SNIPPET: META-ANALYSIS FOR VCE STUDENTS

Let p denote the proportion of adults in Melbourne who think that the price of electricity is too high. A newspaper conducts a telephone poll of $n = 100$ people in Melbourne, and asks them 'Do you think that the price of electricity is too high?' The newspaper reports the results as follows.

In a survey of 100 people chosen at random from Melbourne in a telephone poll, 60% thought that electricity prices were too high.

A casual reader might infer that most people in Melbourne think that electricity prices are too high. After all 60% is a much higher proportion than 50%.

Thus, a point estimate of p is $\hat{p} = .6$. An astute VCE student in Mathematical Methods can calculate a 95% confidence interval for p as follows.

$$\hat{p} \pm 1.96\sqrt{\frac{\hat{p}(1-\hat{p})}{n}} = (0.5040, 0.6960)$$

Notice that the interval does not contain 0.5 (it just misses), and offers reasonable evidence for saying that most adults in Melbourne think that prices are too high.

A competing newspaper conducts the same style of poll with a smaller sample size $n = 50$. Its report is as follows.

In a survey of 50 people chosen at random from Melbourne in a telephone poll, 60% thought that electricity prices were too high.

Our enthusiastic Mathematical Methods student again calculates a 95% confidence interval as follows.

$$\hat{p} \pm 1.96\sqrt{\frac{\hat{p}(1-\hat{p})}{n}} = (0.4642, 0.7358)$$

This second interval contains 0.5, and hence does not provide convincing evidence that most adults in Melbourne think that prices are too high.

The two newspaper reports do not send the same message. A casual reader might simply dismiss the latter survey because the sample size was smaller.

However, our thoughtful student decides to combine the results of the surveys. Why waste good data? It is reasonable to assume that the two samples had no common respondents. We then have a combined survey of $n = 150$ people, chosen at random, 60% of whom think that prices are too high. The student calculates the new confidence interval as follows.

$$\hat{p} \pm 1.96\sqrt{\frac{\hat{p}(1-\hat{p})}{n}} = (0.5216, 0.6784)$$

The interval based on the combined data is further away from 0.5 than was the first interval. This is much stronger evidence for saying that most adults in Melbourne think that prices are too high.

Instead of wasting data by dismissing the smaller study, our student has put the data from the smaller study to good use and arrived at a conclusion that is more compelling than the first study. Furthermore, the student has not had to collect any data at all!

This is an elementary exercise in meta-analysis. Meta-analysis is a branch of statistics based on synthesising statistical results of previous studies to obtain new insight into a phenomenon. In the words of the eminent philosopher of science, Thomas Kuhn, our student has seen 'new things when looking at old objects' (Kuhn, 2012, p. 117).

Cumming (2012) is an excellent introduction to meta-analysis. Geoff Cumming, who is emeritus professor of psychology at La Trobe University, writes as follows.

> I think that meta-analysis is so central to how science should be done that every introductory statistics course should include an encounter with it ...' (Cumming, 2012, p. 181).

The above exercise shows how VCE students might encounter meta-analysis in Mathematical Methods.

ACKNOWLEDGEMENTS

I thank Tina Fitzpatrick and Christopher Lenard for their suggestions.

REFERENCES

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Kuhn, T. S. (2012). *The structure of scientific revolutions, 4th edition.* Chicago: The University of Chicago Press.

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