expressed. Languages and symbols are systems for representing and communicating information, experiences, and ideas. People use languages and symbols to

produce texts of all kinds: written, oral/aural, and visual; informative and imaginative; informal and formal; mathematical, scientific, and technological.

Students who are competent users of language, symbols, and texts can interpret and use words, number, images, movement, metaphor, and technologies in a range of contexts. They recognise how choices of language, symbol, or text affect people's understanding and the ways in which they respond to communications. They confidently use ICT (including, where appropriate, assistive technologies) to access and provide information and to communicate with others.

Principles and Values

This unit focuses on students being informed decision makers and effective communicators for their communities.

The following principle and values are foregrounded:

Community engagement

The curriculum has meaning for students, connects with their wider lives, and engages the support of their families, whānau, and communities.

Innovation, inquiry, and curiosity by thinking critically, creatively, and reflectively.

Equity through fairness and social justice.

Community and participation for the common good.

Respect themselves, others, and human rights.

ROAD SAFETY EDUCATION AS A CONTEXT FOR STATISTICS

Our choice of contexts in Statistics teaching can increase student engagement and activate prior knowledge. It helps to develop students' statistical thinking as they connect what they see in their analysis with their knowledge of the context. There is potential to develop citizenship skills and social competencies.

> *"...opportunities to explore authentic applications that arise out of real-life contexts can have a significant and sustained impact on student knowledge, attitude, self-esteem, independence, and confidence."* (Alton-Lee, 2003)

Young drivers (aged 16-24) are over-represented in crashes in New Zealand. This is due to various factors, but a major contribution is lack of experience. At a time when students are about to become young drivers, or passengers of young drivers, these resources explore important topics. While supporting students to develop their skills in carrying out a statistical enquiry and reporting writing, the students will also develop competencies for citizenship and wellbeing outside of the classroom in a road safety context.

Why do this? Road safety education as a context for Statistics in Year 10:

- is relevant to students as they and their peers are getting closer to learning to drive
- is an accessible and engaging context
- Develops citizenship skills as students consider their role in a wider community
- Foregrounds the key competency of *Participating and Contributing*
- Helps them make sense for themselves about their world
- Empowers them to make decisions using evidence
- Builds social competencies
- Has potential for cross-curricular themes using NZTA's Education Portal secondary curriculum resources available in a range of learning areas
- Supports whanaungatanga – Build relationships with your students by showing them that you care about what happens to them outside of the classroom
- Is important as young drivers in NZ are over-represented in death and serious injury crashes.

A note of caution on the context for teachers

Teachers should be aware that these resources on stopping distances, driver distraction, and driver fatigue might lead to discussion of road crashes or road trauma, although this is not the intended focus of these resources. Students may have first-hand experience of such issues and teachers should be discreet during discussions.

GUIDING PRINCIPLES FOR THE DESIGN OF THESE RESOURCES

There are two guiding principles underpinning the design of these resources.

1. **Resources fully align to the New Zealand Curriculum and support students to progress on to NCEA standards in statistical inference**

These resources are designed to be used by Mathematics and Statistics teachers with their subject classes to support the development of statistical thinking and report writing for statistical inference at Curriculum Level 5 in a meaningful context. They are not intended to be 'something extra' the teacher is expected to do.

2. **Resources fully align to the Waka Kotahi NZ Transport Agency Good Practice in Road Safety Education guidance**

These resources align to evidence-based, effective road safety education strategies. These are outlined in the research summary available here: https://education.nzta.govt.nz/guidelines-and-research/

Importantly, these resources are designed to empower students by developing their knowledge and competencies in road safety through the Statistics curriculum. All resources avoid the use of fear tactics. Fear tactics are ineffective and, at times, have negative unintended consequences by promoting the behaviour the intervention was designed to reduce.

USEFUL BACKGROUND READING

Driver fatigue and distraction

Resource type	Driver distraction	Driver fatigue
DRIVE drive.govt.nz	The dangers of distraction unit	Feeling tired? unit
Infographics	Distraction infographic	Fatigue infographic
Waka Kotahi driver education resources	Driver distraction website	Driver fatigue website

Following distances and the 2-second and 4-second rules

Following distances module on Drive.govt.nz

Young drivers in New Zealand

Overview of young drivers crash statistics

https://www.transport.govt.nz/mot-resources/new-road-safety-resources/young-drivers/

Young driver crash report

https://www.transport.govt.nz/assets/Uploads/Research/Documents/31ad77c71e/young-drivers-2017.pdf

Statistics education

Telling Data Stories: Essential Dialogues for Comparative Reasoning

By Chris Wild, Matt Regan, Maxine Pfannkuch, N. Horton

https://new.censusatschool.org.nz/resource/telling-data-stories-essential-dialogues-for-comparative-reasoning/

Census at School New Zealand website

https://new.censusatschool.org.nz/

TEACHING ACTIVITIES

The two statistical enquiry tasks and their datasets have been created to scaffold report writing for statistical inference at Curriculum Level 5. They can be adapted to suit the teacher and students. A sequence of lesson activities is suggested to support students to write their report. These resources could also be used to scaffold statistical report writing at NCEA Level 1.

It assumes that the statistical concepts have been previously taught. However, the context and resources can be freely adapted to design teaching activities to develop the statistical concepts at this and other levels.

1. Understanding the context

Taking time to work through the context with students supports them to complete statistical investigations by:

- Removing barriers created by the context. Students should be familiar with the context without having to carry out any research. As a class, students will collectively have the background knowledge for these contexts.
- Increasing statistical thinking in the PPDAC process by allowing students to connect their analysis to the context in a meaningful way.
- Providing an authentic learning opportunity as they experience the process a statistician would undergo to understand the context before defining the Problem and Plan (Pfannkuch & Wild, 2000).

Activities 1A and 1B give suggestions for various activities that can be used with students to understand the wider context and variables, and notes for teachers on common misconceptions with the context and variables.

These PowerPoints can be used to go through the context with students:.

- How far until it stops? Activity 1 Understanding the context and variables ppt
- Driven to distraction! Activity 1 Understanding the context and variables ppt

Activity 1A - Brainstorming the context

Students' prior knowledge can be activated on the context using:

- Think-pair-share
- Whole class brainstorm
- Post it notes or SOLO hexagons (How far until it stops? hexagons and Driven to distraction! hexagons) so that ideas can be moved around to make connections.
- Online sticky notes or other collaborative tool, such as Padlet (https://padlet.com/)

The following questions could be used for each context to guide discussion:

How far until it stops?	*Driven to distraction!*
• What do you think affects the stopping distance of vehicles? • Which of these factors are related to the driver, the vehicle, the conditions? • What are the 2-second and 4-second rules? Why are they useful for drivers?	• What do you think the biggest distractions to drivers are? • How does this list compare to the top distractions identified in NZTA's resources? • How do you think tiredness affects your ability to carry out a task (reaction time, accuracy, speed)? • How well do you think you can multitask?

Notes for teachers: *Driven to distraction!*

There are a number of simple activities to dispel the myth of multi-tasking. The links below describe some examples that could be carried out with students:

https://www.weareteachers.com/stop-multitasking/

https://www.weareteachers.com/proving-the-myth-of-multitasking-with-a-simple-experiment/

https://davecrenshaw.com/myth-of-multitasking-exercise/

Activity 1B - Understanding the variables

Now that students understand the wider context it is important to understand the definitions of the variables. As there are only five variables in each context (three continuous and two categorical) it is worth unpacking all of them for the task being done.

Suggested activities for understanding the continuous variables:

How far until it stops?	*Driven to distraction!*
• Draw a diagram which shows the three continuous variables: reaction distance, braking distance, total stopping distance, and be prepared to explain it to another person. • Students could add in the factors affecting reaction distance (e.g. distractions) and braking distance	• Use the links provided in the task to experience the online reaction time test and the typing test. Reaction times: http://www.bbc.co.uk/science/humanbody/sleep/sheep/reaction_version5.swf (requires Flash)

(e.g. condition of the tyres). **Note for teachers**: reaction distance can be readily confused with reaction time and (although connected) students need to be clear before they start this task on the distinction.	https://www.humanbenchmark.com/tests/reactiontime Typing test: http://10fastfingers.com/typing-test/english

A discussion on the categorical variables including their definitions and their limitations can be useful too.

Notes for teachers on the categorical variables:

How far until it stops?	*Driven to distraction!*
The Conditions (wet/dry) variable is the road surface. A common misunderstanding is this means that it is raining (wet) or not raining (dry). This can lead to interesting discussions and higher level thinking about what these results mean for real world driving conditions and how the data would be expected to change if it was raining.	The Texting variable (Text/NotText) is whether or not the student is reading a text message (not typing one). The Tiredness variable (Tired/NotTired) is a self-assessment by students. Students can discuss the limitation of this measurement.

The enquiry task

Once students have gone through activities to understand the context they can write some notes on the context in the Problem section of the task. They are given a number of prompt questions to focus their notes. There is a chance for them to write down any unanswered questions they have about the context. At this stage students are also asked to define the population.

2. Problem

Once students have unpacked the context and variables, they will need to write a question.

One approach is to let students explore the dataset informally using statistical software before they decide on the focus for their enquiry. This will allow them to test out their understanding of variables and their hypotheses before going further.

Activity 2A - Developing question writing

To develop question writing it is useful to have students critique questions against criteria.

Example of a good investigative question:

Do the travel times for students who travel to school by bus from Waiwhetu College in 2020 tend to be longer than the travel times for students who walk to school from Waiwhetu College in 2020?

This question, which is an example given in their investigative task, or any other can be used to unpack the features of a good multivariate investigation question at this level. This can be used to develop criteria for writing and checking questions.

The general structure of the question is given in the investigative tasks as:

Do the **continuous variable** for **group 1** from the **population** tend to be **further/faster/smaller (etc)** than the **continuous variable** for **group 2** from the **population**?

The suggested criteria are:

- is about the population (population is given twice in the question)
- continuous variable identified
- groups identified
- tendency is included
- direction is included
- can be answered with the data available
- follows the general structure of a question at this level.

This PowerPoint goes through some sample questions for *Driven to distraction!* Students can use the criteria provided to critique the question before suggesting what could be improved. They are then encouraged to write their own question and swap with a peer to critique.

- Driven to distraction! CL5 Activity 2A Writing questions ppt

This PowerPoint can be adapted to include examples of typical question errors made by your students.

The enquiry task

Once they have gone through this activity, in the task students are asked to write two questions and to self-assess the questions against the criteria before the teacher checks them. Peer assessment could also be used. Students then select an approved question for their enquiry.

3. Plan and Data

Students are provided with a random sample of 60 for each task. The original dataset has 120 if you want them to have a different sample size or to have different samples to work with. The original dataset can be downloaded from the Education Portal Mathematics and Statistics page.

A useful revision video on sampling methods from Dr Nic's Maths and Stats Youtube channel:

https://www.youtube.com/watch?v=be9e-Q-jC-0

4. Analysis

After using software to produce the distributions and summary statistics, students identify key comparative features of the distributions to discuss in context. Comments should include numerical values and units.

Students are encouraged to discuss the following features of the distributions: shape, overlap, shift, spread, middle 50%, unusual or interesting features. Students should aim to write at least three comparative comments.

There are various mnemonics that have been developed to support students with their writing of analysis statements. OESM is one of these and this video from Dr Nic's Maths and Stats YouTube channel takes students through writing analysis statements:

https://www.youtube.com/watch?v=L-ur3pRYKFk

Other writing frameworks can be found on the Census at School New Zealand website.

Activity 4A - Analysing distributions

The PowerPoints for the tasks *How far until it stops?* and *Driven to distraction!* encourage students to look at the distributions as a whole, note the features of interest, and connect these features to the context:

- How far until it stops? CL5 Activity 4A Writing analysis statements ppt
- Driven to distraction! CL5 Activity 4A Writing analysis statements ppt

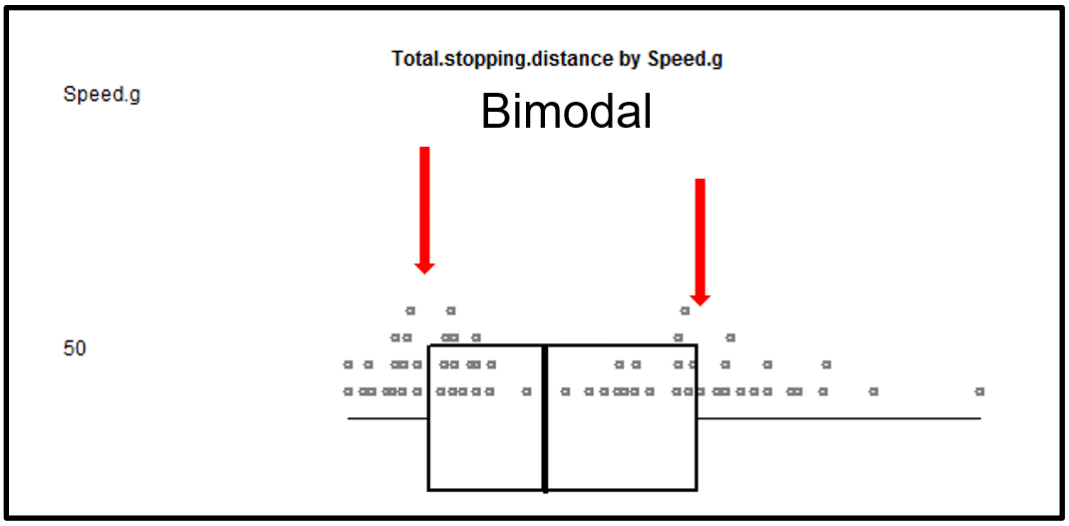
This could be done as a whole class brainstorm to model identifying important features in sample distributions.

Students are scaffolded through writing analysis statements based on the brainstorm of features they notice, with prompts that ask them to add in statistical terms, groups, the variable, and evidence.

While the focus of this activity is on analysing the distributions of samples, students could be asked to write the question to accompany the graphs they have been given. They could also be asked to write up some of their analysis statements based on the framework or structure previously provided to them in class.

Notes for teachers

1. Students noticing features like groups/clusters/bimodal distribution should be asked to explain why this might be given what they know about the context. They should be encouraged to consider the other categorical variables and whether this might explain what they see. For example, in the distribution below, for total stopping distances of vehicles with an initial speed of 50 km/h, the graph is bimodal. This can be attributed to the two road surfaces: Wet and Dry.



Students could be prompted to:

- Justify based on contextual knowledge which modal group is likely to be the dry road surfaces and which is the wet road surfaces.
- Explain how they would test their hypothesis (this might include looking at the raw data or colour coding by the road conditions categorical variable in software)
- Compare the distributions being analysed by their peers in the class to see if those analysing the total stopping distances by conditions see a difference.

2. In the *How far until it stops?* dataset the variable of initial speed (40 km/h and 50 km/h) needs to be converted to a categorical variable when using iNZight.

The enquiry task

Students are encouraged to start by identifying the key features they can see in the graphs and then add in statistical language, groups, the variable, and evidence. Students are provided with useful descriptive and comparative words to help them write their analysis statements.

5. Conclusion

In this section students answer their investigative question, make an inference about the population, justify it with evidence from the sample, and reflect on the context and process.

These resources for Curriculum Level 5 use the *¾-½ rule* for making the call. The making the call rules and the curriculum progression are described further in the Guidelines for "How to Make the Call".

Activity 5A - Conclusion

The PowerPoint for the task *How far until it stops*? shows students examples of making the call and prompts them to justify their inference based on what they see in the sample distributions. Reflection questions on the context and enquiry process are given.

- How far until it stops? Activity 5A Writing a Conclusion ppt

Responses for the reflection questions are not included in this PowerPoint. A whole class brainstorm could be used and then students could select 2-3 questions to write about in their Conclusion section.

Many of the reflection questions on the process and context are also relevant for the task *Driven to distraction!*

The enquiry task

Students are prompted to justify their inference. They are provided with a list of reflection questions to choose from to demonstrate their statistical and contextual knowledge.

REFERENCES

Alton-Lee, A. (2003). *Quality teaching for diverse students in schooling: Best evidence synthesis*. Wellington: Ministry of Education.

Pfannkuch, M., & Wild, C. (2000). Statistical thinking and statistical practice: Themes gleaned from professional statisticians. *Statistical Science*, 15(2), 132–152.