Assessment Schedule – 2021

Scholarship Statistics (93201)

Evidence Statement

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General Principles:

1 Ignore incorrect answers if alongside correct answers. The exception is contradictory statements.

2 Ignore minor copying errors.

3 When required in evidence, answers need to be contextual.

QUESTION ONE

Task Q1(a)(i)

Evidence:

- The median price of Apple phones (about $1400) is higher than that of the other two companies (about $600).
- The price distribution for all three companies is positively skewed, which suggests that there are more models on offer at lower prices.
- While the proportion of Apple phones is about the same for all four colours (about 23% – 29%), about half of the phones of Oppo and Samsung are black and far fewer phones are red (about 8% – 9%).
- Across the different colours, Apple phones are typically more expensive, with a median price of around $1800 for blue phones and around $1300 for phones of the other colours. The median price of blue Oppo phones (around $600) is higher than that of blue Samsung phones (around $500), whereas the median price of black and white Samsung phones (around $650) is higher than that of Oppo phones of the same colour (around $500). The median price of red Samsung and Oppo phones is about the same ($500).
- Blue phones tend to be the most expensive for Oppo and Apple, whereas black and white phones tend to be the most expensive colour for Samsung phones.

Note: Accept other comparisons that are based on a ***key*** *feature of the data displayed in a plot.*

Task Q1(a)(ii)

Evidence:

- We would need to know whether the phone listings offered by the retailer are representative of all phones produced by these brands, e.g.
  - there may be some special editions not available to the retailer
  - they may sell only phones within a certain price range by each producer
  - they may not stock all the colours available for each model
  - whether price characteristics of phones of other colours are available from these brands in New Zealand.

Task Q1(b)(i)

Evidence:

- The relationship between screen size and weight for both Apple and Samsung phones is positive.
- As the screen size increases, the weight tends to increase also.
- For Apple phones, the relationship is (moderately) strong. There is a limited amount of scatter in the graph and the correlation coefficient is 0.89.
- For Samsung phones, the relationship is not as strong as for the Apple phones. There is a moderate amount of scatter in the graph and the correlation coefficient is 0.71.

Task Q1(b)(ii)

Evidence:

- An Apple phone of this screen size would be expected to weigh $-39.21 + 38.81 \times 7.5 = 251.865$, so roughly 250 g.
- A Samsung phone of this screen size would be expected to weigh $-16.11 + 31.41 \times 7.5 = 219.465$, so roughly 220 g.
- Based on the two models, the phone is more likely to be a Samsung phone, as it sits closer to the line fitted.

Task Q1(b)(iii)

Evidence:

- There is no Apple phone with a screen size of more than 7 inches in the data, so it is uncertain whether the model would be appropriate for such a phone.
- There is only one Samsung phone with a screen size of more than 7 inches in the data, but this phone is much heavier than the model would predict (about 270 g with a 7.4 inch screen). This phone also represents an outlier in the data set, and removing it would result in a model with a lower gradient, and therefore a lower predicted weight.
- Samsung data may be better modelled by a non-linear model rather than a linear model.

QUESTION TWO

Task Q2(a)(i)
Evidence:

- Quarterly electronics sales in NZ increase from about $620 million in 2010 to about $1220 million in 2020.
  - In terms of seasonal variation, there is a peak in sales in Q4 with about $130 million more than the trend, and a trough in Q1 with about $50 million less than the trend.
  - There is an unusually high peak at the end of the graph.
- Quarterly accommodation sales in NZ increase from about $650 million in 2010 to about $850 million in 2020.
  - In terms of seasonal variation, there is a peak in sales in Q1, with about $160 million more than the trend, and a trough in Q2, with about $130 million less than the trend.
  - There is a steep decline in Q2 2020, and a possible change to a decreasing trend.
- Accommodation sales increase at a faster rate than electronic sales between 2014–2019, and the seasonality is different.

Task Q2(a)(ii)
Evidence:

- In Q2 2020, the individual seasonal differences for both were much larger than in previous years.
- In the following two quarters, electronics sales increased at a higher rate than before, whereas accommodation sales declined.
- The effect of this was a change in trend in both time series.
- At the time the data was analysed, it was uncertain whether this new trend would continue for both series, or whether the data would revert back to the previous trend, which impacts any forecasts made using this data. For example, there was a lockdown from August 2021 that affected New Zealand which restricted retail stores being open, and so would impact retail sales for electronics and accommodation.
- Seasonal differences for accommodation are more varied, so less precise predictions.

Task Q2(b)
Evidence:

- The fixed phone subscriptions per 100 people increased from about 22 in 1960 to about 46 in about 1996, before decreasing to about 28 in 2017.
- Mobile phone subscriptions per 100 people increased from 0 in 1988 to about 110 in 2005, and after remaining static until around 2012, continued to increase to about 135 in 2017. This means that, on average, people in NZ have more than one mobile phone subscription.
- Fixed broadband subscriptions per 100 people increased from 0 in 2000 to about 36 in 2017.

Task Q2(c)(i)
Evidence:

- Percentage (or other valid numerical expression) increase of mobile phone subscriptions from 2005 to 2008:
  - Fiji: $\frac{600000}{205000} = 2.927$, so a 193% increase
  - NZ: $\frac{4620000}{3530000} = 1.31$, so a 31% increase
- The claim is correct: mobile subscriptions have increased at a higher rate in Fiji in this time period.

Task Q2(c)(ii)
Evidence:

- Interpolating $\frac{2}{3}$ of the difference between 86 000 and 90 000 = $\frac{2}{3} \times 4000 + 86000 = 88\,667$.
- The points (640,88.667) in the Samoa / Fiji graph and (4700,88.667) in the Samoa / NZ graph fit in with the rest of the data, so this seems plausible.

QUESTION THREE

Task Q3(a)
Evidence:

- The design is a comparison of two independent groups.
- The students were the experimental units.
- The treatment variable was distraction and had two levels: no phone notifications and phone notifications.
- The experimental units were randomly allocated to one of the treatment levels.
- The response variable was the number of words recalled correctly.

Task Q3(b)
Evidence:

- Participants were randomly allocated in order to reduce the possible effects of related factors, such as highly focused students who are good at recalling lists of words, but also prefer to switch notifications off.

Task Q3(c)
Evidence:

- The difference between the two means for words correctly recalled was 0.85, which means that, on average, students with no notifications memorised 0.85 more words than those with notifications.
- The tail proportion is 0.069 (6.9%) which provides weak / some evidence to support a claim that the mobile phone notifications reduced the number of words students could remember.

Note: It is both the tail proportion AND the design of the study (experiment) that support this causal claim. Further evidence of this understanding is assessed in 3(e).

Task Q3(d)
Evidence:

- To control for differences in students' memory ability, a paired comparison design could be used in which each student does the word recall activity twice, once with notifications, and once without.
- In this case, the response variable would be the difference of words remembered with / without notifications.
- The order in which students are assigned the treatments with / without notifications should then be randomised to control for other effects, such as fatigue.

Task Q3(e)
Evidence:

- As the categorisation into gamer / non-gamer was observational and not the treatment variable of an experiment, a **causal** claim is not valid.
- Participants were not randomly allocated into these groups and, therefore, other variables that may affect the participants ability to recall a list of words were not controlled.
- Additionally, both "playing video games" and "affects your memory" are very broad descriptions compared to the specific nature of what was asked and / or measured in the study.
- The tail proportion of 0.032 (3.2%) provides only (some) evidence of an **association** between "playing video games" and "memory".

QUESTION FOUR
Task Q4(a)
Evidence:

- School_level was created from the variable year level
- Island was created from the variable region.

Task Q4(b)(i)
Evidence:

- The proportion of students from the North Island who participated in the study decreased from 81.5% to 73.3%, while that of students from the South Island increased.
- While initially most participants came from primary and intermediate schools (58.6%), the proportion of participants from secondary schools increased over time to a high of 69.6% in 2015, and has remained the majority in recent years.
- Mobile phone ownership has tended to increase over the surveys, from 58% in 2005 to 78.3% in 2019.

Task Q4(b)(ii)
Evidence:

- Colour: Using colour for each level of categorical variable helps to communicate the change in proportions for the same levels over time.
- Line segments: Using dots for each percentage and connecting with a line focuses on the difference in proportion between the different comparison groups.
- *(award 1s mark if time order down left hand side is explicitly described as a graphical technique)*

Task Q4(b)(iii)
Evidence:

- In the earlier days of the census, the proportions of participants who came from primary or intermediate schools was higher than in recent years. These younger students may be less likely to own a mobile phone, and, therefore, phone ownership amongst all students in the early years of the census may be under-represented.
- It is not clear that students who participate in the census are representative of all students. Students are probably asked to participate by their teachers, and may be more likely to do so in more affluent schools, because students in these schools are more likely to have devices that allow them to do the online survey. At the same time, these students are also more likely to have mobile phones.

Task Q4(c)
Evidence:

- Number of responses for Always, Often or Sometimes = 530
- Total sample size = 766
- Percentage who responded Always, Often or Sometimes = 69.2%

  Using $\frac{1}{\sqrt{n}}$ rule of thumb for the margin of error.

- Margin of error = $\frac{1}{\sqrt{766}}$ = 3.6%
- Confidence interval = (65.6%, 72.8%)
- It's a fairly safe bet that somewhere between 65.6% and 72.8% of all NZ Y3 to Y13 students always, often or sometimes check their phone as soon as they wake up.
- As the entire confidence interval is above 50%, the claim that most New Zealand Year 3 to Year 13 students who own mobile phones either sometimes, often or always check their phone for messages or notifications as soon as they wake up is supported.

QUESTION FIVE

Task Q5(a)(i)
Evidence:

- For the samples, the mean size of iOS apps is 192.72 MB higher than that of Android apps.
- The variability of app sizes is much smaller for Android apps than for iOS apps.
- There is one Apple mobile phone app that was around 780 megabytes that, due to the small sample size, will have inflated the sample mean.
- It's a fairly safe bet that the mean size of iOS apps released during 2021 is somewhere between 137.6 MB and 261.7 MB higher than the mean size of Android apps released during 2021.
- As the entire confidence interval is positive, we can make a call that on average iOS apps are larger than Android apps.

Task Q5(a)(ii)
Evidence:

- Problem: For students at my school, what is the difference between the mean size of the largest app installed on Apple phones and the mean size of the largest app installed on Android phones?
- Plan: Use some form of random selection to determine which students to survey, so that a representative sample of students from the school was selected. This may be a random, systematic, or stratified sample, where the strata could be year groups.
- Data: Record the size of the largest installed app and the type of phone for each student in the sample.
- Analysis: Use the data collected to construct a bootstrap confidence interval for the difference between mean size of the largest app installed for Apple and Android phones.
- Conclusion: Use the confidence interval to communicate an interval estimate for how much bigger or smaller, on average, the size of the largest app installed is for one of the types of phone versus the other.

Note: Accept other problem statements that involve a comparison of the mean or median largest app size between Apple and Android phones.

Task Q5(b)(i)
Evidence:

- Normal distribution, mean = 52.4, standard deviation = 10.6
- $P(X > 60 \mid X < 70) = \dfrac{P(60 < X < 70)}{P(X < 70)} = \dfrac{0.1883}{0.9516} = 0.1979$

Task Q5(b)(ii)
Evidence:

- Some older phones may not fully charge anymore, so could condition probability on age of phone.
- The day of the week may affect charging behaviour, so could condition probability on day of week.

Task Q5(b)(iii)
Evidence:

- $P(\text{unplugged within 30 mins} \mid \text{computer}) = 0.23 \times \dfrac{0.6}{0.39} = 0.3538$
- $P(\text{unplugged within 30 mins} \mid \text{power outlet}) = 0.23 \times \dfrac{0.4}{0.61} = 0.1508$
- $\dfrac{0.3538}{0.1508} = 2.35$
- People who charged their phone on a computer are more than twice as (135% more) likely to unplug their phone within 30 minutes of a full charge than people using power outlets.

Note: Accept other comparisons of charging behaviours.

Sufficiency Statement

For each question:

Score 1 – 4 No award	5 – 6 Scholarship level	7 – 8 Outstanding Scholarship level
Shows understanding of relevant statistical and probability concepts and methods, and some progress towards applying this in context.	Application of high-level statistical analysis and critical thinking, knowledge and skills, to complex situations. Shows logical development, precision and clarity of ideas.	In addition to the requirements of Scholarship, demonstration of perception and insight, sophisticated integration and abstraction of ideas, independent reflection and extrapolation, and convincing communication.

Cut Scores

Scholarship	Outstanding Scholarship
23 – 32	33 – 40