Year 13 Mathematics

EAS 3.12

Statistical Reports

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Contents

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Statistical Reports 3.12

This achievement standard involves evaluating statistically based reports.

Achievement	Achievement with Merit	Achievement with Excellence
• Evaluate statistically based reports.	• Evaluate statistically based reports, with justification.	• Evaluate statistically based reports, with statistical insight.

- This achievement standard is derived from Level 8 of The New Zealand Curriculum and is related to the achievement objectives
  - Evaluate a wide range of statistically based reports, including surveys and polls, experiments, and observational studies:
    - critiquing causal-relationship claims
    - interpreting margins of error.
- Evaluate statistically based reports involves identifying and commenting on key features in reports relevant to any conclusions made in those reports.
- Evaluate statistically based reports, with justification involves supporting the comments made by referring to statistical evidence and processes described in reports, relevant to conclusions made in those reports.
- Evaluate statistically based reports, with statistical insight involves integrating statistical and contextual information to assess the quality of reports with respect to conclusions made in those reports.
- Evaluating statistical reports requires familiarity with:
  - the statistical enquiry cycle
  - principles of experimental design
  - surveys and polls, including potential sources of bias
  - interpreting statistical inferences
  - interpreting a wide variety of statistical tables and graphs
  - analysing a wide variety of statistical situations
  - critiquing causal-relationship claims
  - interpreting margins of error.

Acknowledgements

The authors wish to acknowledge the inspiration and help we have received from the CensusAtSchool team and in particular Chris Wild and Matt Reagan, Statistics Department of the University of Auckland. The CensusAtSchool site is a must visit for students and teachers of statistics (www.censusatschool.org.nz and new.censusatschool.org.nz).

The iNZightVIT project is led by Professor Chris Wild from the Department of Statistics at the University of Auckland. He comes up with the big (and small) ideas that make iNZight intuitive and easy to learn.

The development of iNZight itself has been shared amongst many statistics students from the university, who have worked part-time on making various parts of iNZight.

Evaluating Statistical Reports

Non-Statistical Errors

When we read a statistical report we wish to see if it is reasonable to draw conclusions based on the report. We will look at three distinct areas.

Non-Sampling Errors in Surveys and Polls (Observational Studies)

Questions that need to be answered about the collection of the statistics are:

- What is the definition of the population?
- Does the sample frame represent the population?
- How was the sample taken from the sample frame?
- Who funded or organised the survey?
- Were the questions worded adequately?

Reports on Statistical Experiments

A correctly managed experiment is the only statistical experiment that can establish the cause of a change (causality). You need to establish:

- How was the experiment carried out?
- How were the subjects selected?
- Was the experiment also published in a scientific journal?
- Are the conclusions consistent with the results?

Sampling Errors

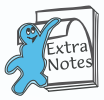
Sampling errors are potential errors that arise from us taking only part of the population.

- How large a sample was used?
- What is the Margin of Error (MoE)?

Commentary on the Report

As this Achievement Standard is looking at reports published in the media we need to consider the comment on the report. Often the media organisation will have someone (often an 'expert') make comments on the statistics. The media will be looking for some comment they can use in a headline. Looking at the commentary we need to ask:

- Are the comments consistent with the results or have they been extended to a different population or setting?



Some of the questions you will need to answer in evaluating a statistical report are:

- **Source of the research:**
  - **Is there potential for a hidden agenda in coming to a conclusion?**
- **Sample and Population:**
  - **What is the population that the research is reporting on?**
  - **How was the sample or participants selected?**
  - **Is the sample likely to be representative of the population?**
  - **If it is a political poll, how did they identify 'likely voters'?**
- **Questions:**
  - **How were the questions developed?**
  - **Were the questions given in the report?**
- **What was the sample size?**
- **What was the margin of error or experimental error?**
- **Are inferences and conclusions justified by the results?**
- **Is the interpretation in the report or media article consistent with the results?**
  - **Are the 'expert' comments in line with the report's conclusions?**
  - **Was causality implied and stated for an observational study?**
- **Evaluation:**
  - **Is the report believable?**

Example

Categorise the following statistical study as a poll, survey, experiment or randomised experiment. Identify the explanatory variable and the response variable.

All the students in Year 11 are asked how often they buy 'junk food'. They are then given a taste of a new purple coloured drink and are asked whether they would buy the new purple coloured fruit drink.

This is a poll (or survey).

The explanatory variable is the amount of 'junk food they buy'.

The response variable is whether they would buy the new fruit drink.

Achievement – Categorise the following statistical studies as a poll, survey, experiment or randomised experiment. Comment on it and identify the explanatory variable and the response variable.

1. A teacher wants to see the effect of homework on class performance in a post topic test. She teaches the first topic with no homework and the second topic with homework.

2. A politician wants to examine the relationship between paid working hours and how early people get up in the morning. He rings the first 30 people on the electoral roll and asks them.

3. A rugby coach wants to examine kicking style to see if it affects the distance a player can kick. He randomly assigns his players to two groups and gets one group to kick the ball normally and the second group to kick the ball but with a spin on its long axis.

4. A health researcher wants to examine the effect of binge drinking on teenagers' academic progress. He makes two random groups on the basis of the amount of binge drinking and studies school academic results for two years.

Political Polls

Political polls

A political poll has an extra complication compared to a survey of defining the population and getting a sample frame to sample. The population is not just the people eligible to vote. Just because a person can vote does not mean they will even register as an elector.

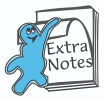
In New Zealand in 2011 there were about 3 267 00 adults (18 years and older) but only 3 071 000 were registered to vote. The poll will ask if you are a registered voter and not include any response if you are not.

The main problem is the registered voters who do not vote. Of the 3 071 000 registered voters, 2 279 000 voted, approximately 74.2%. Therefore when the research organistion contact an eligible voter they have to estimate if you are going to vote because if you are not, then there is no point in them recording your opinion as to what the outcome of an election is likely to be. Colmar Brunton for example, polls registered voters but asks the question whether are you 'quite likely' or 'very likely' to vote so they can further filter the results.

Each research organisation will have a different approach to try and get an estimate of the voters on election day. As well as asking a self assessment question as to whether you are likely to vote, they may also ask who you voted for in the last election. If you have previously voted and are very likely to vote, then your opinion will be counted. If you did not vote last time or you are newly eligible to vote then they have to make some decisions as to whether your opinion gets counted. They will filter out the opinions of voters who they feel are less likely to vote.

If we look at the last polls prior to the 2011 general election (see table below) you can see variation. Some of this variation is sampling variation (see the section on Margin of Error) and some is the methodology and in particular the difficulty in identifying a sample of people who represent the population of people that will vote at the election.

Most came within their stated Margin of Error for the major parties but the prediction for New Zealand First is interesting. If any party got over 5% of the vote they can enter parliament so correctly predicting that NZ First would break 5% was important.



Opinion polls and the Margin of Error

Opinion polls usually quote a Margin of Error. This is a sampling statistic and is not a reflection of how accurate the survey methodology was. It does not attempt to access non-sampling errors. If a pollster stood by the local railway station and asked the first 1000 people who they supported we would say their poll had no credibility but they can correctly state their Margin of Error is ± 3.2%.

Poll source	National	Labour	Greens	ACT	Maori	NZ First	Don't know or other	Margin of Error
Roy Morgan	49.5	23.5	11.1	1.1	1.4	6.6	6.8	± 3.2
3 News / Reid Research	50.8	26.0	13.4	1.5	1.0	3.1	4.2	± 3.2
One News Colmar Brunton	50.0	28.0	10.0	1.7	2.0	2.4	5.9	± 3.1
Fairfax Media	54.0	26.0	12.0	0.7	1.1	4.0	2.2	± 3.1
Herald Digipoll	50.9	28.0	11.8	1.8	0.4	5.2	1.9	± 3.4
Horizon Poll	40.0	29.0	12.0	2.0	1.0	9.6	6.4	± 1.9
Actual Result	47.3	27.5	11.1	1.1	1.4	6.0	5.6	

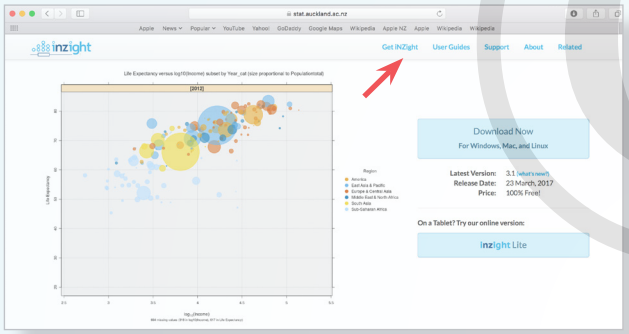
iNZight

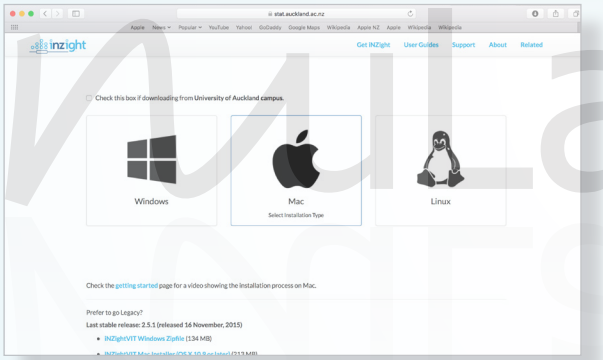
iNZight / VIT Demonstration

A good demonstration of confidence intervals and the rule of thumb is part of the iNZight package. Go to the iNZight website at

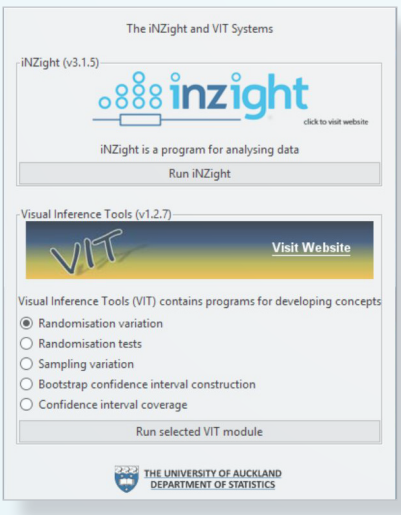
https://www.stat.auckland.ac.nz/~wild/iNZight/index.php

and choose the option 'Get iNZight'. Select the option 'Desktop' and follow the instructions to download the required version for either Windows or Mac.





Once installed you will have two programs. iNZight and VIT. Boot VIT and the following window appears.



Download your own copy now

This statistics package is available for free from the Auckland University website:

https://www.stat.auckland.ac.nz/~wild/iNZight/getinzight.php

About iNZight

iNZight was initially designed for New Zealand high schools, allowing students to quickly and easily explore data and understand some statistical ideas (using the companion program VIT).

However, iNZight now extends to multivariable graphics, time series, and generalised linear modelling (including modelling of data from complex surveys).

iNZight is FREE!! That means you can download and use it however you want, for whatever you want. There are absolutely no restrictions. You can download it for yourself or redistribute it. You can even modify it if you are so inclined! However, it is important to note that iNZight comes with absolutely no warranty.

Acknowledgements

The iNZight Team

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CensusAtSchool

The data we have used in the VIT demonstrations in this book come from the CensusAtSchool database.

CensusAtSchool NZ involves an online student's survey for Years 5 through to 13. Schools take part voluntarily, with students completing the survey during lesson time, then submitting their data to contribute to an international database. Some questions are in common with the other countries, to provide comparisons between countries, while tailoring the remainder of the questionnaire to reflect the interests of New Zealand children. Results and sample data are made available to teachers once the 'census' is complete, with classroom resources released over time.

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43. a) Margin of Error = ± 4.5%

b) Cannot conclude he is real as the interval 47.5% to 56.5% has a lower limit less than 50%. Can conclude that less than half believe Santa Claus is a Democrat because the upper limit of the interval 39.5% to 48.5% is less than 50%.

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44. a) Margin of Error = ± 2.8%
Confidence interval 88.2% to 93.8%.

b) As the online poll percentage (0.91) is outside the range 0.3 to 0.7 the margin of error will be smaller than that calculated using the RoT in part a).

45. a) Margin of Error = ± 3.1%

b) Confidence interval 47.9% to 54.1%.

46. a) Margin of Error = ± 2.2%

b) 1189 people in this group without a tattoo.
Margin of Error = ± 2.9%
Confidence interval 42.1% to 47.9%. No the majority of non-respondents do not feel a tattoo makes a person less attractive as the upper limit of the interval is less than 50%.

47. a) Margin of Error = ± 3.2%

b) Yes majority oppose keeping the drinking age at 18 years as between 53.8% to 60.2% say they were wrong and the lower limit of the interval is greater than 50%.

48. a) Margin of Error = ± 3.2%

b) Confidence interval 57.8% to 64.2%.
Yes majority believe in evolution as the lower limit of the interval is above 50%.

49. A sample size of 625.

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50. a) Margin of Error = ± 2.9%

b) MoE (difference) = ± 5.8% (2 x MoE)
95% CI for difference = 8.7% ± 5.8%
= [2.9%, 14.5%]

51. a) Margin of Error = ± 2.27%

b) MoE (difference) = ± 4.5% (2 x MoE)
95% CI for difference = 3% ± 4.5%
= [⁻1.5%, 7.5%].
Because the lower limit of the confidence interval is below 0 we cannot claim there are more strong supporters in the population than opponents.

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52. a) 1111 people.

b) MoE (difference) = ± 6.0% (2 x MoE)
95% CI for difference = 15.0% ± 6.0%
= [9%, 21%].
Because the the lower limit of the confidence interval is above 0 we can state that there is a statistical difference in support for banning semi-automatic guns.

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53. Margin of Error = 1.8%
MoE of difference = ± 2.7%. (1.5 x Av MoE)
95% CI for difference = 6% ± 2.7%
= [3.3%, 8.7%].
Support has fallen by between 3.3% and 8.7% as the lower limit of the confidence interval is greater than 0.

54. a) MoE of difference = ± 6.8%. (1.5 x Av MoE)

b) 95% CI for difference = 23% ± 6.8%
= [16.2%, 29.8%].
Yes support has increased for changing the flag as the lower limit of the confidence interval is greater than 0.

55. a) MoE of difference = ± 8.3%. (1.5 x Av MoE)

b) 95% CI for difference = 7% ± 8.3%
= [⁻1.3%, 15.3%].
Cannot conclude that there is a difference between the local community and the rest of New Zealand as the lower limit of the confidence interval is less than 0.

56. a) MoE of difference = ± 5.8%. (1.5 x Av MoE)

b) 95% CI for difference = 8% ± 5.8%
= [2.2%, 13.8%].
Can conclude that there is an increase in the percentage of Americans who believe in global warming as the lower limit of the confidence interval is greater than 0.

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57. MoE (difference) = ± 8.9% (2 x MoE)
95% CI for difference = 7.0% ± 8.9%
= [⁻1.9%, 15.9%].
Cannot conclude that more New Zealanders oppose than support mining in World Heritage sites as the lower limit of the confidence interval is less than 0, i.e. support could range in favour of mining by up to 1.9% and opposing mining up 15.9%.

58. MoE (difference) = ± 6.1% (2 x MoE)
95% CI for difference = 14.0% ± 6.1%
= [7.9%, 20.1%].
Can conclude that the majority of people in Germany support the view as the lower limit of the confidence interval is greater than 0.

59. a) MoE of difference = ± 3.9%. (1.5 x Av MoE)

b) 95% CI for difference = 5% ± 3.9%
= [1.1%, 8.9%].
Can conclude that there is an increase in the percentage who want farmers to be taxed for taking water from the environment as the lower limit of the confidence interval is greater than 0.

60. a) MoE of difference = ± 5.2%. (2 x MoE)

b) 95% CI for difference = 17% ± 5.2%
= [11.8%, 22.2%].
Can conclude that there are more supporters