National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Exemplar for Internal Achievement Standard

Mathematics and Statistics Level 2

This exemplar supports assessment against:

Achievement Standard 91265

Conduct an experiment to investigate a situation using statistical methods

An annotated exemplar is an extract of student evidence, with a commentary, to explain key aspects of the standard. It assists teachers to make assessment judgements at the grade boundaries.

New Zealand Qualifications Authority

To support internal assessment

	Grade Boundary: Low Excellence
1.	For Excellence, the student needs to conduct an experiment to investigate a situation using statistical methods, with statistical insight. This involves integrating statistical and contextual knowledge throughout the investigation process which may involve reflecting on the process, or considering other relevant variables. This student's evidence is a response to the TKI assessment resource 'Memory Tests'. The student has posed an investigative question (1), planned the experiment (2), conducted the experiment and collected data (3), selected appropriate displays and measures (4), discussed displays and measures (5) and communicated findings in a conclusion (6). The student has integrated statistical and contextual knowledge in the planning of the experiment (7) and has reflected on the process and considered other variables (8). For a more secure Excellence, the student could have discussed in more detail how their findings and reflections could be used to improve the experimental design and strengthened the integration of statistical and contextual knowledge in the response.

Student 1: Low Excellence

NZQA Intended for teacher use only

The purpose of my investigation is to see if time affects short term memory. (1)
Question: Is the number of items recalled after seeing a set of objects affected by the length of time between seeing the objects and writing them down?

From the information I was given I found that short term memory is 'the capacity for holding a small amount of information in mind in an active, readily available state for a short period of time.' Short term memory can be as short as a few seconds.

For my experiment I am going to take photographs of 10 objects and print them in black and white onto a single page. I am going to use a class of 30 year 10 students for the experiment. They will need to have a piece of blank paper and a pen. The variables will be the number of items that are remembered initially and then the number of items remembered after 10 minutes.
The students will be shown the page of objects and have one minute to study the objects. I will then take the page away and get them to write down all of the objects that they can remember over a two minute period. The two minutes will be timed to ensure consistency. Once the two minutes is up I will collect in the sheets of paper. I will wait a further 10 minutes before asking the students to write down as many objects that they can still remember. They will have another two minutes, which I will time, to write down the objects they can remember. I choose 10 minutes because the reading I did suggested that short term memory was restricted to a limited time. I also felt that 10 minutes was a good test to see how well the students had initially studied the original photos as this could also increase the initial number of objects remembered and the number of objects remembered after 10 minutes. It is important that the students don't have an opportunity to discuss the items they remembered during the 10 minute wait so I am going to ask them to read silently during that time. (2)
For each student I will allocate a number from 1 – 30 so they won't be identified and shouldn't feel any peer pressure about their memory.
10 objects will be used because I don't think anyone will remember all 10 of them, so it should be enough to get varied results from the experiment.
The objects are a pie, stereo, laptop, glasses, a calculator, finger, bucket, fence, car and batteries. I chose these objects as they were readily accessible objects at school and therefore easy for me to photograph.
I have chosen a black and white copy of the images because: (7)

1. the images appear more clear i.e the edges of the shape are sharper meaning that the object itself is more recognisable than in colour
2. the background colour does not interact with the object and hence the object is better represented.

I think that the number of objects that people remember initially will be more than the number of objects they remember after the 10 minute break, because based on my own experience and my readings, remembering things after a break is a lot harder than recalling them immediately. (7)

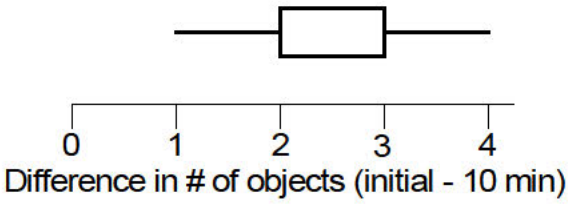
Because for this experiment I am investigating if there is a difference in the number of objects remembered I am going to take each individual student's results immediately after they have seen the pictures and then subtract from the same individual student the number of objects they remembered after 10 minutes. (3)

I have included the data in the appendix.

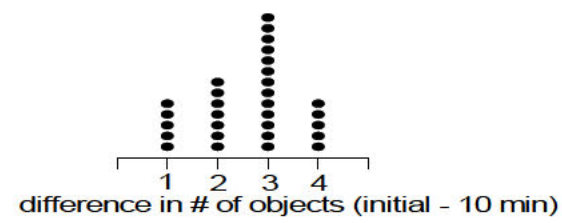
Table of measures of differences before and after 10 minutes.

Min	LQ	Median	Mean	UQ	Max
1	2	3	2.6	3	4

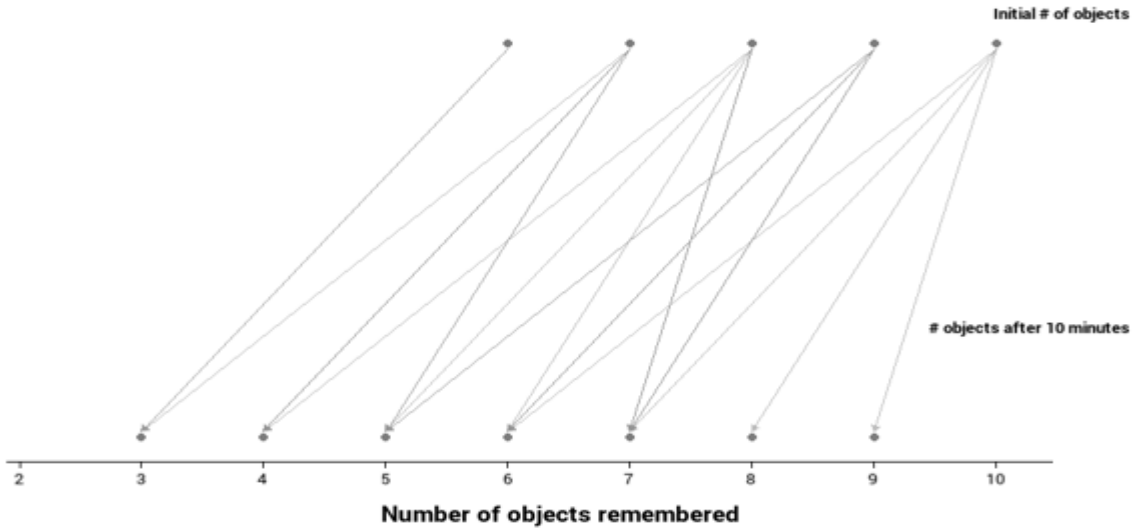
Box and whisker plot of differences



Dot plot of differences



(4)



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Looking at my graph I can see that four students in the class were able to remember all of the objects at the beginning so had a very good short term memory. All of the students remembered less objects after the 10 minute wait because the lines on my arrow graph show a decrease in items remembered. The difference in the number of objects that was remembered varied with the most common difference being three less objects remembered. I can see this from the dot plot of the differences where 3 is the highest column on the graph.

There was more variation in the number of objects remembered after 10 minutes than in the number of objects remembered initially. This is shown in the arrow graph where initially there were 6 – 10 objects remembered, and after 10 minutes this had stretched to 3 – 9 objects remembered. The full extent of the spread is hidden due to a number of double ups for example two students who went from 8 to 6 and three students who went from 9 to 6.

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None of the differences were zero and the distribution of differences on the box and whisker plot shows a small amount of left skew because there is a tail to the left. It is not that clear that people with a good initial memory also have a good memory after 10 minutes. Looking at the raw data (attached in the appendix) and the differences in the number of objects that were remembered, the largest difference was four less objects remembered and on the arrow plot this corresponds to the points (8, 4),(9, 5) and (10, 6). Also from the raw data it was interesting to note that of the four people that remembered all 10 objects initially, only two of them were able to recall more objects after 10 minutes than people who had scored below them initially. The people that remembered one less object after 10 minutes than they did initially were people that had a good memory (remembered 10, 9 or 8 objects) at the start.

I set out in my investigation to see if there was any difference in memory over time. The results I gathered from my experiment indicate that time does have an effect on memory as all the students in the class remembered less objects after the 10 minute break. This has been graphically shown in the arrow graph with all the lines moving in the same direction (downwards to the left).

6

From the reading I was given, I learnt that the amount of information that can be kept in short term memory can vary but based on the results of a famous experiment on short term memory the number given is often seven plus or minus two which is between five and nine items. This number fits with the results of my experiment.

As a follow up, I would like to see if colour photo objects have the same effect as black and white images. Based around the research I was given one article stated that people remember objects better when they are in colour. This contradicted what some of the other articles suggested. So I think I should test to see if giving the objects in colour would result in fewer objects being remembered.

8

	Grade Boundary: High Merit
2.	For Merit, the student needs to conduct an experiment to investigate a situation using statistical methods, with justification. This involves linking components of the experimental process to the context, explaining relevant considerations in the investigation process, and supporting findings with statements which refer to evidence gained from the experiment. The student has posed an investigative question (1), planned the experiment (2), conducted the experiment and collected data (3), selected appropriate displays and measures (4), discussed displays and measures (5) and communicated findings in a conclusion (6). The student has conducted an experiment to investigate a situation using statistical methods. They have justified components of the process by explaining relevant considerations in the introduction (7) and in the planning of the experiment, and also by supporting findings with statements which refer to evidence gained from the experiment (8). To reach Excellence, the student could provide more evidence of integrating statistical and contextual knowledge. For example, the student could have discussed whether the findings for the experiment agree or not with the research. They could also reflect on the experimental design and consider improvements in light of experience.

Student 2: High Merit

NZQA Intended for teacher use only

My experiment is about guessing the age of a person by looking at the picture of a person. I will investigate whether wearing make-up has an effect on the guess of the age. From the information I was given I have found that people wear make-up aimed at making them look very much younger than their real age and making it harder to guess their age. I also found that most women are hardly seen without make-up. From the information/ideas I found out that comparing two photos, one with make-up on and another one without make-up can create a different estimation of a person's age. The photos of a person with make-up and another without make up can lead people toward an answer which is different, because makeup affects the look of a person by covering dark and red spots, wrinkle, discoloration area, breakouts and any other undesirable spots or areas on their face. These things make photos of a person with and without make-up guide people into different estimates of the real age. I'm not sure if wearing make-up will always make people look younger, because often teenagers wear make-up to look older and women wear make-up to look younger, so my problem for this investigation is "Does changing the picture of a person wearing make-up and without make-up have an effect on the estimation of my cousins real age?"

7

1

I will investigate this problem by using two photos of my cousin who is aged 32. There are two treatment groups in this experiment: one is the photo of my cousin with her make-up on and another one is the photo of cousin without her make-up, to see if there is a difference of the estimation of her age between the two photos/groups. Both of these photos have a question "How old is she?" underneath.

Each photo will be pasted onto a power point display in colour. (These have been included in the appendix).
The experimental group will be year 13 students a total of 50 students. I have to ensure that the 50 students selected for this experiment both have a maths class at the same because the experiment needs to run at the same time to afford contamination of the data and it would be easier to do at one time. I learnt from my research given to me that I needed to randomize my two groups. Once I have my experimental participants I will ask each person to select from a bag a piece of paper. There are 25 yellow pieces of paper and 25 blue pieces. This will randomize my groups which means I should not end up with all females in one group and all males in another, or all of the people who know something about how make-up can affect the estimate of a person's age in one group and all the people who know nothing about how make-up may affect a person's estimate of age in another, as this could skew the results because females are more likely to understand the effect make-up can have on a person's appearance. I then split the two groups into different rooms because I didn't want the two groups talking to each other before or during the experiment as this could affect the results. I then went into the room of 25 participants and requested silence and then waited till everyone stop talking I then showed them the picture using power point of my cousin with make-up and asked them to write down on the yellow blank piece of paper my cousin's age. Once I had collected all the answers back in I went into the second room where the other group were waiting and repeated the process from the first room, except this time the photo was of my cousin not wearing make-up and the answers were written down on the blue piece of paper. There was no time limit as I felt that a time limit might rush people into making silly estimates. I will record the data from the collected answers on to a spreadsheet. (Which I have attached in the appendix).

2

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The response variable of this experiment will be the estimated age of cousin in years.
The variables we can control in this experiment are:

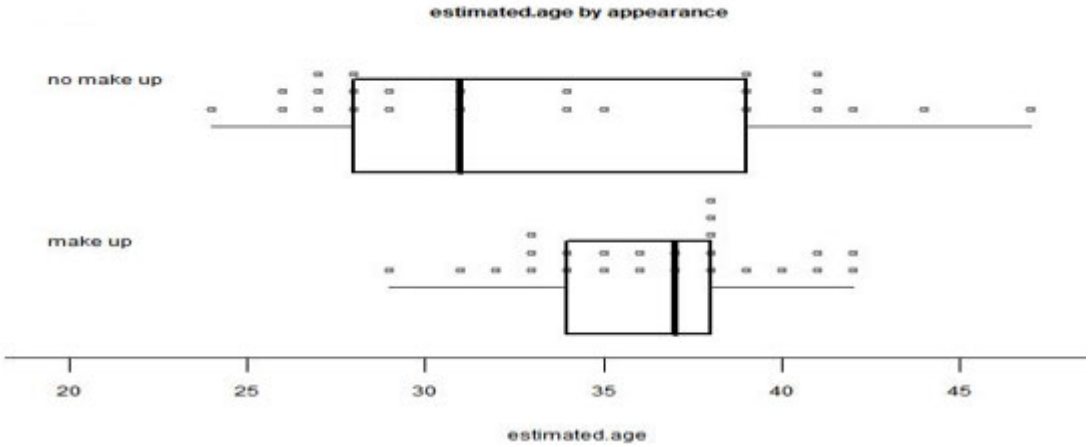
- Each group will answer the question in the same test condition, same date, same time and are in the same group.
- The power point display the students will see, will have the photos in colour with the same question "How old is she?" underneath.
- The students will get to see the power point display at the same time and the coloured paper once the student has written their answer.
- The photos of my cousin were taken one after another in the same direction with the same facial expression and the same lighting conditions. I did this to ensure that the only difference was the make-up.

7

- Students were required not to speak or communicate in any way to one another. I did this to ensure that some students who already had previous/current knowledge of how make-up works could not influence those who did not.

The variables that we cannot control are:

- The personal knowledge of the students because some students might know me and have seen my cousin before at my house.
- Some of the students might just guess random answers.



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Summary of estimated age by appearance

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	Sample.Size
no make-up	24	28	31	33.48	39	47	25
make-up	29	34	37	36.40	38	42	25

From the graphs of the two sets of data it is obvious that the average estimate of my cousins age when wearing make-up is greater than when not wearing make-up. This is confirmed by the value of the medians. For no make-up the median estimate is 31 years whilst for make-up it is 37 years. This suggests that people are likely to think people are older if they wear make-up.

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It is also obvious that there is much more variability in the estimate of ages when there was no make-up than when there is make-up. This is shown by the overall width of the dot plots and the width of the boxes. The box is 4 years wide for make-up and 11 years wide for no make-up.

The graph for the no make-up estimates is skewed to the right. The top half of the age estimates are much more spread out (from 31 years to 47 years) than the bottom half from 24 to 31 years. This is mirrored in the middle 50% because the median estimated age is towards the left of the box.

8

The graph for make-up is not so skewed as it is quite symmetric. This suggests that wearing make-up hides peoples real age and people estimates of the age of the person are more consistent than without make-up. and equally likely to be an under or over estimate.

I believe my experiment was well-designed, in that I tried to eliminate all factors that influence how old you appear apart from make-up, and executed. The median age estimate for wearing make-up (37) is greater than that for not wearing make-up (31) for the two groups in this experiment and this suggests that wearing make-up can influence the estimation of a person's age.

8

If I were to repeat this experiment I would give every student only 2 minutes to answer.

	Grade Boundary: Low Merit
3.	For Merit, the student needs to conduct an experiment to investigate a situation using statistical methods, with justification. This involves linking components of the experimental process to the context, explaining relevant considerations in the investigation process, and supporting findings with statements which refer to evidence gained from the experiment. This student's evidence is a response to the TKI assessment resource ‘Jump line'. The student has posed an investigative question (1), planned the experiment (2), conducted the experiment and collected data (3), selected appropriate displays and measures (4), discussed displays and measures (5) and communicated findings in a conclusion (6). Components of the process have been justified by supporting findings with statements which refer to evidence gained from the experiment. For a more secure Merit, the student could provide more depth in the explanation of the relevant considerations in the planning of the experiment, for example, an explanation for the 2.3 m distance for the target line. The student could also clearly identify what other variables were controlled in the experiment.

Student 3: Low Merit

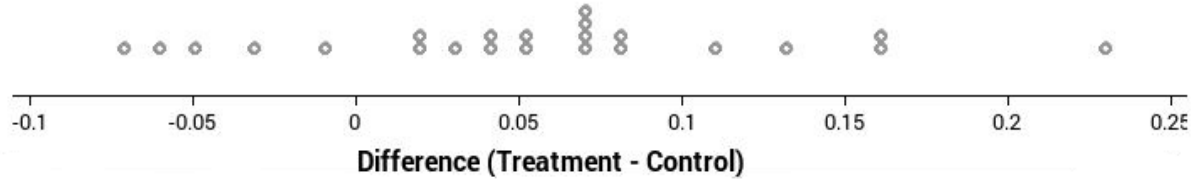
NZQA Intended for teacher use only

The problem I am investigating is whether having a target line on the ground will effect the distance the students from the year 9 maths class will jump. This will exhibit that the participants prefer to have a set goal which is a good direction in fueling ambition. (1)
I think that the students will jump further with a line on the ground as a target to reach.
We will do the experiment outside on the area of grass behind A4. Because we are going to ask all the participants to jump with bare feet grass will be better to jump on than the concrete. We will have a line on the ground as a start line. This will be a piece of tape pinned at either end so it stays in the same position. Each student will stand with both feet behind the line and be asked to jump with two feet as far as they can. We will tell them they can bend their knees and swing their arms but their feet have to be beside each other and not one forward and one back and they have to land on both feet. (2)
Once we have explained the rules for the jump we will give the instruction 'Try and jump as far as you can.' I will be at the start line making sure the take off is correct and the other people in my group will mark the landing point and measure the distance of the jump. A tape measure will be used and we decided to measure to cm.
The treatment is the target line. We will mark out a line 2.3 metres away from the starting line. It will be also pinned at either end so it cannot move. The instructions for the second jump will be the same as the first jump but this time there is the target line to aim for. Before the class do the second jump we will remind them about the rules for the jump.

Control (no line)	Treatment (line)	Difference
1.52	1.45	-.07
1.46	1.54	.08
2.0	1.94	-.06
1.26	1.33	.07
1.56	1.61	.05
1.96	2.0	.04
1.63	1.67	.04
1.59	1.70	.11
1.49	1.48	-.01
1.62	1.85	.23
1.72	1.69	-.03
1.58	1.66	.08
1.45	1.52	.07
1.45	1.47	.02
1.18	1.31	.13
1.41	1.57	.16
1.33	1.28	-.05
1.48	1.51	.03
1.49	1.56	.07
1.61	1.66	.05
1.60	1.67	.07
1.62	1.78	.16
1.29	1.31	.02

(3)

Dot plot of differences between control and treatment



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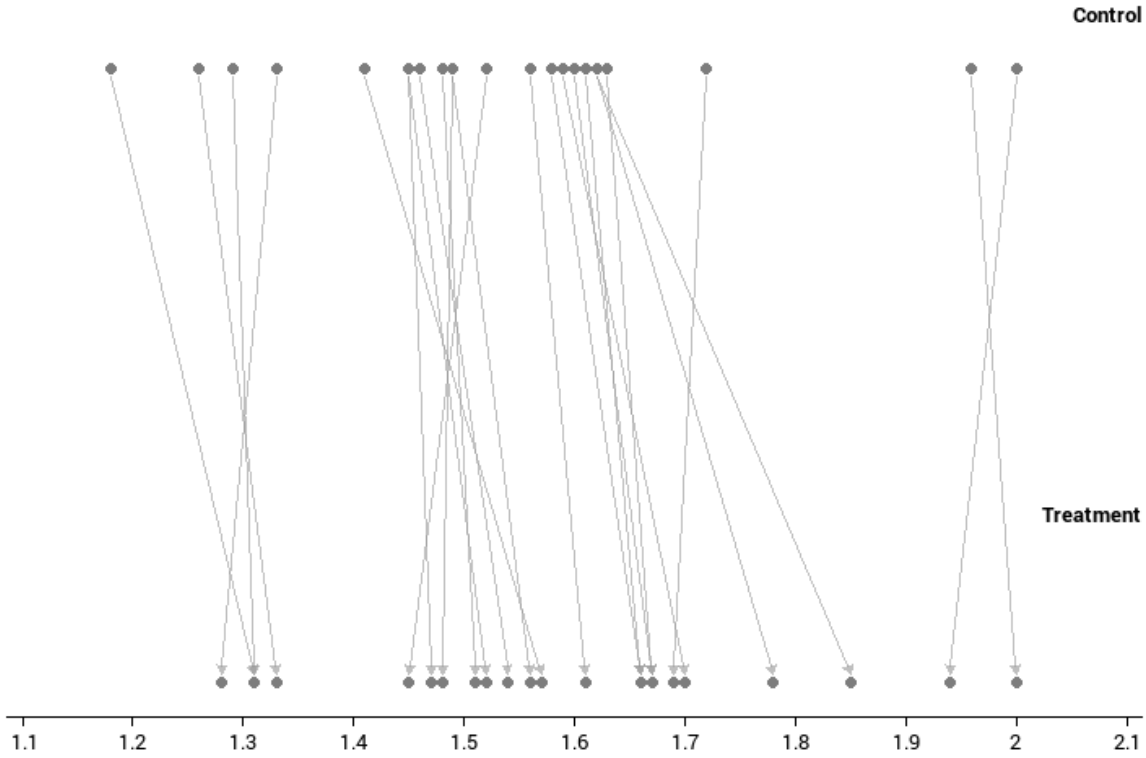
Line graph of jumping to target measurements done in metres



4

In the table most of the differences are positive and on the dot plot there are five differences that are negative meaning five people jumped shorter than their first jump without the line and their differences ranging from 1 cm to 7 cm. On the line graph most of the arrows go across to the right meaning the treatment jump with the target line was further than the control jump without the line.

5

The data implied that I was correct with what I thought that the students from the year 9 class would jump further when there was a line on the ground as a target to reach. 18 of the 23 students jumped further so having the line on the ground did seem to effect the distance the class jumped.

6

	Grade Boundary: High Achieved
4.	For Achieved, the student needs to conduct an experiment to investigate a situation using statistical methods. This involves showing evidence of using each component of the investigation process. This student's evidence is a response to the TKI assessment resource 'Memory Tests'. The student has posed an investigative question (1), planned the experiment (a paired comparison with a 10 minute wait time as the intervention) (2), conducted the experiment and collected data (3), selected appropriate displays and measures (4), discussed displays and measures (5) and communicated findings in a conclusion (6). To reach Merit, the student could support findings with statements which refer to evidence gained from the experiment and explain relevant considerations in the investigation process, for example, the reason for a 10 minute wait before listing the objects a second time.

Student 4: High Achieved

NZQA Intended for teacher use only

Question: Does the time between seeing some objects effect the number of objects that are remembered? (1)

For my experiment I am going to take photographs of 10 objects and print them in black and white onto a single page. I am going to use a class of 30 year 10 students for the experiment. They will need to have a piece of blank paper and a pen.
Each student will be shown the page of photographs and have one minute to look at the objects. I will then take the page away and get them to list all the objects that they can remember. I will give them two minutes to do the list. I will then wait 10 minutes and ask them to list the objects they can still remember. (2)
I will give them two minutes to do the second list. I will then count the number of objects they remembered at the beginning and then count the number of objects they remembered after 10 minutes.

I want to see what happens to the number of objects that are remembered from listing them straight after they have been seen and then listing them after a 10 minute wait so I am going to find the difference between the number remembered at the beginning and the number after 10 minutes.

Student number	Objects remembered at the beginning	Objects remembered after 10 minutes	Difference in # of objects remembered
1	9	7	2
2	9	7	2
3	10	8	2
4	8	7	1
5	9	5	4
6	7	5	2
7	7	4	3
8	9	6	3
9	10	7	3
10	10	9	1
11	9	5	4
12	8	7	1
13	7	3	4
14	7	4	3
15	8	7	1
16	7	4	3
17	8	5	3
18	7	4	3
19	9	6	3
20	6	3	3
21	9	6	3
22	9	7	2
23	8	7	1
24	7	5	2
25	10	6	4
26	8	6	2
27	7	4	3
28	9	6	3
29	6	3	3
30	8	4	4

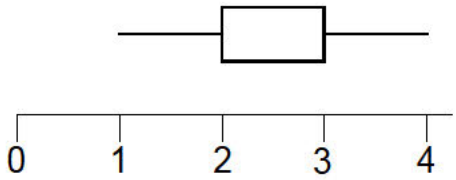
(3)

Only four students in the class were able to remember all of the objects at the beginning. Every student in the class remembered less objects after the 10 minute wait. The most common difference was three less objects remembered. 5
Mean for memory at beginning = 8.17 (2dp)
Standard deviation for beginning memory = 1.16(2dp)
Mean memory after 10 minutes = 5.57 (2dp)
Standard deviation for memory after 10 minutes = 1.54 (2dp)
At the start, a student in the year 10 class was able to remember 8.2 objects but after 10 minutes the average had dropped to 5.6 objects. There was more spread in the memory after 10 minutes than there was at the beginning.

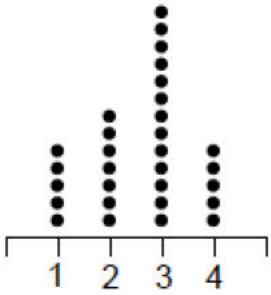
Statistics for difference in the memory (At beginning memory – 10 minute memory)

Min	LQ	Median	UQ	Max	Range	Mean
1	2	3	3	4	3	2.6

Difference in # of objects remembered



Dot plot difference in # objects remembered



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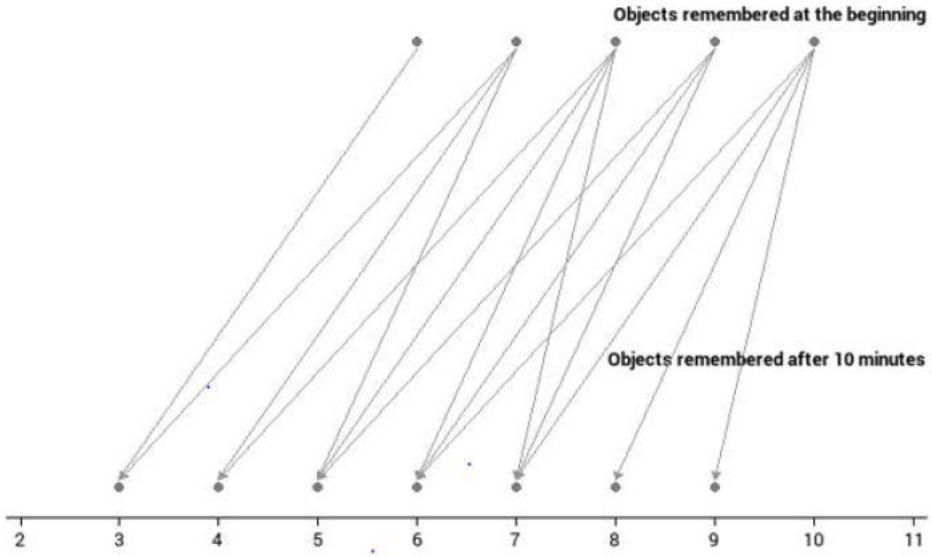
For the students in the year 10 class the smallest difference in memory was 1 (one less object remembered after the 10 minutes) and the largest difference was four as shown on the dot plot. The box and whisker plot shows a range of 3 indicating that there was very little change between the students memory at the start and after 10 minutes. 5



4

From my investigation I wanted to see if there was any difference in memory over time. Based on my experiment this is the case as all the year 10 students in the class remembered less objects after the 10 minute break so the break did effect the number of objects remembered. 6

	Grade Boundary: Low Achieved
5.	For Achieved, the student needs to conduct an experiment to investigate a situation using statistical methods. This involves showing evidence of using each component of the investigation process. This student's evidence is a response to the TKI assessment resource ‘Jump line'. The student has posed an investigative question (1), planned the experiment (2), conducted the experiment and collected data (3), selected appropriate displays and measures (4), discussed displays and measures (5) and communicated findings in a conclusion (6). For a more secure Achieved, the student could provide clearer detail in the plan about the position of the goal and further detail about the style of the jump. They could also give additional detail in the discussion of the displays and measures.

Student 5: Low Achieved

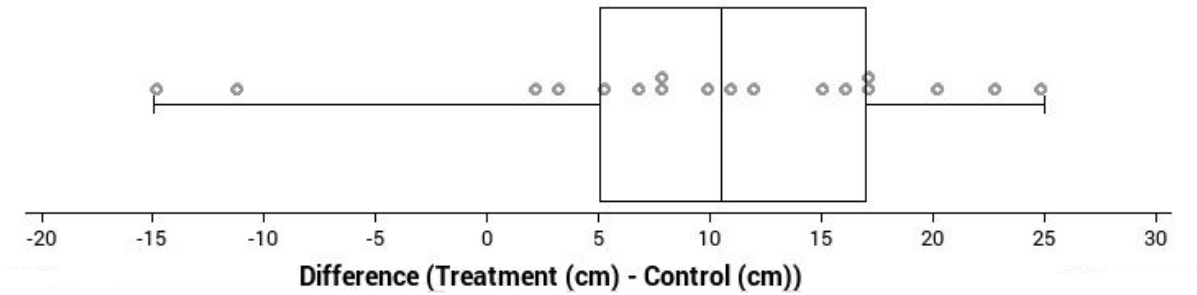
NZQA Intended for teacher use only

Students usually perform better with a set goal so I wish to run an experiment to see if students in my allocated year 9 class will be able to jump further if they know there is a set goal to reach.
The problem that I am investigating is does having a set goal to reach influence how far they will jump. I think the experimental units will jump further with the set goal rather than when they don't because they'll have something to aim for. 1
The control will be jumping as far as they can without the goal.
The treatment will be jumping with the goal and seeing if they can jump further than the previous one.
The response variable will be how far the students can jump. The jumps will be measured twice – once with no goal and once with a goal.
Controlled variables:
Each student will jump from the same starting line.
Both parts of the experiment will be conducted at the same time of day.
Students will wear the same uniform and the location will be the same.
They will jump with both legs together for both parts of the experiment.
Experimental steps:
Students will be told to stand on the marked line and jump as far as they can.
The length of the jump will then be measured. 2
Repeat for all students and then set up the goal they should try and reach.
They will be told to stand on the line to jump again and try to reach the goal.
This will be measured and recorded.

Control (cm)	Treatment (cm)	Difference (cm)
135	152	17
142	150	8
179	182	3
120	145	25
198	183	-15
160	167	7
150	158	8
124	141	17
180	182	2
140	155	15
137	148	11
165	188	23
150	160	10
145	165	20
165	154	-11
133	138	5
127	139	12
118	134	16

3

Box and whisker and dot plot of the differences between control (jumping with no goal) and the treatment (jumping with the goal)



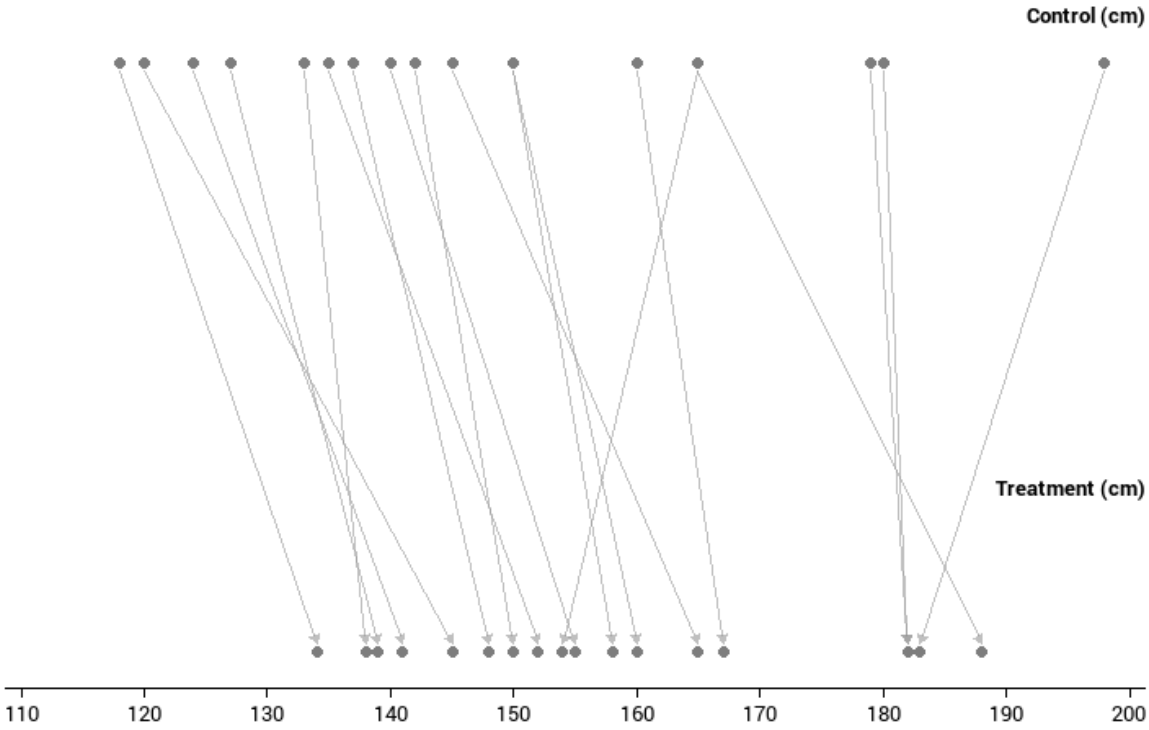
5 point summary:

Min	Q1	Med	Q3	Max
-15	5	10.5	17	25

IQR = 12, Range = 40

4

Link graph for how far they can jump



I can see from my link graph that almost all of the lines are going across to the right indicating to me that the year 9 students jumped further with the goal. Two of the lines are going the other way meaning two of the 18 students did not beat their previous jump.
The control results range from 118 to 198 whereas the treatment results range from 134 to 188. The range between the two jumps was 40. This is quite a big difference between the two jumps. The median difference was 10.5 cm meaning that students on average jumped 10.5 cm more with the goal.

5

The question that I investigated was does having a set goal influence the distance the students in my year 9 allocated class can jump. The answer to my question was Yes. It does influence the distance and the students tend to jump further knowing with a goal.

6

	Grade Boundary: High Not Achieved
6.	For Achieved, the student needs to conduct an experiment to investigate a situation using statistical methods. This involves showing evidence of using each component of the investigation process. This student's evidence is a response to the TKI assessment resource 'Memory Tests'. The student has posed an investigative question (1), planned the experiment, (a paired comparison with a 10 minute wait as the intervention) (2), conducted the experiment and collected data (3), selected appropriate displays and measures (4) and communicated findings in a conclusion (5). To reach Achieved, the student would need to discuss the displays and measures. The response could also be strengthened by the inclusion of an arrow diagram which would allow the student the opportunity to discuss differences for individual participants in the experiment.

Student 6: High Not Achieved

NZQA Intended for teacher use only

1

Question: Does the time between seeing objects effect the recall of the objects?

For my experiment I am going to take photographs of 10 objects and print them in black and white onto a single page. I am going to use a class of 30 year 10 students for the experiment. They will need to have a piece of blank paper and a pen. The variables will be the number of items that are remembered initially and then the number of items remembered after 10 minutes.

The students will be shown the page of objects and have one minute to study the objects. I will then take the page away and get them to write down all of the objects that they can remember over a two minute period. Once the two minutes is up I will collect in the sheets of paper. I will wait a further 10 minutes before asking the students to write down as many objects that they can still remember. They will have another two minutes, which I will be timed, to write down the objects they can remember. I choose 10 minutes because my research suggested that short term memory was restricted to a limited time. I also felt that 10 minutes was a good test to see how well the students had initially studied the original photos as this could also increase the initial number of objects remembered and the number of objects remembered after 10 minutes. I am going to ask them to read silently during that time.

2

10 objects will be used. The objects are a pie, stereo, laptop, glasses, a calculator, finger, bucket, fence, car and batteries. I chose these objects as they were readily accessible objects at school and therefore easy for me to photograph.

I think that the number of objects that people remember initially will be more than the number of objects they remember after the 10 minute break.

Because for this experiment I am investigating if there is a difference in the number of objects remembered I am going to take each individual student's results immediately after they have seen the pictures and then subtract from the same individual student the number of objects they remembered after 10 minutes.

Data from the class:

Student number	Memory after looking at the objects	Memory after 10 minutes	Difference in memory
1	9	7	2
2	9	7	2
3	10	8	2
4	8	7	1
5	9	5	4
6	7	5	2
7	7	4	3
8	9	6	3
9	10	7	3
10	10	9	1
11	9	5	4
12	8	7	1
13	7	3	4
14	7	4	3
15	8	7	1
16	7	4	3
17	8	5	3
18	7	4	3
19	9	6	3
20	6	3	3

21	9	6	3
22	9	7	2
23	8	7	1
24	7	5	2
25	10	6	4
26	8	6	2
27	7	4	3
28	9	6	3
29	6	3	3
30	8	4	4

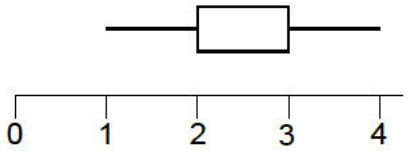
3

Mean after seeing the objects = 8.17 (2dp)
Mean after 10 minutes = 5.57 (2dp)
No student remembered more after 10 minutes as shown by the difference in the two means.

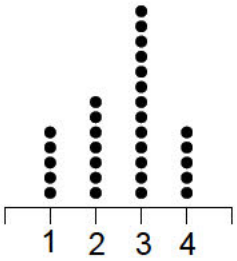
Statistics from the experiment

Min	1
LQ	2
Median	3
UQ	3
Max	4
Range	3

Difference in memory



Dot plot of difference in memory



4

Students in my experiment showed that they remembered less after 10 minutes. So the time did affect their recall.

5