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

Exemplar for Internal Achievement Standard

Mathematics and Statistics Level 1

This exemplar supports assessment against:

Achievement Standard 91944

Explore data using a statistical enquiry process

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

New Zealand Qualifications Authority

To support internal assessment

Grade: Achieved
For Achieved, the student needs to explore data using a statistical enquiry process, This involves explaining the source of the data used in a statistical enquiry, presenting the data using at least one appropriate visualisation, and describing features of the data in context with reference to at least one visualisation. The student has explained the source of the data. The evidence includes identifying who the population of interest is, what the variables are that are being investigated, and how the data being investigated was collected. The sample data has been presented using comparative dot plots and box and whisker graphs. Three comparative features of the data have been described appropriately in context for centre (median), spread (interquartile range), and shape. The features are identifiable in the visualisations provided. For Merit, the student would need to complete the statistical enquiry process by making a correct call and providing more evidence of justification in their response. While features of the data have been justified in context, appropriate justification would need to occur in another part of the statistical enquiry process, e.g. in making an informal inference justification. This could occur by correctly using the data and measures evident in the visualisation to make the call.

Achieved

NZQA Intended for teacher use only

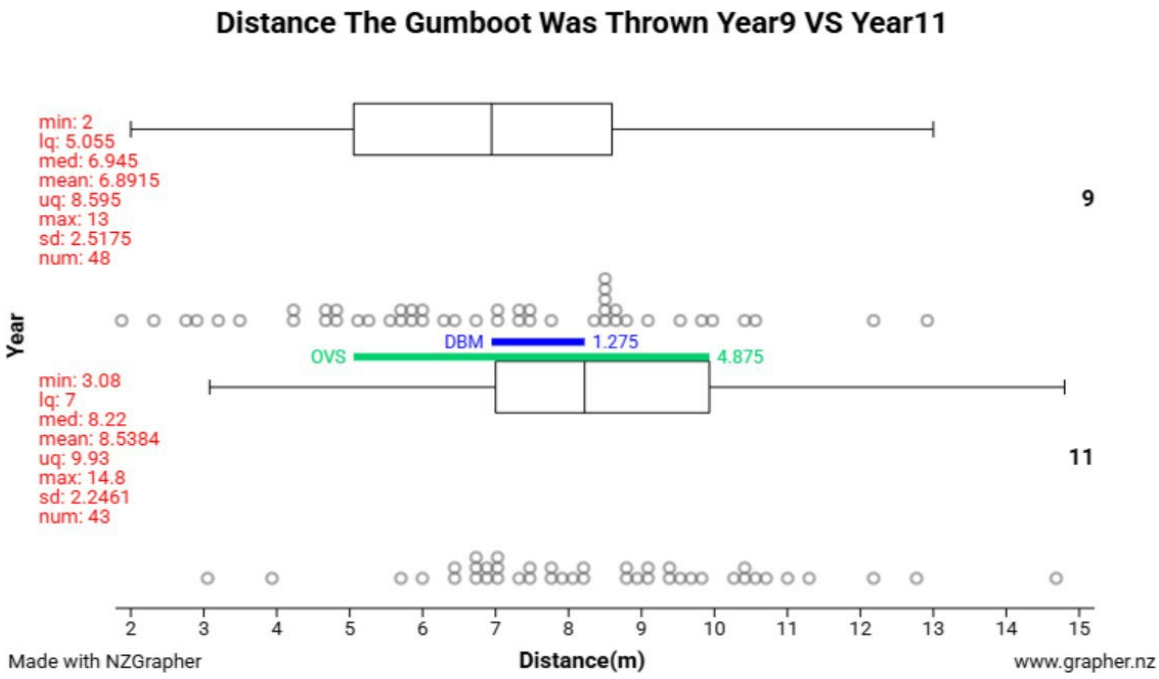
Purpose:
A random sample of students were taken from the whole roll of year 9 and 11 school students to see if the students in year 11 tend to throw a gumboot further than the students in year 8 , for all the students at [redacted] high school in 2025.

Question:
Do the students in year 11 tend to throw a gumboot further than students in year 9, for all the [redacted] High School students in 2025?

I think that the year 11 will throw a further distance than the year 9 because they might have more strength,have a lighter boot, had no blazers or jerseys on and could have more muscle.

Plan:
The two groups where year 9s and year 11s, the data was collected by some of the year 11 math students, the variable being measured is how far gumboots can be thrown. The data was collected at [redacted] high school the data was sourced by the sample that was taken from each year9 and year11 class, the data was collected during period 5 on a Friday and period 3 on a Tuesday at [redacted] in 2025.the method in which the data was collected is one student would stand at the throw line and check if they did step over the line, one student would move the measuring tape and read the distance, and one student would stand next to the measuring person and record the distance on paper. The data collection process included many specific steps because they wanted all the results to be equal and to see fairly what year tends to throw the farthest, but they had many disruption and incidents such as one boot was heavier and longer than the other, they all stood in different spots when throwing leading to wrong calculations

Data:



Centre:
In my graph I can see that the two middle 50% for the distance the year 9s threw the gumboot and the distance the year 11s threw the gumboots are overlapping by a big amount. The LQ for the year 9s is 5m which is 2m less than the LQ for the year 11s distance(7m). The medians for the distances are very similar, with the years median being 6.94m and the year 11s median being 8.22m. The middle 50%of the distance the gumboot was thrown for the year 11s is overlapping from the middle 50% of the year9s
My question is asking if the year 11 students tend to throw a gumboot further than students in year 9 for all of the students at [redacted]but the sample shows that the years tend to throw quite far. This could be because the year 9s might have had the lighter boot so it was easier to throw, the measurement could have been taken from the toe of the gumboot,it could have bounced further.

Spread:
In my sample of the distance the gumboot was thrown i can see the variation of the distance that the gumboot was thrown for the year 9s is greater than the variation of the distance that the gumboot was thrown for the year 11s this can be measured by the IQR which is 2.93m for the distance the gumboot was thrown for the year 11s and 3.54m for the distance the year 9s threw the gumboot. There was a bit of a difference (0.61m), it shows slightly on the graph that there is a bit of a difference in the distance. I think it's noticeable that the distance varied more than half a metre more than the other distance is 2.93m. Looking at the overall range in the distance, the year 11s threw the gumboot (14.8m-3.08m=11.72m) compared to the year 9s(13m-22m=11m). This makes sense because there was a recording showing that one of the boots was thrown into a bush and it was still measured or some year 11s that might be stronger than the other younger girls which might decrease the variation.

Shape:
The shape of the distance the year 9s threw the gumboot is left skewed and the shape of the distance the year 11s threw the gumboot is uniform/normal. For the year 9s there is a noticeable peak at around (8.5m) and for the distance the year 11s threw there is no peak but there is a little cluster at 6.7m-7.2m.

Conclusion:
DBM (difference between the medians) is
1.275 OVS (overall visual spread)is 4.875
DBM/OVS=1.275/4.875=0.261
0.2 is the same as 0.2 so I can make the call that one is larger than the other because they are both the same.

Answer:
I can tell the students in year 11 tend to throw a gumboot further than the year 9 students for all the [redacted] High School students in 2025.

This makes sense because some students could've gotten a longer heavier boot while others could have gotten a lighter boot,some peoples boot might have bounced further and the measurement was taken from where the boot stopped. One of the data collection days

it was raining, some people threw under arm and some threw over arm. This could be why the sample has less variation. This is a good thing because the amount of observations taken could have ruined the outcome if there was less observations taken.

Grade: Merit
The criteria for Achieved and Merit have been met. Evidence is provided of explaining the source of the data used in a statistical enquiry, presenting the data using at least one appropriate visualisation, and describing features of the data in context with reference to at least one visualisation. In addition to the above, there is evidence of connecting ideas within the statistical enquiry process to complete an investigation. A purpose has been identified, a question posed, and an appropriate call made. This takes the form of an informal sample to population inference. Features of the data such as centre, spread, and shape have been justified in context, using at least one appropriate visualisation and measure. There is additional evidence of justification occurring in the conclusion of the statistical enquiry process, where the call made has been appropriately supported with the data and measures evident in the visualisation. For Excellence, the student would need to provide more evidence of statistical insight. While there is some evidence of reflecting on the process when discussing features, and evidence of incorporating contextual knowledge in both the discussion of the features and the conclusion, statistical knowledge in the completed investigation needs to be more strongly incorporated for statistical insight to be at the level required for Excellence. For example, considering how uncertainty around the possible variation of measurements discussed in the plan could be related to features seen in the visualisation, such as clusters or unusual values.

Purpose:

“Do students from Year 11 tend to throw a gumboot further than students in Year 9, for all of the students at [redacted] high school 2025?”

I think that Year 9 students will throw a gumboot further than the Year 11 students because it has been proven that as girls stop doing as much sports and athletic activities as they get older. So I think Year 11 students will tend to throw the gumboot a shorter distance than the Year 9 students.

Plan:

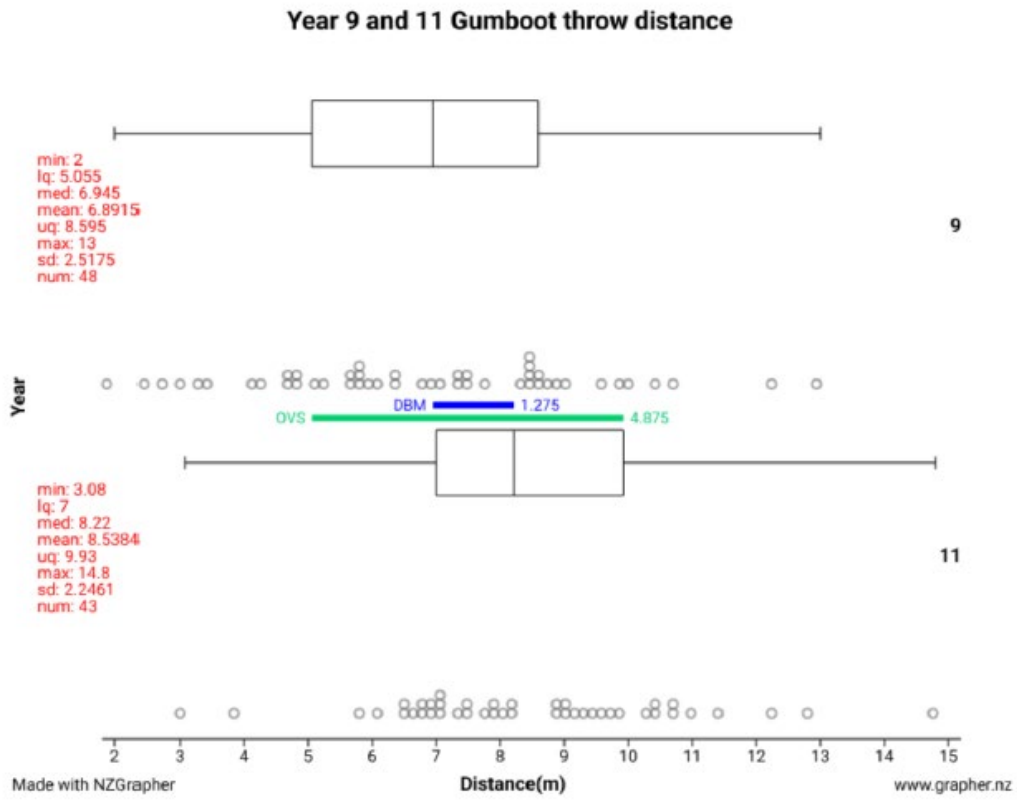
This was a random sample taken from the entirety of Year 9 and 11 students. The random sample of people were pulled out of class on period 5 on Friday and period 3 on Tuesday. It was a group of students who were given instructions and a demonstration from [redacted]. There were four station that were set up for throwing, each station had a wooden starting line with a measuring tape ready to go behind the wood. The measuring tape was moved on an angle if needed to get the correct measurement. Each student participating was allowed to have a run and spin if they wanted to, each student was instructed to stay behind the wooden starting line.

There was at least three students at each station at all times. One student making sure the participant was staying behind the throwing line, another student was required to move the measuring tape and read out the distance and the third was there standing next to the person measuring so they would then record the measurement down on paper.

Since there were four different stations all being run by students there could be an uncertainty in the measurements if someone was pulling the measuring tape tighter and someone at a different station was giving it more slack. They could have read it wrong due to bad eyesight or there could have been miscommunication when the person measuring was telling the person writing it down. Some people could have been wearing blazers therefore affecting their throw could also affect the accuracy of the data which could possibly make it harder to make the call.

Data:

I have taken a sample from the year 9 and 11 students at [redacted] for my investigation. Each dot on the graph represents one students gumboot throw distance.



Analysis:

In my sample the middle 50% of gumboot throw distances for year 9 students is a decent amount lower on the scale than the middle 50% of gumboot throw distances for year 11 students. The LQ (7m), median (8.22m) and UQ (9.93m) are all higher for the gumboot throw distance for year 11 students than the gumboot throw distance for year 9 students, with a LQ of 5.055 m, median of 6.945 m and UQ of 8.595 m. Although there is a difference in these values for each group, I can see that the middle 50% boxes for the gumboot throw distance of the year 9 students and year 11 students still overlap significantly. This makes sense because the year 11 students will have more experience as a whole compared to the year 9 students. Although if I was to take another sample this could be different because it could be a group of very athletic year 9 students and a group of year 11 students were many of them have dropped out of their sports and other athletic activities. The reason I think that is because it has be proven that when girls get older they often stop doing their sports.

I can see that the middle 50% box of gumboot throw distances of year 9 students is more spread out than the gumboot throw distances for the year 11 students. The IQR for the year 11 students gumboot throw distances is about 2.93 m and the IQR of the year 9 students gumboot throw distances is about 3.54 m. This is about

0.61m times as much variation in the year 9 students gumboot throw distances than in the year 11 gumboot throw distances. It could be that the some of the year 9 students are going through puberty and growth spurts while some of them are not, meaning some year 9 students will have longer arms for example. Unlike the year 11 students who are more likely to be finished growing so their distances don’t fluctuate as much.

In my sample I can see that the gumboot throw distance for both the year 9 students and year 11 students don't have a particularly obvious skew in either of them. This could be due to the same sample size in the graph. Although the gumboot throw distance for the year 9 students could been seen as slightly skewed to the left. There is a main cluster in the year 9

students gumboot throwing distance, the cluster is around the 9 m mark ranging from near 8.2 m to 9.5 m. The year 9 students have another smaller cluster of gumboot throw distances around 5.7 m to 6.3 m. Just like the year 9 students, the year 11 students also have 2 main clusters. The first main cluster of gumboot throw distances for year 11 students is around 8.9 m to 10 m, the second cluster for the year 11 students is around 6.5 m to 7.2 m. In the year 11 students gumboot throw distances, there is no clear peak unlike the year 9 students gumboot throw distances, there is a slight peak due to the main cluster. There is a semi large gap in the middle of the graph for the year 11 students gumboot throw distances, the gap goes from around 8.2 m to 8.8 m. That could be because in the sample taken there was some shorter students restricted to shorter gumboot throw distances and some taller students allowing them to throw a greater distance. If I had taken another sample that would definitely affect the gaps, maybe some of the taller students had their blazers on so that could effect their gumboot throw distance and potentially close the gap.

Conclusion:

I can conclude that I cannot make the call. I came to this conclusion by calculating the DBM (1.275m) over the OVS (4.875m). 1.275 divided by 4.875 is 0.26. I cannot make the call that year 11 students tend to have a further gumboot throw distance than the year 9 gumboot throw distances for all of the year 9 and year 11 students at [redacted] High school in 2025 because the DBM/OVS is less than 0.33 for group sizes of less than 100. This doesn’t makes sense because the year 11 students are more grown, making them taller, have longer arms and more sporting experiences. Although there is still some uncertainty because since the data was taken from 4 different stations they could all be slightly different and if it was a different group od year 9 students and year 11 students the data could have been different. I don't think we can be 100 percent sure about this outcome because is was only a small sample of students that was taken, only 92 students participated in throwing the gumboot so the data could be collected. I can conclude that I cannot say that Year 11 tend to throw a gumboot further than students in Year 9, for all of the students at [redacted] high school 2025.

Grade: Excellence
The criteria for all levels of achievement have been met. Evidence is provided of explaining the source of the data used in a statistical enquiry, presenting the data using at least one appropriate visualisation, and describing features of the data in context with reference to at least one visualisation. In addition, there is evidence of connecting ideas within the statistical enquiry process to complete an investigation. A purpose has been identified, a question posed, and an appropriate call made. This takes the form of an informal sample to population inference. Features of the data have been justified in context using at least one appropriate visualisation and measure. There is further evidence of justification in the conclusion, where the call made is appropriately supported with data and measures evident in the visualisation. The student has provided evidence of statistical insight, as required for Excellence. There is evidence in the plan and the conclusion of reflecting on the process when discussing methods to minimise variation in relation to the data collection process. These include considering weather conditions, how the measurements are taken, and the type clothing being worn. Statistical and contextual knowledge has been incorporated on several occasions in both the discussion of features and the conclusion. For example, considering how uncertainty around possible variation of measurements discussed in the plan impacted the features evident in the visualisation. This occurred when features involving centre, spread, and shape were analysed and made sense of statistically.

Purpose:
"Do students from Year 11 tend to throw a gumboot further than students in Year 9, for all of the students at [redacted] High School 2025?"

Prediction:
I think that I will find that Year 11 students tend to throw a gumboot further than students in Year 9, for all of the students at [redacted] High School 2025. I think this because year 11 students are older and therefore further along in development and will have more muscle mass and be closer to being adults.

Plan:
1. A random sample of students was taken from the entire roll of students in years 9 and 11 classes. These students were asked to participate in the activity during Period 5 on Friday and Period 3 on Tuesday and Period 3 on Thursday.
2[redacted] gave the instructions for the throw to all of the students and did a demonstration.
3. Four stations each had a throwing line set up, with a measuring tape ready to go from behind the wooden starting line to the landing place of the gumboot. The measuring tape was moved on an angle if needed to measure how far from the line the gumboot travelled (as in shot put).
4. Each participating student was instructed not to cross the throwing line. They may have a run up and a spin if they would like.
5. Students collecting data:
➔ One student would stand at the throw line and check they did not step over the line.
➔ One student would move the measuring tape and read the distance.
➔ One student would stand next to the measuring student and record the distance onto paper.
6. Once they had finished their throw the participants were asked to return to their class.

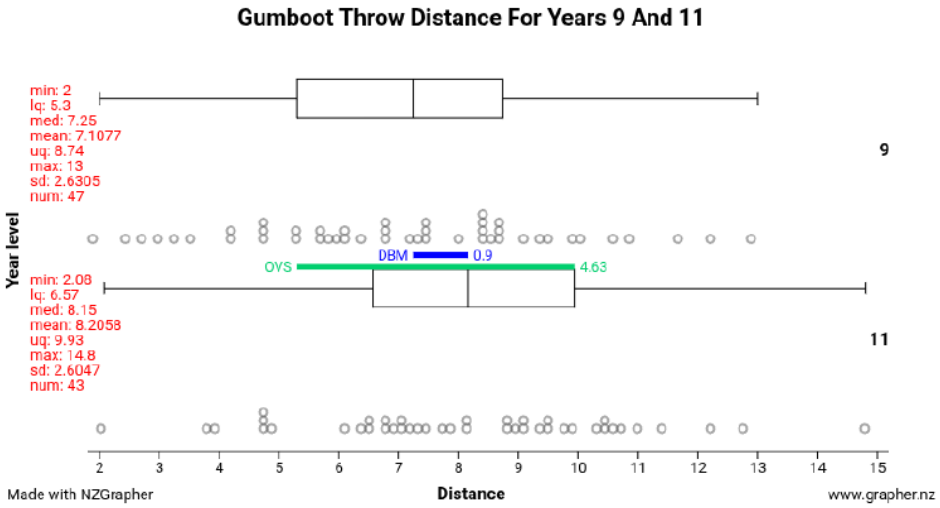
Variation:
Weather: When the data was collected on Friday Period five it was raining. As the data was collected outside on the field the rain could have an impact on the results. For example the gumboots could have become slippery as they got wet, meaning that when a student went to throw the gumboot it could have slipped out of their hand. This would impact the data as it would cause a shorter throw since the student was not able to put full force into it.
The fact that it was raining could also affect students' attitude towards the data collection. As it was rainy and cold it is likely that students quickly threw the gumboot before returning to their class as they wanted to get out of the cold. This would mean that the data collected is not an accurate representation of the throwing capabilities of the student as they did not put any effort into the throw, causing a shorter distance.
If the Gumboot Throw experiment was conducted inside, for example the gym, this would mitigate any variation that would be caused because of the weather.
Timing: The data was collected at different times on different days, this could have an affect on the results of the experiment. For example, the attitude of the students taking part in the experiment would vary from a period five on a friday to a period three on a tuesday. On a Friday students are often tired and ready for the weekend, this feeling is especially strong in

the last period of the day. This could affect the attitude and the effort students put into their throws as if they were feeling quite tired on Friday their throws may not have as much force as those who threw on Tuesday or Thursday. This would cause shorter measurements in those students, causing variation in the data.
If all of the students threw on the same day, in the same period, this would remove any variation that could be caused due to the time of day, and what day it is.

Measurement: The measurement was done in groups, meaning that there were multiple 'throwing stations' set up with different students running them. This could cause a variation in the data as the way the throws were measured were not exactly the same. There are two main changes that could have occurred between groups, the first one being how they measured and the second one being where on the gumboot they measured from.
How they measured could vary from group to group, for example one group may measure from the middle point of the board and then pull the measuring tape on an angle to the gumboot whereas another group may move both the measuring tape to the gumboot as well as moving it along the board as to measure in a straight line. This change of measurement technique between groups would have caused variation in the data. The group which is measured on an angle would get a more accurate read as they are measuring from the same place every time and if the group was thrown on an angle then the actual distance it was thrown is longer than the distance of the boot to the board in a straight line. The group which is measured by moving both ends of the tape would not get as accurate a reading as the other group since measuring in a straight line would shorten the measurement taken.
Where on the gumboot the groups measured from would also cause variation in the data. If one group were to measure from the point of the gumboot closest to the throwing board and another were to measure from the point on the gumboot furthest from the board there would be variation in the data. Another group may simply pick a point on the gumboot, for example the toe, and measure that point no matter how the gumboot landed. This would mean that the measurement of the throw distance would change from throw to throw, resulting in variation in the data.
If there were clearer instructions on how to measure the gumboot. For example to always from the point closest to the board, and also to measure from a set point in the middle of the board and pull the tape on an angle. This would reduce the variation from the measurement and result in more accurate data.

Clothing: The majority of students who threw were in uniform with some year 11's in P.E gear. There were some differences between students in terms of whether or not they were wearing a blazer. Some students threw while in just a jersey or their white shirts while others threw while also wearing a blazer. This could cause variation in the data as the blazers are more restricting items of clothing meaning that those who threw in a blazer would have a more restricted range of motion than those who did not.This could result in a shorter distance thrown. The students who were wearing P.E gear would have a better range of motion than those who were in jerseys or shirts, as they were wearing clothes designed for sport, which would then result in a longer distance thrown. Ensuring that all students are in school uniform and remove their blazer before throwing would mitigate this variation.

Data:



Analysis:

Centre:

The middle 50% of Gumboot throwing distance for year 11 at [redacted] High School is shifted further to the right than the middle 50% of year 9 at [redacted] High School. The LQ (6.57m), UQ (9.93m), and Median(8.15m) of the Year 11 throws are all higher than that of the Year 9 throws, with a LQ of 5.3m, a UQ of 8.74m, and a Median of 7.25m. Although the Year 11 box is shifted further up the graph there is still a significant amount of overlap between the two boxes, with the Medians both falling inside the box of the other.

The middle 50% of year 11 throwing distance being slightly higher than that of year 9 makes sense as year 11's tend to be older than year 9's, meaning that they will be further along in their development and therefore have more muscle mass, resulting in the ability for longer throws. However this change is not extremely significant when looking at a difference of just two years, meaning that the throws would be more similar. This is likely why there is quite a lot of overlap between the two boxes.

There is likely also overlap due to the fact that in many cases the gumboot slipped out of the students hands or skimmed along the ground, for both year levels. These measurements would not be an accurate representation of the students abilities and would then bring the middle 50% down.

Spread:

The Variation in the Middle 50% of Gumboot Throwing distance is very similar between the two year levels. The IQR of year 9's is 3.44m and the IQR for year 11's is 3.36m. There is only a 0.08m difference between the two IQR's. This shows us that there is almost the exact same amount of variation in throwing distance between year 9 and year 11.

This could be because of the fact that in both year levels there is a similar amount of students who are involved in sports which involve the arm strength and the ability to throw long distances as those who are not (and just a similar mix of active vs inactive students in each year level). The students who are involved in these types of sports would then be able to throw further than those who are not. It is also likely that there was a similar amount of students who's throws were affected by things such as the gumboot slipping out of their hand, resulting in a shorter distance thrown. As the likelihood of either of these things

happening is even between both years 9 and 11 it makes sense that the variation of the middle 50% is practically the same.

Shape:

The year 9 data I can see some small clusters at 5.7m-6.1m, 7.25m-7.5m and 8.5m-8.69m. There is also a slight peak in the data at 8.5m.

There is a larger cluster in the year 11 data from 8.9m-9.9m, there is also a smaller cluster at 4.76m-5m.

The data for both Year 9 and Year 11 throwing distance is quite spread out along the graph as a whole, however there is a gap in the year 11 distance from 5m to 6.2m.

I wonder if the fact that the data is quite spread out and irregular is due to issues when the distance was being measured, specifically because of the variation caused due to the different methods used to collect the measurements. For example, groups who measured from the point on the gumboot which is furthest away from the board would have a longer distance recorded than those who measured from the closest point on the gumboot even if the throw landed in the same spot.

Unusual features:

I can see two unusual features in the Year 11 data. There is an outlier at 2.08m and another outlier at 14.8m. The next point after the 2.08m outlier is 3.8m, meaning that there is a 1.72m gap. This outlier could have been because the gumboot slipped out of the students hand, this could have been because they threw it on the rainy day. The gumboot slipping would then mean that they didn't get a full throw and then resulted in this short distance.

The next outlier in the year 11 data is at 14.8m, this is quite a long throw as the next point on the graph is at 12.8m, meaning that the student threw at least 2m further than anyone else in the year 11 sample. This is likely because the student who threw this gumboot was involved in sports which required throwing and arm strength, meaning that they have trained and now have the ability to throw long distances.

I can't see any unusual features in the year 9 data. While there are some points on the graph which are similar to the outliers in the year 11 data as the points are so spread out along the graph I don't see them as outliers. This is likely because the data is quite irregularly shaped due to issues when measuring the throw as I mentioned in the shape analysis.

Conclusion:

From my sample I cannot make the call that Year 11 students tend to throw a gumboot further than students in Year 9, for all of the students at [redacted] High School 2025. I cannot make this call because the medians both fall inside the box of the other and the DBM/OVS is less than 0.33 (0.9/4.63 = 0.19 (Rounded to 2 d.p). The fact that I cannot make this call is not what I expected as I had thought that as year 11 students tend to be older and therefore further along in development so they generally have more muscle mass and are stronger. However the fact that I cannot make the call could be because while year 11s are older there is only a roughly two year (or less) difference between the two year levels. This would then mean that there is not a big enough difference in ability between the two year levels for one group to throw significantly further or shorter than the other (especially since the students measured were all female and have less testosterone so they don't necessarily have as large of a change in muscle mass during these two years).

However when conducting the experiment there were a lot of things which happened that likely caused variation and uncertainty. For example the fact that there was such a difference in the way the throws were measured between groups and the fact that it was raining on one of the days data was being collected. Both of these things caused uncertainty in the data, as

the rain caused the gumboots to slip out of peoples hands which then resulted in a shorter throw which was not accurate of the students ability. And the difference in measurement meant that often the actual distances the students threw was not measured and since the way it was measured changed from group to group the data collected varied in accuracy.
If I were to re-conduct this experiment I would make some adjustments to how the data was collected. Ideally the gumboot throwing would be done inside or on a nice day, so things like rain and cold weather wouldn't affect the students' throws. I would also ensure that there were clear instructions on how to measure the distance, (from the middle of the board on an angle to the boot and at the closest point on the boot to the board) as to mitigate the uncertainty caused by the measurement. I would also allow students to re-throw the gumboot if it slipped out of their hand or skimmed along the ground. This would mean the distance measured would be an actual representation of how far the students can throw, making my data more accurate. Also it would be good if the students didn't wear their blazers so they would have a full range of motion allowing for a more accurate throw and then more accurate data.
I wonder if I were to make these changes and remove as much uncertainty from the data as possible I would then be able to make the call that Year 11 students tend to throw a gumboot further than students in Year 9, for all of the students at [redacted] High School 2025.