NCEA Level 1 · AS 91944: Exploring Data with the Statistical Enquiry Cycle

Name: Date:

Hey! This standard is all about running a proper statistical investigation from start to finish, asking a good question, sorting your data, making sensible graphs, and writing conclusions that the numbers actually support. Work through each section in order, and always back up what you say with evidence from your data.

Revision summary

- The statistical enquiry cycle (PPDAC): Problem (pose a comparison/summary question), Plan (how to get data), Data (collect/clean/source), Analysis (graphs + summary stats), Conclusion (answer the question with evidence).
- A good comparison question names the two groups, the numeric variable, and asks which tends to be bigger, e.g. 'Do Year 11 boys tend to be taller than Year 11 girls at our school?'
- Measures of centre: mean = sum of values ÷ number of values; median = middle value when ordered; mode = most common value.
- Measures of spread: range = max − min; interquartile range IQR = upper quartile (Q3) − lower quartile (Q1). IQR describes the middle 50% and resists outliers.
- Shape: describe as symmetric, right-skewed (tail to high values) or left-skewed (tail to low values); note any clusters, gaps or outliers.
- Best displays: dot plot or box plot for one numeric variable (great for comparing two groups), bar chart for categories, back-to-back or paired displays for comparisons.
- Comparing groups: compare medians (centre), overlap of boxes/IQRs (spread), and shape. If the difference in medians is large relative to the spread, you can make a stronger 'back to the population' claim.
- Conclusions must be evidence-based: quote actual values from your graphs/stats, and only generalise beyond the sample cautiously if the data was collected sensibly.

Key skills

1. The number of texts sent by 9 students at Avondale College in one hour: 3, 5, 5, 8, 10, 12, 14, 18, 22. Find the median and the range.

2. Calculate the mean of these weekend earnings (in $): 40, 55, 60, 60, 85.

3. For the data 12, 15, 15, 18, 20, 21, 25, 30, find the lower quartile (Q1), upper quartile (Q3) and the interquartile range.

4. A dot plot of daily bus wait times (minutes) has most dots between 2 and 6, with one dot far out at 20. Describe the shape and identify any outlier.

Achieved

5. A student wants to investigate reaction times at Vertex Academy. Write a suitable investigative comparison question, and state what data would need to be collected.

6. Given the shoe sizes of 10 netball players: 6, 7, 7, 8, 8, 8, 9, 9, 10, 11, choose a suitable display and describe the shape and centre.

7. The times (minutes) for 12 people to complete a 3 km parkrun in New Lynn: 16, 18, 18, 19, 20, 21, 22, 23, 24, 25, 27, 30. Find the median and the IQR.

8. A café records the number of coffees sold each hour: 14, 22, 18, 30, 25, 19. Calculate the mean and state whether the mean or median better represents a 'typical' hour if one hour had a huge one-off order of 90 coffees added.

Merit

9. Two Year 11 classes did the same 40-mark test. Class A: median 26, Q1 20, Q3 31. Class B: median 24, Q1 22, Q3 27. Compare the two distributions, linking centre and spread, and comment on which class did better.

10. A student collected commuting distances (km) from a survey posted only in the school's cycling club group chat, then concluded 'most students at our school live within 5 km of school'. Explain two problems with this conclusion and how the plan could be improved.

11. Weekly pocket money ($) for a sample: 5, 10, 10, 12, 15, 15, 15, 20, 25, 60. A student says 'the average is $18.70 so a typical student gets about $19'. Using the shape of the data, evaluate this claim and suggest a better summary.

Excellence

12. Two box plots comparing sleep hours of Year 9 and Year 13 students overlap: Year 9 median 8.5 h (IQR 7.5–9.5), Year 13 median 6.5 h (IQR 5.5–7.5). Explain, with justification, whether it is reasonable to claim that in the wider student population Year 13 students tend to sleep less than Year 9 students.

13. Prove that adding a single new value equal to the current mean of a data set leaves the mean unchanged, and explain what this shows about the mean's sensitivity.

14. A student surveyed 200 people at Avondale train station one Monday morning and found the median daily screen time was 1.5 hours, concluding 'New Zealanders spend about 1.5 hours per day on screens'. Critically evaluate every stage of this enquiry (problem, plan, data, analysis, conclusion) and describe a redesign that would support a valid national claim.

Answer key (for parents and tutors)

1. The number of texts sent by 9 students at Avondale College in one hour: 3, 5, 5, 8, 10, 12, 14, 18, 22. Find the median and the range.
   Ordered already. There are 9 values, so the median is the 5th value = 10 texts. Range = max − min = 22 − 3 = 19 texts.
   Achieved fluency: correctly locates the median and computes range.

2. Calculate the mean of these weekend earnings (in $): 40, 55, 60, 60, 85.
   Sum = 40 + 55 + 60 + 60 + 85 = 300. Mean = 300 ÷ 5 = $60.
   Achieved fluency: applies the mean formula correctly.

3. For the data 12, 15, 15, 18, 20, 21, 25, 30, find the lower quartile (Q1), upper quartile (Q3) and the interquartile range.
   8 values. Lower half: 12, 15, 15, 18 → Q1 = (15 + 15) ÷ 2 = 15. Upper half: 20, 21, 25, 30 → Q3 = (21 + 25) ÷ 2 = 23. IQR = 23 − 15 = 8.
   Achieved fluency: finds quartiles and computes IQR.

4. A dot plot of daily bus wait times (minutes) has most dots between 2 and 6, with one dot far out at 20. Describe the shape and identify any outlier.
   The distribution is right-skewed (has a tail towards the higher values). There is an outlier at 20 minutes, which is well separated from the main cluster between 2 and 6 minutes.
   Achieved fluency: describes shape and identifies an outlier.

5. A student wants to investigate reaction times at Vertex Academy. Write a suitable investigative comparison question, and state what data would need to be collected.
   Example question: 'Do students who play video games regularly tend to have faster reaction times than students who don't, at Vertex Academy?' Data needed: for a sample of students, record each person's reaction time (in milliseconds, measured with a reaction test) and whether they play video games regularly (yes/no). The reaction time is the numeric variable and the gaming group is the category used to split the two groups.
   Achieved: poses a sensible comparison question and identifies the variables/data required.

6. Given the shoe sizes of 10 netball players: 6, 7, 7, 8, 8, 8, 9, 9, 10, 11, choose a suitable display and describe the shape and centre.
   A dot plot is suitable for this single numeric variable. Median: 10 values, average of 5th and 6th = (8 + 8) ÷ 2 = 8. Mode = 8 (appears three times). The distribution is roughly symmetric, centred around size 8, ranging from 6 to 11 with no obvious outliers.
   Achieved: selects an appropriate display and describes centre and shape.

7. The times (minutes) for 12 people to complete a 3 km parkrun in New Lynn: 16, 18, 18, 19, 20, 21, 22, 23, 24, 25, 27, 30. Find the median and the IQR.
   12 values. Median = average of 6th and 7th = (21 + 22) ÷ 2 = 21.5 min. Lower half (first 6): 16, 18, 18, 19, 20, 21 → Q1 = (18 + 19) ÷ 2 = 18.5. Upper half (last 6): 22, 23, 24, 25, 27, 30 → Q3 = (24 + 25) ÷ 2 = 24.5. IQR = 24.5 − 18.5 = 6 min.
   Achieved: computes median and IQR from a straightforward data set.

8. A café records the number of coffees sold each hour: 14, 22, 18, 30, 25, 19. Calculate the mean and state whether the mean or median better represents a 'typical' hour if one hour had a huge one-off order of 90 coffees added.
   Original mean = (14 + 22 + 18 + 30 + 25 + 19) ÷ 6 = 128 ÷ 6 ≈ 21.3 coffees. If 90 is added, the data becomes seven values summing to 218, mean ≈ 31.1, pulled up by the extreme value. The median (order the seven: 14, 18, 19, 22, 25, 30, 90 → median = 22) is barely affected. So the median better represents a typical hour, because it is not distorted by the single unusually large value.
   Achieved: applies mean/median and identifies the effect of an extreme value.

9. Two Year 11 classes did the same 40-mark test. Class A: median 26, Q1 20, Q3 31. Class B: median 24, Q1 22, Q3 27. Compare the two distributions, linking centre and spread, and comment on which class did better.
   Centre: Class A's median (26) is higher than Class B's (24), so Class A students tended to score slightly higher. Spread: Class A's IQR = 31 − 20 = 11, while Class B's IQR = 27 − 22 = 5. So Class B's middle 50% of scores are much more consistent (bunched together), whereas Class A's scores are more spread out, some did very well, others

less so. Linking these: although Class A has the higher centre, the difference in medians (only 2 marks) is small compared with the spread, so I can't confidently say Class A is clearly better overall. Class A tended to score a little higher but less consistently; Class B was more reliable but slightly lower on average.

Merit: links centre and spread together to make a relational comparison.

10. A student collected commuting distances (km) from a survey posted only in the school's cycling club group chat, then concluded 'most students at our school live within 5 km of school'. Explain two problems with this conclusion and how the plan could be improved.
Problem 1, sampling bias: the sample came only from the cycling club, who are more likely to live close to school (they cycle), so it is not representative of all students. Problem 2, overgeneralising: the conclusion claims something about 'most students at our school' from a biased, self-selected sample, so the evidence doesn't support it. Improvements: use a random sample across all year levels and transport types (e.g. randomly select students from the whole school roll), and word the conclusion to match what the data actually shows, only generalising cautiously if the sampling was fair.

Merit: connects the sampling method to the validity of the conclusion.

11. Weekly pocket money ($) for a sample: 5, 10, 10, 12, 15, 15, 15, 20, 25, 60. A student says 'the average is $18.70 so a typical student gets about $19'. Using the shape of the data, evaluate this claim and suggest a better summary.
Mean = (5+10+10+12+15+15+15+20+25+60) ÷ 10 = 187 ÷ 10 = $18.70. But the data is right-skewed: nine values are $25 or under, and one large value ($60) pulls the mean up. The median = average of 5th and 6th values = (15 + 15) ÷ 2 = $15, which is below the mean. So the mean overstates the 'typical' amount. A better summary of the centre is the median ($15), because it is resistant to the high outlier and better reflects what most students actually receive.

Merit: links shape/skew of the data to the choice of an appropriate centre measure.

12. Two box plots comparing sleep hours of Year 9 and Year 13 students overlap: Year 9 median 8.5 h (IQR 7.5–9.5), Year 13 median 6.5 h (IQR 5.5–7.5). Explain, with justification, whether it is reasonable to claim that in the wider student population Year 13 students tend to sleep less than Year 9 students.
The medians differ by 2 hours (8.5 vs 6.5), which is large compared with the IQRs (both 2 hours wide). Because the shift between the two distributions is about the same size as the spread within each group, the boxes barely overlap, Year 13's upper quartile (7.5) equals Year 9's lower quartile (7.5). This clear separation means the difference is unlikely to be just sampling variation. So, provided the samples were randomly and fairly selected from each year level, it is reasonable to make a 'back to the population' claim: Year 13 students at this school do tend to sleep less than Year 9 students. The justification is that the difference in centres is large relative to the spread, giving a distinct shift rather than heavy overlap.

Excellence: justifies a population inference using the size of the shift relative to spread.

13. Prove that adding a single new value equal to the current mean of a data set leaves the mean unchanged, and explain what this shows about the mean's sensitivity.
Let the data have n values with sum S, so mean = S ÷ n. Add a new value equal to the mean, i.e. add S ÷ n. New sum = S + S/n = S(n + 1)/n. New count = n + 1. New mean = [S(n + 1)/n] ÷ (n + 1) = S/n. This equals the original mean, so the mean is unchanged. This shows the mean is a 'balance point' of the data: adding a value at the balance point doesn't shift it. It also illustrates the flip side, adding a value far from the mean shifts it noticeably, which is why the mean is sensitive to outliers while the median often is not.

Excellence: proves a general result algebraically and interprets its meaning.

14. A student surveyed 200 people at Avondale train station one Monday morning and found the median daily screen time was 1.5 hours, concluding 'New Zealanders spend about 1.5 hours per day on screens'. Critically evaluate every stage of this enquiry (problem, plan, data, analysis, conclusion) and describe a redesign that would support a valid national claim.
Problem: no clear investigative question was posed before collecting, the study seems aimed at a broad national claim, which is too ambitious for one location. Plan/Data: the sample is people at one train station, on one Monday morning, this is a convenience sample biased towards commuters and workers, and excludes non-commuters, other regions, weekends and different times, so it can't represent all New Zealanders. Analysis: only a single median is reported; there's no measure of spread or shape, and no display, so the pattern and variability are hidden. Conclusion: it generalises from a biased local sample to the whole country, which the data cannot

support. Redesign: pose a specific question (e.g. 'What is the typical daily screen time of NZ adults?'), use a large, random, nationally representative sample across regions, ages and days, collect screen time reliably (e.g. from device logs rather than recall), then analyse with a dot/box plot plus median and IQR, and only generalise to the population the sample was drawn from, acknowledging sampling variation.

Excellence: critiques the full PPDAC cycle and redesigns it to justify a valid inference.