PRIMARY + STEM

Teaching Resource

ACTIVITY:

Tracking athlete performance

ACTIVITY OVERVIEW

Students can use athlete performance-tracking as an example of data collection and use, learning about the different components involved and collecting their own performance data.

Data is collected using a combination of sensors, with the aim to improve athlete performance, reduce injuries and assist with coaching.

SYNOPSIS

Wearable technology is being used to track data about the performance of athletes all over the world - recording information about changes in speed, distance covered, and the position of bodies. Wearables are any sensor, tracker, monitor or smart device that is worn on your body and produces data from your activity.

Data is collected using a combination of sensors, with the aim to improve athlete performance, reduce injuries and assist with coaching.

This data is fed into algorithms, developed by the tracking companies, to give the athletes and their teams real-time data about the athlete's specific movements.

It's not just professional athletes that are tracking their activity - personal fitness trackers have become increasingly popular over recent times. Students can use athlete performance-tracking as an example of data collection and use, learning about the different components involved and collecting their own performance data.

Foundation – Year 2

- Collect, explore and sort data, and use digital systems to present the data creatively (VCDTDI015)
- Explore how people safely use common information systems to meet information, communication and recreation needs (VCDTCD018)

Year 3 – 4

- Collect, access and present different types of data using simple software to create information and solve problems (VCDTDI021)
- Explain how student-developed solutions and existing information systems meet common personal, school or community needs (VCDTCD025)

Year 5 - 6

- Acquire, store and validate different types of data and use a range of software to interpret and visualise data to create information (VCDTDI028)
- Explain how student-developed solutions and existing information systems meet current and future community and sustainability needs (VCDTCD034)

ACTIVITY, MATERIALS AND INSTRUCTIONS

Activity - Collecting and using athlete performance data

Students will collect data on their performance in selected physical activities, present this data, then think about the potential uses for this information. Some students may have their own personal fitness trackers, but, in this activity, we will collect our own data and think about how this is done by sensors and computers for athletes. Students may have seen tracking data displayed on television during AFL matches, or during the Olympics, where athlete variables such as speed, distance covered, or heart rate are displayed on screen.

Materials (for class of 30 students)

- Stopwatches x 30
- Tape measure (a long one – 20m+) or trundle wheel
- Gumboot x 2
- Access to basketball court or oval

Instructions

Choose from the following physical activities:

1. Running time

   Trackers can record an athlete's speed and the distance travelled.

   Use a basketball court or oval.

   Use stopwatches to record the time it takes each student to sprint across the court/oval. Teacher to assist younger students with timing, but older children can time one other.

   Note – teacher can be included in the sprinting data.

2. Gumboot throwing

   By putting sensors on players' shoes, the kick velocity (speed in a particular direction) can be calculated.

   Mark a throwing line on the ground. You must stay behind this line when throwing the gumboot. Students to throw gumboot as far as possible, with each person given two throws. Measure the distance of each gumboot throw using the tape measure or trundle wheel.

3. Heart rate

   Your heart rate, or pulse, is a measure of how fast your heart is pumping blood around your body. It is good for our body to work hard every now and then, but we don't want a high pulse all the time.

   Measure your resting pulse – feel your neck, wrist, or ankle for a pulse. Count beats for 10 seconds then multiply by six (to give the number of beats per minute). Then, do some exercises (e.g. jumping, kicking, dancing) while you play a popular song. Record your pulse again.

Use your whole class data to make a table or graph.

How is this data helpful? What useful things could our fastest classmates do? Could our heart rate information be useful to our doctors? Who is going to be most helpful throwing balls back over the fence?

Professional sporting talent scouts can predict which sports young athletes might be best suited for by using data collected from wearable technology.

Is our data reliable? Have we taken enough measurements? Are we accurate with our timing/pulse taking? How could we improve?

HOW TO USE THIS ACTIVITY WITH YOUR STUDENTS

Foundation - Year 2

Use this activity to explore data collection with your students. In the suggested activities, students use stopwatches, tape measures and their own fingers to measure their own performance. For professional athletes, wearable tracking devices can be used to measure many different movements that they make when they are playing their sport.

To begin this topic, students can be prompted to move their bodies like different athletes:

Move like a swimmer, move like a racing car driver, move your body like a tennis player. Which sports need fast people? Which sports need people who can run for a long time? Which sports need people who can jump well?

Many different types of movements are made in sports and scientists are helping athletes to measure their movements, with sensors carried on their bodies, so that they can work out how to perform better in their sports and also how to stop themselves from getting hurt.

Design a wearable tracker for your pet (e.g. dog, cat, bird). What do they do that you would you like to track?

Think about different types of movements that your pet makes. What does your pet do during the day when you are at school?

How many times does Mia bark? How many times does Max poo?

Years 3/4

Data collection is an important aspect of the STEM curriculum areas and is more than just asking people questions about favourite colours, foods, pets and tossing coins.

Scientists collect data through repeated measurements of all different types of activities, including sports scientists, who monitor professional athletes. Use this activity to get the kids up and moving and relate their study of technology to some of their favourite sports people.

Introduce the topic using the BTN video clip (see resource list below), so that students can see the AFL players and the technology they are using. Some students in this age group may have their own fitness trackers or be familiar with those used by other members of their families, and can add this knowledge to a class discussion.

Extend gumboot throwing to different projectiles (e.g. balls, clothes, paper, pencils), to incorporate the forces part of the science curriculum for these year levels.

Measure distances thrown by students. Discuss how the different objects move through the air. Describe the effects of gravity and air resistance (friction from air) on your chosen objects.

Years 5/6

Introduce this topic to your students using the video clip from ABC's BTN (see resource list below), so they can see the AFL players and the tracking technology they are using.

You may have students in your class who are wearing their own fitness trackers or are familiar with those used by family members.

Use this personal experience to explore your students' knowledge of movement tracking.

Expect more from these students when it comes to planning your activity. Year five and six students should be able to plan materials and how to record data for the three activities. Encourage students to record activity data in a spreadsheet, if possible.

Data can be shared between class members, using your school's choice of software, then converted into an appropriate graph, showing your overall class performance. If time permits, use this opportunity to discuss the privacy concerns of this kind of data collection.

Who should be able to access an athlete's activity information?

Who should be able to access my mum's fitness tracker data? What could we do if we had this information?

Can taller people throw things further? Make a prediction.

Measure students' height. Make a dot plot graph with height on the y-axis and gumboot distance on the x-axis. Is there a pattern?

Can taller people throw things further? Or is it people who are good at throwing because they've practised?

DISCUSSION SECTION AND KEY THEMES

KEY THEMES

What's inside wearable technology for athletes?

Accelerometer:

- measures acceleration (including starting and stopping)
- measured in m/s^2 (metres per second squared) or g (G-force = $9.8m/s^2$)
- affected by gravity

Magnetometer:

- measures position in space / location (using Earth's magnetic field)
- includes compass information (e.g. north, south)

Gyroscope:

- measures how fast something is spinning on an axis
- measured in RPM (rotations per minute) or o/s (degrees per second)
- used for space navigation, missile control, underwater and flight guidance
- not affected by gravity
- detects when your body moves, even when your feet aren't moving

Tracking engine:

- works with satellites to give your position
- uses GPS (Global Positioning System) or GNSS (Global Navigation Satellite System)
- can work with LPS (Local Positioning System) – uses short-range signalling beacons placed around a sports field or stadium, to give more precise location information

Microprocessor:

- records over 1000 data points per second in real-time
- stores data on the device to be analysed later

Battery:

- powers the tracker
- needs to be charged regularly

What information is collected?

Information collected by wearable technology includes:

- distance covered
- high-intensity distance
- sprint distance
- acceleration/deceleration
- top speed
- work rate (m/min)
- kick velocity (if you have a foot sensor)
- heart rate

Tracking Australian athletes

The Australian Institute of Sport (AIS) runs the Athlete Management System (AMS), used by national sporting organisations. This provides a central database to manage data from athletes across many sports. Data is collected to improve health and performance, as well as reduce the impact of injury and illness.

The AIS started working with wearable technology in the lead-up to the Sydney 2000 Olympics, with money provided by the Australian Government.

QUESTIONS AND ANSWERS

What other ways do athletes use digital technology to help their performance?

- Film performance to analyse later
- Full-body suits that are used with Augmented Reality (AR) and Virtual Reality (VR)
- Heads Up Display (HUD) glasses – worn by cyclists, showing information on the inside of the glasses (e.g. speed, incline, heart rate)
- Smart goggles for swimmers, giving similar useful information to cyclist glasses
- Multiple sensors on different body parts to track movements
- Training management software – also includes information about diet and sleep
- Communication – online videos, online exercise journals

Do kids use activity tracking devices?

Yes, there are children's versions of some fitness trackers (including Fitbit and Garmin). The wearer needs to do a certain amount of activity to get rewards. These fitness trackers are also used by parents to monitor the location of their children.

How does the data get from the tracking device to the coach's computer?

Data is transmitted in binary code, made up of 0s and 1s.

The data travels from the device using radio waves, then is received by the tracking company's computer.

There, it is processed through their algorithms, where it is converted into useful information (this takes only seconds). The data is then made available to the coach and can be accessed on their computer. All the data travelling in 0s and 1s is decoded by receiving computers into the useful athlete information.

What other living things do we track?

Scientists use trackers to monitor the location and behaviour of many different animals, which are better observed without people nearby (as the presence of people may alter animal behaviours).

There is an amazing collection of animal tracking data at Movebank (https://www.movebank.org/), where you can see the tracking data for over 1000 types of animals, including penguins, bats, foxes, cats, flying foxes, cockatoos, sea-eagles, bettongs, green pythons, curlews and whales around Australia.

Do we monitor things that aren't alive?

Yes, people track many objects and monitor their performance using digital technology. Our cars have computers, which collect and process data. My car can let me know when it's time for a service, when its tyres need air, or when the engine oil needs topping up. Grand Prix racing cars have sensors and monitoring equipment collecting data about all aspects of car performance. This data is sent back to the car support teams, to help them to improve performance in that race and in the future.

We can monitor our energy use at home. People with solar panels can use an app to see how much solar power is being generated, how much is being used and how much is being exported to the electricity grid for everyone else to use.

As far as tracking the location of objects, we do this with many items, including phones, space junk, luggage, Uber drivers and buses.

Who has access to the information collected by activity trackers?

Athletes using performance-tracking devices are covered by privacy agreements and security provided by the company that supplies their wearable technology.

Data from personal fitness trackers is available to whoever you allow access. When using a fitness tracker, you should check your privacy settings to see who gets to see your data (it could be made public on their website or on social media). Some companies will let you know that they are sharing or selling your data to other companies.

For example, they may collect your information to sell to advertising or health insurance companies (but would usually remove personally identifying data before sharing). And yes, hackers may try to access fitness tracking data, as it contains a lot of information about your life.

Can an activity tracker detect when someone handballs or kicks the footy during an AFL match?

The AFL has been using wearable technology for many years now.

They use a combination of wearable sensors and video analysis to track footy player performance.

For example, when you see a player's statistics on screen during a match, the distance covered or heart rate is from the wearable sensors, but disposals or goals are recorded by a person watching. Computers and digital technology are not good enough at identifying people holding or touching the ball on a busy footy field – yet.

How do fitness trackers measure our steps?

The tracker uses algorithms, made up of mathematical equations developed by each tracker company. These calculations take into consideration laws of physics, how often and how much your speed changes, the timing of pauses and previous collected data.

Researchers have found that trackers are less accurate when you are walking slowly, may not detect steps if worn on the wrist and may underestimate steps taken when doing housework or other activities with a lot of arm movement.

Are there ways to trick an activity tracker?

You can't trick trackers like the ones that the AFL uses, with three different measurement sensors, but yes, you can trick a regular fitness tracker. People have played around with many ways to get a tracker to register steps without actually moving your feet. These tricks include playing the drums, conducting a choir, folding laundry, opening/closing doors and cupboards, washing your hands, or shaking your wrist. People have also experimented with attaching the tracker to other objects, including a hamster wheel, bike, dog, metronome, ceiling fan, power tools, or even putting it in the clothes dryer.

The part that detects movement is the accelerometer, which records change in your speed. If the device is on your wrist and you move just your arms, it assumes that your whole body is moving. If your arms are still (e.g. cycling) it may not count steps. If the tracker vibrates (e.g. riding over bumpy ground) it may count extra steps.

But you can "train" trackers to detect cheating behaviours. Manufacturers can update their algorithms to ignore movements that match up with identified cheating movements that have been studied by the tracking company.

What else uses the same technology found in athlete trackers?

The combination of sensors found in athlete performance tracking devices is also known as an Inertial Measurement Unit (IMU). This combines multiple sensors to provide multi-axis motion tracking. This technology is also used in our phones, Augmented Reality (AR), Virtual Reality (VR), drones, gaming controllers and robots.

OUTSIDE OR SUPPLEMENTARY READING

BTN "AFL Science", 22 March 2022 (video clip)

https://www.abc.net.au/btn/classroom/afl-science/13800418

AFL fastest players of 2021

https://www.afl.com.au/news/686152/speed-kings-telstra-tracker-reveals-your-clubs-fastest-player-in-2021

10,000 Steps – information about being active

https://www.10000steps.org.au/articles/

Physical Activity and Exercise Australian Guidelines for children

https://www.health.gov.au/health-topics/physical-activity-and-exercise/physical-activity-and-exercise-guidelines-for-all-australians/for-children-and-young-people-5-to-17-years

Movebank: animal tracking data

https://www.movebank.org/

Monitoring Formula One drivers for safety

https://www.nytimes.com/2018/08/31/sports/autoracing/safety-technology-formula-one.html

Monitoring Formula One cars

https://aws.amazon.com/f1/

Examples of different athlete performance tracking

https://www.catapultsports.com/stories

TOPIC WORDS

- Data
- Athlete
- Algorithm
- Performance
- Tracker
- Device
- Sensors
- Accelerometer
- Gyroscope
- Magnetometer
- Wearables
- Satellite
- Speed
- Distance

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