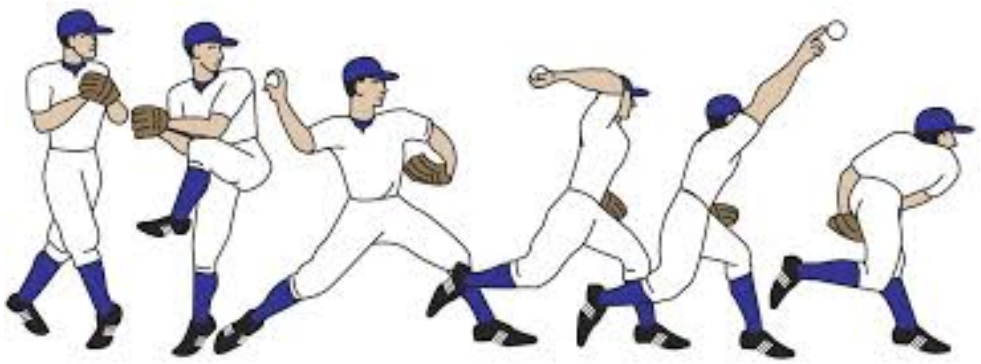
Anatomy of a Throw

Want to perfect your pitch?

How can understanding how your body works improve your throw?



Have you ever dreamed of kicking a football like Jonathan Thurston or bowling out Steve Smith? Well here's a chance to learn the secret to becoming a sporting superstar.

When investigating any human (or animal!) movement it is very helpful to understand how each body part contributes to the overall movement. This analysis can help researchers understand if someone is utilising optimal technique, particularly in elite sport where athletes and coaches are trying to gain a competitive edge.

“Throw-like” movement patterns are ones in which several body segments work together one after the other to finish with a maximum end speed. Throwing, kicking, serving, swinging a bat, and bowling are all examples of throw-like patterns. Figuring out what the contribution is from each body segment is then particularly useful in sports like tennis, cricket, rugby, baseball, javelin, soccer, and many, many more.

The simplest way to judge how much an action or body section contributes to a throw is to compare the results with and without that action. By then looking at each component individually, we can even compare the movement patterns between different people! In this workshop, we will investigate how much a run-up contributes to how fast you can throw a ball.

The Experiment – How fast can you throw?

In this experiment, we will measure how much using a run-up contributes to how fast you can throw a ball. To do this, volunteers will be recorded with a camera performing a throw with and without a run-up. The footage will be then analysed.

Today, you'll hear the word **velocity** being used. Velocity is a measure of the **speed** of an object but velocity also tells us about the **direction** that an object is travelling.

Procedure

1. Students will perform a warm up.
2. Students will be split into two groups. The groups will then investigate what makes a good throw, prompted by the demonstrator. At the end of this short investigation, each group will choose their "best" thrower to be the volunteers.
3. Predict the percentage of a throw that you think the run up contributes to the velocity of a throw. Does it contribute only 10%, or perhaps 50%, or maybe even 80%? Write your predictions into Table 2 in the first empty column.

The demonstrator will set up a grid board and camera so that the movement of the ball across the grid line can be tracked.

4. The volunteers will throw a ball as far as possible under each of the conditions listed below. Each throw is recorded using a high-speed camera.
   a. Throw with a run up
   b. Throw without a run-up

The demonstrator will connect the camera to a computer and set up software for analysis.

5. **For your group's volunteer:** Use the video clips to determine the horizontal distance (x) and the vertical distance (y) that the ball travelled during the first frame after the ball left the hand. Use **metres** as the units. Record the data in Table 1. Also record the time of the first frame in seconds.
6. Repeat Step 4 for the second throw (no run-up) recording x and y in Table 1.
7. Determine the horizontal (v_x) and vertical (v_y) velocities of the ball as it left the hand. Record this data in Table 1. Use the formula **Velocity = distance ÷ time** (just like speed!).
8. Determine the total velocity (v) of the ball as it left the hand. This can be found using the formula: $v = \sqrt{{v_x}^2 + {v_y}^2}$. Record this data in Table 1.

Table 1

	Throw Type	Code	Horizontal distance x (m) (convert to metres!)	Vertical distance y (m) (convert to metres!)	Time for the first frame (seconds)	Horizontal velocity v_x (m/s) $v_x = x \div t$	Vertical velocity v_y (m/s) $v_y = y \div t$	Total velocity v (m/s) $v = \sqrt{{v_x}^2 + {v_y}^2}$
A.	Run-up	v_1						
B.	No Run-up	v_2						

Table 2

	Prediction: I think this body part contributes ___% to the speed of a throw.	Velocity contributed by the run-up (m/s) $DV = v_1 - v_2$	Percentage $\frac{DV}{v_1} \times 100$
Group A			
Group B			

Discussion:

How do your results compare with your predictions?

Procedure (continued)

You will now need to calculate the difference in velocity (DV) to find out what the contribution from the run-up is. To do this, find the difference between the velocity for the first throw (with run-up) and second throw (without run-up).

$$\text{DV for run-up} = V_1 - V_2$$

9. Calculate and record the difference in velocity in Table 2.
10. Calculate the percentage that the run-up contributes to the total throw and record in Table 2.

$$\text{(Remember: percentage} = \frac{DV}{v_1} \times 100)$$

11. Did the run-up contribute to the speed of the fastest throw? If so, by what percentage?
12. Compare the results for the DV and percentage due to the run-up for your group with the other group, and record the other group's results in Table 2.
13. Which group's thrower showed the biggest improvement due to the run-up?

Do boys and girls throw differently?

Find out at: https://www.youtube.com/watch?v=LD5Xm5u7UDM

Challenge

In baseball, the pitcher throws the ball without a run-up. In cricket, the bowler can use a run-up but cannot bend their elbow when bowling. Who do you think can deliver the ball the fastest and why?

Puzzle

The box below is a Magic Square. This means the numbers in every row, column and diagonal adds up to the same number. In this case, that number is 71. But there are some numbers missing! Fill in the missing numbers (they are all different). What is the number in the shaded box?

10			
		12	18
11	30		
22		9	32

To gain **EXP** and level-up your mathematician, email your answers to the **Challenge** and **Puzzle** questions to Dr Greg at Gregory.Boyle@my.jcu.edu.au.

Q: Why was Cinderella so bad at baseball?

A: Because her coach was a pumpkin!