NCEA Level 2 statistical inference (AS91264): teacher guide

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

Statistical enquiry tasks

How far until it stops?

Context: vehicle stopping distances in wet and dry conditions and at different speeds.

Dataset: 3 continuous and 2 categorical variables with 60 records.

PowerPoints:

Activity 1 understanding the context

Activity 4A writing analysis statements

Activity 5A writing conclusions

Driven to distraction!

Context: driver distraction and driver fatigue.

Dataset: 3 continuous and 2 categorical variables with 60 records.

PowerPoints:

Activity 2A writing questions

Additional resources

HookED SOLO Hexagons stopping distances

HookED SOLO Hexagons distraction and fatigue

Lotus diagram template

Curriculum connections

Mathematics and Statistics Achievement Objective at Level 7

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:

Carry out investigations of phenomena, using the statistical enquiry cycle:

- conducting surveys that require random sampling techniques, conducting experiments, and using existing data sets
- evaluating the choice of measures for variables and the sampling and data collection methods used
- using relevant contextual knowledge, exploratory data analysis, and statistical inference.

Make inferences from surveys and experiments:

- making informal predictions, interpolations, and extrapolations
- using sample statistics to make point estimates of population parameters
- recognising the effect of sample size on the variability of an estimate.

(Highlighted statements are the ones covered by these resources)

Key competencies

Participating and contributing.

Using language, symbols and texts.

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
- 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 becoming young drivers, or passengers of young drivers, these resources explore important topics.

- Relevant to students as they and their peers learn to drive.
- Accessible and engaging context.
- Develops citizenship skills as students consider their role in a wider community.
- Whanaungatanga – build relationships with your students by showing them that you care about what happens to them outside of the classroom.

A note of caution

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

Guiding principles for the design of these resources

These resources are designed to be used by Mathematics and Statistics teachers with their classes to support the assessment of AS91035 in a meaningful context.

They are not intended to be 'something extra' the teacher is expected to do.

These resources align to evidence-based, effective road safety education strategies. These are outlined in the Good practice in road safety research summaries on the Waka Kotahi Education Portal.

Good practice in road safety

Importantly, these resources have been 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 have been shown to be at best ineffective and at times have negative unintended consequences by promoting the behaviour the intervention was designed to reduce.

Websites

Driver fatigue and distraction

Driver distraction (Waka Kotahi)

Let driving distract you (marketing campaign – Waka Kotahi)

The dangers of distraction (online lesson – Drive)

Diverted attention crash statistics (Ministry of Transport)

Driver fatigue (Waka Kotahi)

Feeling tired? (online lesson – Drive)

Fatigue crash statistics (Ministry of Transport)

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

Following distances module on Drive

Young drivers in New Zealand

Young driver safety statistics (Ministry of Transport)

Statistics education

Telling Data Stories: Essential Dialogues for Comparative Reasoning

Census at School New Zealand

Teaching activities

These activities and exemplars have been created to support the use of the practice internal assessment tasks to teach report writing for AS91264. They can be adapted to suit the teacher and students.

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.

Understanding the context

Take time to work through the context with students. This supports them to complete the practice assessment by:

- removing barriers created by the context.
- increasing statistical thinking in the PPDAC process by allowing students to connect their analysis to the context in a meaningful way.
- modelling strategies for understanding unknown contexts (such as in an assessment).
- 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, 1B, and 1C 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.

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.

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 here: Waka Kotahi Distraction Infographic 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?

After an initial brainstorm of ideas, students can use the provided weblinks in each resource to add to their knowledge, challenge misconceptions (for example around multi-tasking), or to add in sources to back up their knowledge.

This PowerPoint presentation goes through factors affecting vehicle stopping distances for the *How far until it stops?* task:

How far until it stops? Activity 1A Understanding the context PPT

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.

Students could make notes, write post-it notes with ideas, or create SOLO hexagons to capture their thinking on the variables.

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 (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.	Use the links provided in the task to experience the online reaction time test and the typing test. Reaction time test Typing test

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.

Activity 1C – putting it altogether

Using a graphic organiser is an effective tool to allow students to make connections between the various ideas on the context and variables from Activities 1A and 1B. Some ideas described below to choose from are: Lotus diagram, Mindmap, and Hexagonal thinking.

Lotus diagram

A lotus diagram puts the central ideas about a topic at the centre and encourages students to expand on these (see below).

	Continuous variable 1			Continuous variable 2			Continuous variable 3	
			Continuous variable 1	Continuous variable 2	Continuous variable 3			
	Categorical variable 1		Categorical variable 1	**Topic**	Categorical variable 2		Categorical variable 2	
			Purpose	Population	Reflections on the context			
	Purpose			Population			Reflections on the context	

To find out more about lotus diagrams:

Mind maps and lotus charts (Virtual Library)

Thinking tools: lotus diagram (Vimeo)

You can do this with students working in a spreadsheet or as a paper copy by printing the Activity 1C lotus diagram template.

In the spreadsheet by updating the variables in the centre, the variables about the outside will auto-update.

An exemplar has been created for the *How far until it stops?* task:

How far until it stops Level 2 Activity 1C Lotus diagram (Excel file)

Students could be given prompts for what to write around each subtopic. For example:

- Variables: definition, units, what factors affect it, what they would expect to see in the data (hypotheses), limitations, etc.
- Reflections on the context: limitations, who might be interested in the investigation and why, etc.

Not all boxes need to be filled in. Students can also write questions in the boxes with things they are unsure about.

In an assessment, students may have more variables but they could still use this to understand a subset of them. This allows students to understand more deeply about the context and make an informed selection of variables for their investigation.

Mindmaps

Mindmaps work in a similar way to the Lotus diagram to support students to organise their ideas from Activities 1A and 1B.

To find out more about Mindmaps, including links to free online software for developing editable Mindmaps:

Mind maps and lotus charts (Virtual Library)

Hexagonal thinking

Students organise their SOLO hexagons with single ideas on the context and variables on each hexagon and start to explain the connections (relational thinking) and generalise (extended abstract thinking). These ideas are annotated and students can explain their thinking to their peers and teacher.

To find out more about hexagonal thinking:

The Awesome Six Sided World of Hexagonal Thinking

How to make connections using SOLO Taxonomy Hexagons (HookEd – YouTube)

You can use the Word file included with this resource or download SOLO hexagons here:

HookED SOLO Hexagon Generator

Or Word documents with the contexts of these tasks have been created:

HookED SOLO Hexagons Stopping Distances

HookED SOLO Hexagons Driver distraction and fatigue

Problem

Once students have unpacked the context and variables, they need to think about the problem they will investigate, how it links to the purpose of the investigation set out in the task and write a question.

One approach is to let students explore the dataset informally using statistical software before they decide on the focus for 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. This PowerPoint goes through some sample questions for *Driven to distraction!*

Driven to distraction NCEA 2 activity 2A writing questions PPT

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

Plan and Data

Students must take a random sample for this standard but for these practice assessments, since the dataset is small, you might tell them the sample has already been taken.

Students should still practise writing up this section. Ideally students should be able to justify their choice of both sampling method and sample size in context of the task.

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

Sampling

Analysis

After using software to produce the distributions and summary statistics, students identify key comparative features of the distributions to discuss in context, using contextual knowledge to link to the investigative question and the population. 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:

Analysing and commenting on graphical output using OSEM

Other writing frameworks:

Census at School results for Achievement Standard 1.10

Another structure to use is:

- 'I notice…' (what you see)
- 'This means that…' (what it means in the sample)
- and 'I wonder…' or 'I expect…' (linking back to the investigative question and population)

Activity 4A - Analysing distributions

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

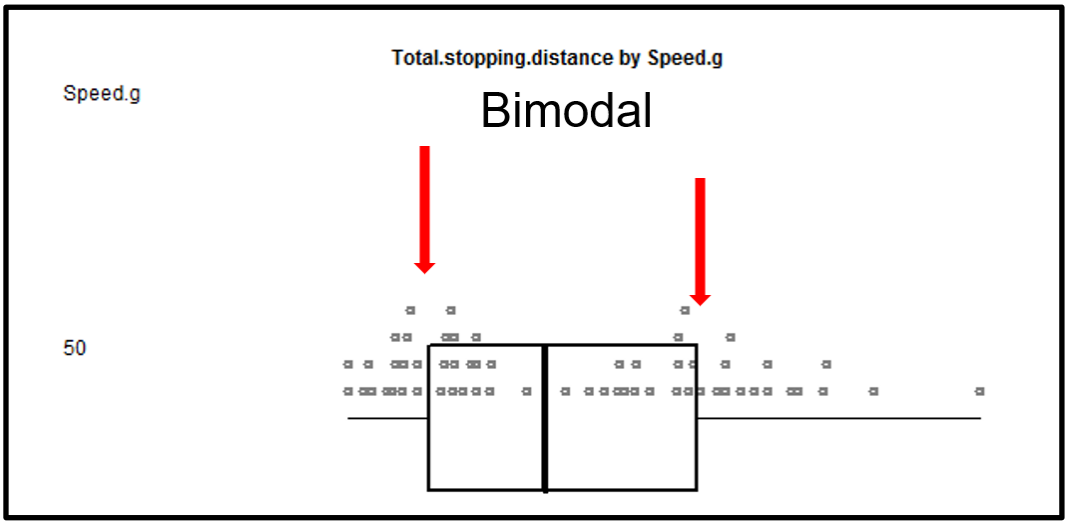
How far until it stops? NCEA 2 activity 4A writing analysis statements PPT

The above resource, includes printable slides without the PowerPoint annotations at the end which can be given to students to discuss and annotate.

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

Students noticing features like groups, clusters and 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.

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.

Conclusion

In this section interpreting informal confidence intervals is included, although students may do this in the Analysis section.

Activity 5A – conclusion

This PowerPoint for the task *How far until it stops*? task models how to interpret informal confidence intervals, write a conclusion, and provides reflection questions on the inquiry process and context.

How far until it stops? NCEA 2 activity 5 writing conclusions PPT

The slides can be edited to match the wording that students have been previously taught.

Responses for the reflection questions are not included in this PowerPoint. Students can be encouraged to form their own responses to some of the questions and discuss with peers. Some examples of possible student responses can be found in the assessment schedule for the task.

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

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.