Answers

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1. $\bar{x}$ = 53.5 (1 dp)
Median = 50.5

2. $\bar{x}$ = 4.59 (2 dp)
Median = 4.58

3. $\bar{x}$ = 46.8 (1 dp)
Median = 45.5

4. $\bar{x}$ = 7.2 (1 dp)
Median = 7.55

5. Control: $\bar{x}$ = 1.18 (2 dp)
Median = 0
Treatment: $\bar{x}$ = 1.33 (2 dp)
Median = 1

6. Control: $\bar{x}$ = 2.10 kg (2 dp)
Median = 2.1 kg
Treatment: $\bar{x}$ = 2.12 kg (2 dp)
Median = 2.1 kg

7. Control: $\bar{x}$ = 5.25 kg (2 dp)
Median = 4.86 kg
Treatment: $\bar{x}$ = 5.11 kg (2 dp)
Median = 4.83 kg

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8. LQ = 2.36
UQ = 7.25
IQ range = 4.89
Range = 9.24

9. LQ = 27
UQ = 66
IQ range = 39
Range = 98

10. LQ = 4.1
UQ = 8.5
IQ range = 4.4
Range = 11.4

11. LQ = 192
UQ = 784
IQ range = 592
Range = 857

12. a) LQ = 7, UQ = 8
IQ range = 1, Range = 5
b) LQ = 4.5, UQ = 8
IQ range = 3.5, Range = 5
c) Range in both cases is 5, yet the distribution in Question 12 b) has more data further from the median so the IQR is larger.

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13. a) Mean = 23.9, Median = 24
LQ = 24, UQ = 25
IQ range = 1, Range = 8
b) Mean = 23.9, Median = 25.5
LQ = 24, UQ = 27
IQ range = 3, Range = 28
c) Mean same but median up 1.5. Range is now 28, while the IQR has increased from 1 to 3. The results are spread more but the IQR is not affected by data at the extremes (results of 0 etc.).

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14. $\bar{x}$ = 4.93 (3 sf)
s = 2.77 (3 sf)

15. $\bar{x}$ = 48.7 (3 sf)
s = 29.9 (3 sf)

16. $\bar{x}$ = 501.4 (4 sf)
s = 283.2 (4 sf)

17. $\bar{x}$ = 50.7 (3 sf)
s = 30.5 (3 sf)

18. a) $\bar{x}$ = 61.5 (3 sf), s = 13.1 (3 sf)
b) From 48.4% to 74.6% there are 20 (67%) of the results.

19. a) Group B has the greatest standard deviation. The data is spread over a greater range (10.93 as opposed to 7).
b) Group A and C have exactly the same spread but each data value in group C is exactly 222 greater than the corresponding value in group A.

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20. $\bar{x}$ = 1.2 (1 dp)
s = 1.8 (1 dp)

21. $\bar{x}$ = 2.5 (1 dp)
s = 2.1 (1 dp)

22. $\bar{x}$ = 39.0 (1 dp)
s = 3.5 (1 dp)

23. $\bar{x}$ = 23.0 (1 dp)
s = 2.0 (1 dp)

24. $\bar{x}$ = 42.5 (1 dp)
s = 5.2 (1 dp)

25. $\bar{x}$ = 70.4 (1 dp)
s = 19.0 (1 dp)

Page 13 cont...

26. Before
$\bar{x}$ = 1.9 days (1 dp)
s = 1.9 days (1 dp)
After
$\bar{x}$ = 1.4 days (1 dp)
s = 1.5 days (1 dp)

Despite the number of 0 days dropping the system is reporting fewer absences (reduced by 0.5 days) and less spread of results (Std. Dev. down by 0.4 days).

27. School
$\bar{x}$ = 2.3 grades (1 dp)
s = 1.1 grades (1 dp)
Homework
$\bar{x}$ = 2.3 grades (1 dp)
s = 1.6 grades (1 dp)

The mean grade was the same but the spread increased (Std. Dev. up by 0.5) implying there were higher and lower grades. Possibly some cheated and some did not do their homework.

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28. Control $\bar{x}$ = 5.28 (2 dp)
s = 1.31 (2 dp)
Exp. Grp. $\bar{x}$ = 5.35 (2 dp)
s = 0.82 (2 dp)

The mean has increased slightly as a result of the instruction but the standard deviation has dropped considerably showing less variation of results after the instruction.

29. a) $\bar{x}$ = 3.03 people (3 sf)
s = 1.68 people (3 sf)
b) $\bar{x}$ = 2.43 people (3 sf)
s = 1.55 people (3 sf)
c) There are typically 3 people in a random NZ house ($\bar{x}$ = 3.03), but in their Hutt Valley sample the mean drops by half a person per house ($\bar{x}$ = 2.43). There is slightly more variation in the NZ sample as it has a higher standard deviation.

30. $\bar{x}$ = 0.83 for both groups but the standard deviation shows the spread has increased from s = 1.6 for the control group to s = 1.8 for the experimental group. There is a greater spread of results even though the means are the same.

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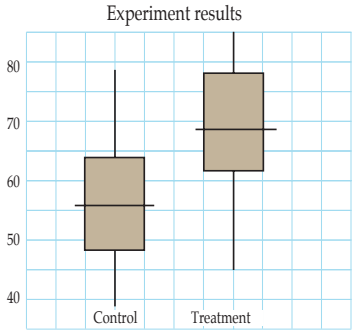
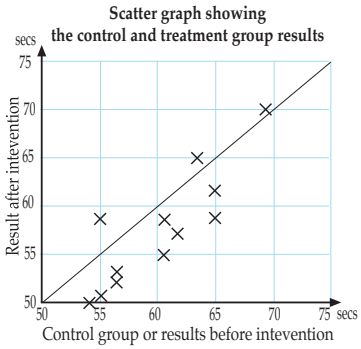
31.



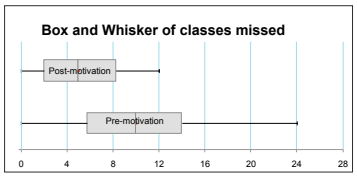
The treatment group shows a significant improvement. Three-quarters of the control group achieved under 64% while three-quarters of the treatment group achieved more than 62%.

32.



From the scatter graph we can see that most but not all the results are below the y = x line showing a reduced time. Therefore we can conclude that runners tend to run a faster time after the training break than before the break. The effect of the break is to tend to reduce the running time.

33.



From the side-by-side box and whisker graphs we can see number of classes missed tends to be less after the motivational programme than before the programme. Three quarters (upper quartile) of the students have missed less classes than the median number of classes missed by the same group before the motivational programme.

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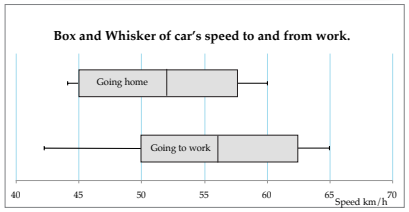
34. a)

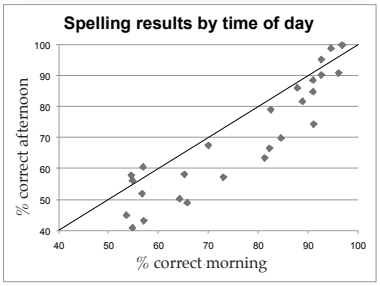
	Work	Home
Min.	42	44
LQ	50	45
Med.	56	52
UQ	63	57
Max.	65	60

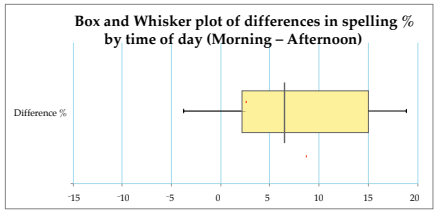


b) The workers going home tended to travel slower than the workers going to work. The slowest speed was a car going to work but the lower and upper quartiles of the workers travelling home was 5 km/h slower than the workers travelling to work. The median of workers travelling home was also less (4 km/h). The middle 50% of workers (LQ to UQ) on average travelled 5 km/h slower when going home.

35. a)

	Morn.	Aft.
Min.	53	38
LQ	57	50
Med.	77	65
UQ	91	86
Max	97	100





b) On the scatter graph most of the points are below the line y = x which means the students tended to have a higher score in the morning than in the afternoon.

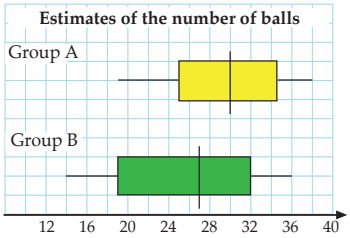
Page 18 Q35 b) cont...

b) This conclusion is supported by the summary statistics where the median is 12% higher in the morning. The box and whisker plot of paired differences also shows most students have increased scores in the morning test as the LQ, median and UQ have all increased (positive difference).

Page 19

36. a)

	Group A	Group B
Min.	19	14
LQ	25	19
Med.	30	27
UQ	34.5	32
Max.	38	36
Mean	29.8	25.7
S.D.	5.4	6.8



b) Group A's LQ was 25 which meant that 75% of their estimates were larger than 25. Group B's mean was 25.7 and its median was 27 showing that their average result was closer but their spread of results was large (S.D. = 6.8) meaning Group B's results were widely spread, not clustered around 25.

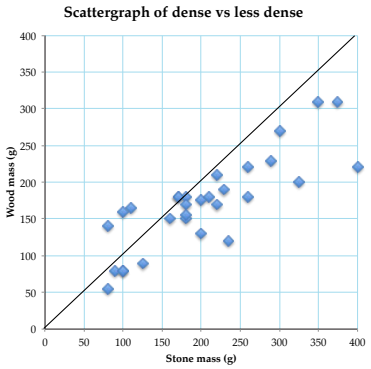
c) The middle 50% of Group A was from 25 to 34.5 balls (IQR = 9.5) which meant the estimations for this group were more consistent. Group B's IQR of 13 showed that this group had more trouble in coming to a consistent estimate.

Page 19 Q36 cont...

36. d) Group A tended to give estimates greater than Group B as shown by their higher minimum, LQ, median, UQ and maximum. Even so it is difficult to make a judgement as the difference in the medians is only three and given the large spread ($S.D._A = 5.4$ vs $S.D._B = 6.8$) there is insufficient evidence to draw a conclusion as to whether spreading the balls affects a person's ability to estimate the number of balls.

Page 20

37.



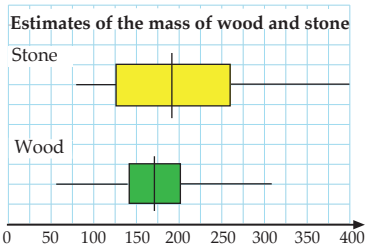
b) The scatter graph is best as we wanted to see if the intervention (changing the density of the object) affected the estimation of the mass. By comparing the results to the line y = x we can see if there is a trend towards one side.

c) There are thirty estimates of (stone, wood) of the same mass and only four of these have the less dense wood being estimated as heavier than the more dense stone. Twenty six are the same or have the more dense object as heavier. This is shown on the graph as most of the points are under the y = x line.

	Stone	Wood
Min.	80	55
LQ	125	140
Med.	190	172.5
UQ	260	200
Max.	400	310

Page 20 Q37 d) cont...

Therefore in conclusion for the same weight people tend to estimate a more dense object (stone) as heavier than the same mass but less dense (wood).



It is difficult from the box and whisker graph to draw a conclusion. It tends to show that the mass of wood estimates is lower but reinforces how much better a scatter graph is for this test–retest experiment.

Page 21

38. A number of interventions are possible such as;
Just roll all five and leave any that come up SIX and roll the remaining dice again. Repeat this once more so some dice will be rolled up to three times.

Authors' results

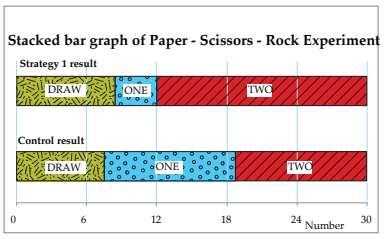
	Control	Expt.
Min.	13	6
LQ	16	19
Med.	18	21
UQ	21	25.5
Max.	25	29

The intervention tends to be an improvement upon the control. The box and whisker graph shows the results after intervention of the experiment tended to increase by 3 to 4. The median and LQ increased by 3 while the UQ increased by 4.5. The minimum of the experiment (6) is lower than the control (13) but it is an outlier.

Page 22

39. A number of interventions are possible such as: *As scissors is the only result that beats paper and Player One never selects paper, Player Two should randomly select from rock or paper only.*

Authors' results



The intervention tends to be an improvement upon the control. The Author's control had approximately equal results for a Draw (8/30), Player One winning (11/30) and Player Two winning (11/30). The experiment results had the Draw (9/30) being similar while Player One winning dropped to (3/30) and Player Two winning was up considerably (18/30). In theory the control should give equal results for Draw, Player One and Player Two winning. In the Author's experiment in theory Draw and Player One winning should have been equal at a probability of 0.25 while Player Two should have won with a probability of 0.5.

Page 24

40. **Explanatory variable**
Temperature of water.
Response variable
Height of the bean plant in millimeters.

41. **Explanatory variable**
Size of fuel discount incentive.
Response variable
Amount of dollars spent on the weekly supermarket shopping.

42. **Explanatory variable**
Breast feeding or not.
Response variable
Days ill with common illnesses.

43. **Explanatory variable**
Hours spent sleeping.
Response variable
Reaction time in seconds.

44. **Explanatory variable**
Amount of nutrients.
Response variable
Number of leaves on the plant or the height of the plant in cm.

45. **Explanatory variable**
Colour of test paper.
Response variable
Percentage correct in test.

46. **Explanatory variable**
Time of day test given.
Response variable
Percentage correct in test.

47. **Explanatory variable**
Frequency or length of meditation.
Response variable
Days ill with common illnesses.

48. **Explanatory variable**
Colour of car (light / dark).
Response variable
Accident rate of each category.

49. **Explanatory variable**
Whether they have had a holiday.
Response variable
Weight (kg).

Page 33

50. a)
- Same number of letters and positioning of letters on each equivalently numbered card.
- Letters randomly placed on cards.
- Number of letters increases from 7 to 15 per card.

b) In order to make sure that the two tests are equivalent (or parallel) and that the only difference is that Test 1 involves listening to ten minutes of Mozart's music prior to it.

c) Investigating remembering numbers or words rather than just letters of the alphabet or a mixture of all three on each card.

51. Other possible answers.

Instructions Test 1:
Thank you for taking part in the Mozart Effect experiment.

You will now be shown a set of ten cards. Each card will be held up for three seconds. When the card is removed you are to write down all the letters on the card you can remember.

Write the letters you recall against the applicable card number on the Student Result Sheet Test One that you have been given.

Only write letters that you recall. You may be penalised for any incorrectly recorded letter.

Let us begin.

Card 1 (*hold up card one for three seconds*).

Record the letters you recall from card 1 on your sheet now.

Adopt the same procedure for the next nine cards.

Thank you for taking part in the first part of the Mozart Effect experiment.

Page 33 Q51 cont...

Test 2 should be conducted on another day from the first test.

Instructions Test 2:
Thank you for taking part in the second part of the Mozart Effect experiment.

The first part of this experiment involves you listening to ten minutes of Mozart's music prior to undertaking the test.

Please put on the provided headphones and listen to the music. After ten minutes you will be told to remove the headphones and Test 2 will commence.

Ten minutes later
Please remove your headphones.

You will now be shown a set of ten cards. Each card will be held up for three seconds. When the card is removed you are to write down all the letters on the card you can remember.

Write the letters you recall against the applicable card number on the Student Result Sheet Test Two that you have been given.

Only write letters that you recall. You may be penalised for any incorrectly recorded letter.

Let us begin.

Card 1 (*hold up card one for three seconds*).

Record the letters you recall from card 1 on your sheet now.

Adopt the same procedure for the next nine cards.

Thank you for taking part in the final part of the Mozart Effect experiment.

Page 34

52. Teacher marked.

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Practice Internal Assessment – Conducting an Experiment 2.10

Your experiment and report should be teacher marked but below are some key points with regard to the marking.

To Achieve students need to conduct an experiment to investigate a situation using statistical methods showing evidence of using each component of the investigation process.
This will mean: posing a question about the experimental situation; planning the experiment by determining appropriate variables and measures and data collection and recording methods; conducting the experiment and collecting data; selecting and using appropriate displays and measures; discussing displays and measures; and communicating findings in a conclusion.
In their report the student needs to have:

- Posed an investigative question about the experimental situation.
- Planned the experiment. They have clearly identified variables used, or how the variables were measured, or the sample or experimental units used.
- Described how the experiment was conducted and how the data was collected and recorded. Experimental data is included in the report.
- Selected and used appropriate displays and measures.
- Discussed the displays and measures.
- Communicated findings clearly.

To Achieve with Merit, students need to show evidence of conducting the experiment to investigate the situation using statistical methods, linking this to the context, explaining relevant considerations, and making supporting statements.
This will mean: posing a question about the experimental situation; planning the experiment by determining appropriate variables and measures and data collection and recording methods; conducting the experiment and collecting data; selecting and using appropriate displays and measures; discussing displays and measures; and communicating findings in a conclusion.
In their report the student needs to have:

- Posed an investigative question about the experimental situation. Linked the purpose or question to the situation being investigated.
- Planned the experiment. They have clearly identified variables used, how the variables were measured, and the sample or experimental units used. They have considered related variables and possible effects of these.
- Described how the experiment was conducted and how the data was collected and recorded. Experimental data is included in the report.
- Selected and used appropriate displays and measures.
- Discussed the displays and measures, using supporting evidence that is linked to the context.
- Communicated findings clearly, and has linked findings to the experimental situation.

To Achieve with Excellence, students need to show evidence of conducting the experiment to investigate the situation using statistical methods, integrating statistical and contextual knowledge throughout the process.
This will mean: posing a question about the experimental situation; planning the experiment by determining appropriate variables and measures and data collection and recording methods; conducting the experiment and collecting data: selecting and using appropriate displays and measures; discussing displays and measures; and communicating findings in a conclusion.
In their report the student needs to have:

- Specified the purpose of the investigation and the investigative question, and shown how these are relevant to the situation being investigated.
- Planned the experiment. They have clearly identified variables used, how the variables were measured, and the sample or experimental units used. They have considered related variables and possible effects of these, and have developed a plan to mitigate against these if possible.
- Described how the experiment was conducted and how the data was collected and recorded. Experimental data is included in the report.
- Selected and used appropriate displays and measures.
- Discussed the displays and measures, integrating statistical and contextual knowledge.
- Communicated findings clearly, and has linked findings to the experimental situation. They have reflected on key aspects of the experimental process, for example they may have considered possible sources of variability in the data, considered effects of related variables, considered other areas to investigate.

The final grade will be decided using professional judgement based on a holistic examination of the evidence provided against the criteria in the Achievement Standard.