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.

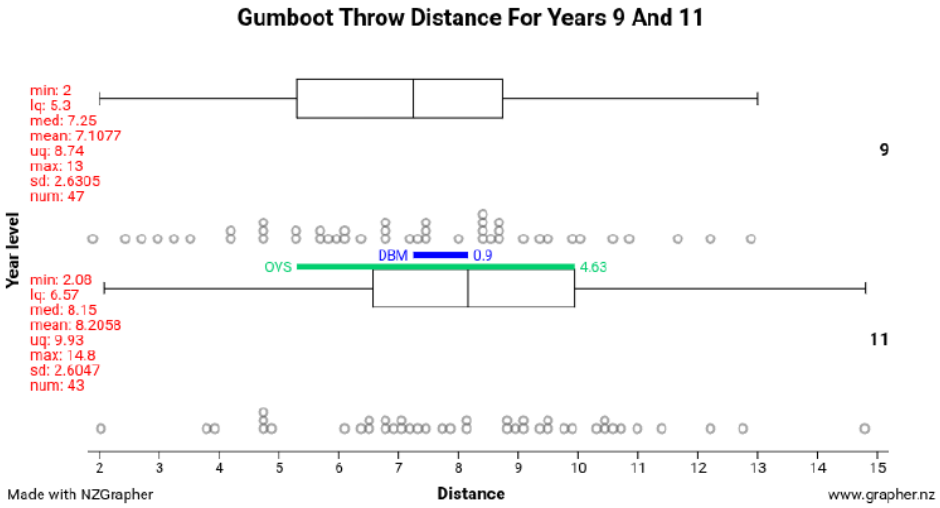
Variation:
Weather: When the data was collected on Friday Period five it was raining. As the data was collected outside on the field the rain could have an impact on the results. For example the gumboots could have become slippery as they got wet, meaning that when a student went to throw the gumboot 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.