Biomechanics

Implementation – QLD 2019 PE

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Overview

- Syllabus – then and now
- What do you need to do? - Stlap's
- Types of data required for biomechanics
- Performance analysis of biomechanics
- Methods of collecting data for performance

What has changed? 2010 syllabus v 2019 syllabus

2010	2019
• Biomechanics was a stand-alone topic for one term • Students analysed their own technique • Assessment was compulsory for each stand-alone topic (performance and theoretical)	• Biomechanics is now a combined topic with functional anatomy (33 notional hours) • Students collect primary AND secondary data to evaluate biomechanical strategies. • Separate assessment can be delivered for each topic in unit one, or it can be a combined assessment instrument covering all unit one objectives. NB - The suggested assessment technique for topic two is a Project — folio

Data – Syllabus objectives 4, 5 & 6

Why is there so much ‘talk’ about DATA?

- 2019 PE syllabus has 230 references to data

(I counted, so there could be some statistical variation….)

- Heavy emphasis on teachers and students using data in Teaching and Learning
- Next slide STLAP for Unit 1. Let’s identify all the data-related experiences

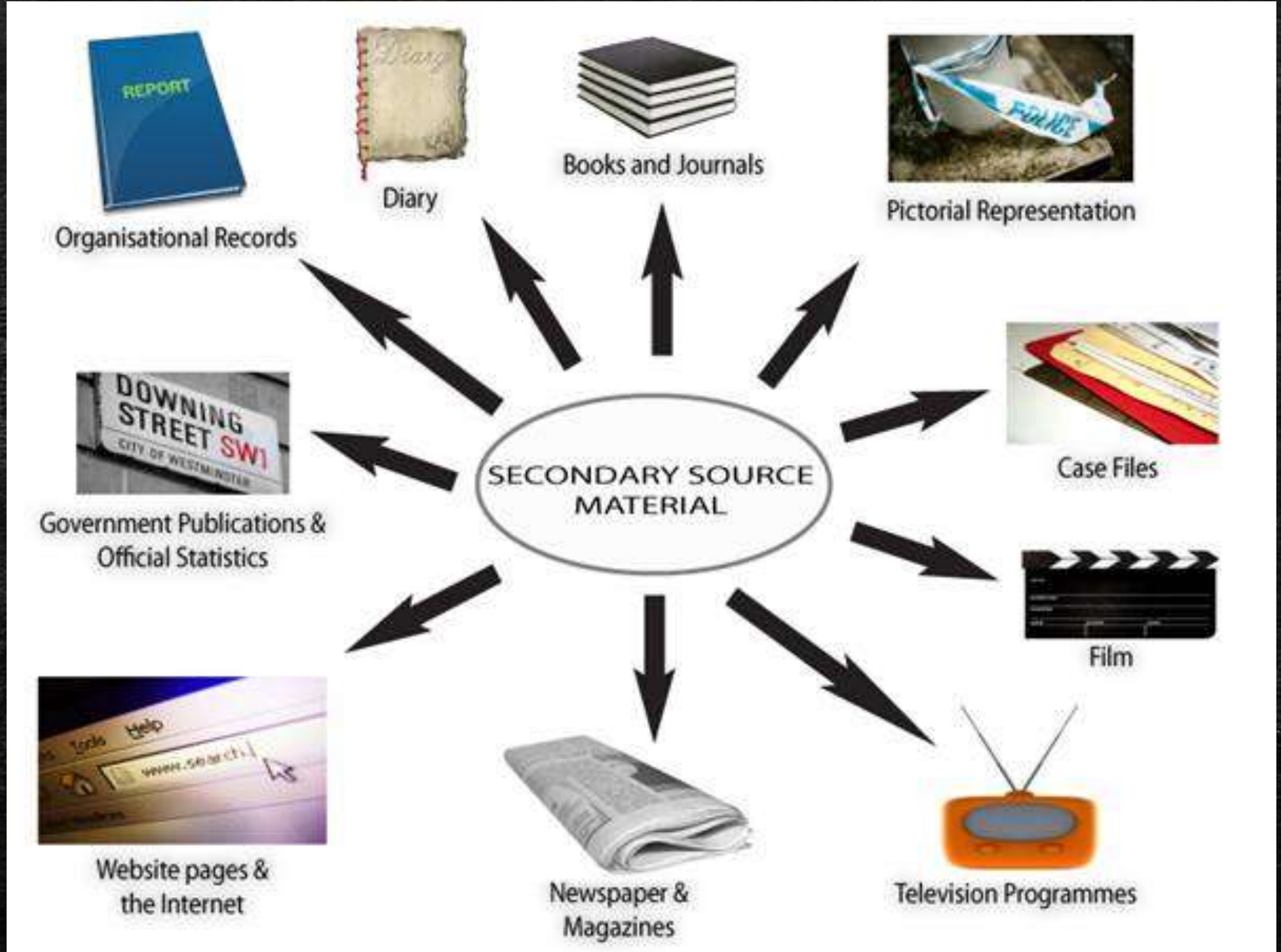
STLAP Unit 1 Physical Education 2019

Notional hours	Unit objectives	Subject matter	Sample learning experiences	Teaching and learning — underpinning factors	Possible resources
Topic 2: Functional anatomy and biomechanics integrated with badminton					
Stage 1: Engage and understand					
2 hours	1	• recognise and explain that functional anatomy is the study of the function of muscles and bones in movement • recognise and explain that biomechanics is the study of the laws of mechanics related to movement • recognise and explain that specialised movement sequences in the selected physical activity are comprised of phases and sub-routines that can be investigated as part of a biomechanical analysis	**Brainstorm activity** Students discuss the following questions: • What is functional anatomy? • What is biomechanics? • What is the relationship between functional anatomy and biomechanics? **Group activity** Students: • undertake research to investigate – what a biomechanical analysis entails – how phases and sub-routines contribute to a biomechanical analysis – the phases and sub-routines for the forehand serve in badminton. **Group activity** Students: • investigate a selected badminton shot (forehand clear, forehand smash, backhand serve, drop shot) • research online video footage of the chosen badminton shot • analyse video footage to compile information about – the phases of the shot – the subroutines of the shot • share their analysis with the class and record information.	**Literacy skills** • using biomechanics ideas and information in classroom, real-world and/or lifelike contexts to progress their own learning • comprehending to make meaning of biomechanics language and texts **21st century skills** • collaboration and teamwork — focusing on participating in activities and interacting with others to share experiences, contribute observations and produce a determined outcome • critical thinking — focusing on analytical thinking and reasoning • communication — communicating ideas effectively by composing text and/or verbally sharing to demonstrate knowledge and understanding • personal and social skills — demonstrating adaptability, open- and fair-mindedness and leadership when working with others to achieve a desired outcome • ICT skills — using technology to access visual evidence and analyse information	• Blazevich, AJ 2010, *Sports Biomechanics*, 2nd edn, Bloomsbury Publishing, Great Britain • Bartlett, R 2007, *Introduction to Sports Biomechanics: Analysing human movement patterns*, 2nd edn, Routledge, New York. • Chapman, AE 2008, *Biomechanical Analysis of Fundamental Human Movement*, Human Kinetics, Champaign, Illinois • Hall, SJ 2015, *Basic Biomechanics*, 7th edn, McGraw-Hill Education, New York • McGinnis, PM 1999, *Biomechanics of Sport and Exercise*, Human Kinetics, Champaign, Illinois. • Watkins, J 1999, *Structure and Function of the Musculoskeletal System*, Human Kinetics, Champaign, Illinois

Notional hours	Unit objectives	Subject matter	Sample learning experiences	Teaching and learning — underpinning factors
		muscles and tendons that act together to produce forces that cause movement – external forces, which result from the interaction between the body and the environment; these can include ▪ contact forces, e.g. friction, a ball being struck by a bat ▪ non-contact forces, e.g. gravity • gather primary data about the influence of biomechanical and functional anatomy concepts and principles on personal performance of specialised movement sequences and movement strategies in authentic performance environments	▪ musculo-tendon force ▪ ligament force and resultant joint force ▪ tensile and compressive forces – external forces, which are comprised of ▪ contact forces, e.g. friction, striking a ball or object ▪ non-contact forces, e.g. gravity • record information in a graphic organiser (see Figure 2 at the end of this document). **Performance activity: Badminton serves** Students: • learn the grip and stance for the different type of badminton serves (forehand, backhand, long, short) • practise serving the shuttle using different serves (forehand, backhand, long, short) • work to improve serving accuracy using 'Box It' and 'Box It 2' drills (refer to Possible resources) • identify and describe – the types of forces (internal and external) that affect the performance of their serves – alterations to the execution of serves to improve force production and accuracy • gather video evidence of personal performance to use for analysis.	biomechanics language and texts **21st century skills** • collaboration and teamwork — focusing on participating in activities and interacting with others to share experiences, contribute observations and produce a determined outcome • communication — communicating ideas effectively by composing text and/or verbally sharing to demonstrate knowledge and understanding • personal and social skills — demonstrating adaptability, open- and fair-mindedness when working with others to achieve a desired outcome • ICT skills — using technology to gather and analyse information
4 hours	1, 2, 3	• recognise and explain that motion is movement that occurs when an object has changed position in space and in time, due to the application of forces. Motion can be – linear, where movement is along a straight line, there is no rotation and all body parts move in the same direction at the same speed – curvilinear, where movement is along a curved path – angular, where all the parts of a body move through a rotational pathway, through the same angle, in the same direction and at the same time. It is the rotary movement about an axis – a combination, which recognises that most movements in biomechanics are a combination of linear and angular motion • identify and explore the components of projectile motion in a suitable physical activity, including speed, angle and height of release • gather primary data about the influence of biomechanical and functional anatomy concepts and principles on personal performance of specialised movement sequences and	**Activity** Students: • individually research motion and compile information into a T-chart. This should include – a definition of motion – a definition and description of each type of motion including ▪ linear motion ▪ curvilinear motion ▪ angular motion ▪ combination of linear and angular motion – the similarities of each type of motion, e.g. the application of a force, similarities between rectilinear and curvilinear motion – the differences of each type of motion – examples of each type of motion in badminton – a definition and explanation of projectile motion, including speed, angle and height of release (refer to Figure 3: Projectile motion graphs at the bottom of this document) – a description of the influence of speed, angle and height of release on performance in badminton. **Performance activity: Gather video evidence** Students: • investigate projectile motion during the performance of the serve by – altering the angle of release and discussing	**Literacy skills** • using biomechanics ideas and information in classroom, real-world and/or lifelike contexts to progress their own learning • comprehending to make meaning of Physical Education language and texts **Numeracy skills** • using mathematical concepts such as angles to recognise patterns and relationships in physical performance **21st century skills** • collaboration and teamwork — focusing on participating in activities and interacting with others to share experiences, contribute observations and produce a determined outcome • critical thinking — applying analytical thinking, problem-solving and decision-making in Physical Education contexts to progress their own learning

Types of data

- Primary data – this includes any data that you collect yourself relating to your performance. Videos, photos, sketches, statistics (times, distances etc.)
- Secondary data – any data that you did not collect yourself, but relates to your performance
- Students are expected to be able to obtain both for analysis


REPORT
Organisational Records
Diary
Books and Journals
Pictorial Representation
DOWNING STREET SW1
CITY OF WESTMINSTER
Government Publications & Official Statistics
SECONDARY SOURCE MATERIAL
Case Files
Film
Website pages & the Internet
Newspaper & Magazines
Television Programmes

Performance analysis approaches for Biomechanics

- Quantitative – focuses on collecting and analysing data that can be recorded numerically (this is objective analysis). Eg: He jumped 1.91cm to clear the high jump bar.
- Qualitative – focuses on collecting and analysing data that can be recorded in words (this is subjective analysis). Eg: He jumped really high to clear the high jump bar.
- Recent biomechanical texts reflect the shift from mathematical, engineering or physics backgrounds and a predominant research culture that was evident in early Sport Sciences. The shift is moving towards qualitative data.
- More biomechanist graduates will go on to work as 'movement analysts' or 'performance analysts' (rather than become sport biomechanists).

Qualitative Analysis

How do we get Qualitative Data?

- Video recording or observation
- Movement pattern representations, such as graphs, graphic organisers, written comments.

There is an ever-increasing marketplace for this type of software. We will cover some at the end of the presentation.

Qualitative Analysis

Who uses it?

- Teachers, coaches, athletes, physiotherapists, gait analysts, and judges of artistic sports such as ice dancing and gymnastics
- Performance analysts
- NRL bunker, Tennis Hawkeye, Cricket Hotspot

Qualitative Analysis

Why is it used?

- To differentiate between individuals or teams
- To improve movement or performance
- To detect errors and see where improvement needs to occur
- To provide subjective feedback

Quantitative Analysis

How do we get Quantitative Data?

- Image-based motion analysis (mostly video), marker tracking systems, electromyography, force and/or pressure plates

Quantitative Analysis

Who uses this?

- Mainly researchers

Quantitative Analysis

Why is this used?

- To aid performance comparisons
- To determine how improvement must occur
- To predict injury risk
- To provided precise/objective feedback

Functional anatomy and biomechanics

From the syllabus:

"Students are engaging in learning that involves integration of functional anatomy and biomechanics subject matter and a selected physical activity"

Why ?

So they can analyse and discuss in appropriate language what is occurring in videos like this…….

Dani Stevens – Discus Biomechanics

- http://mobile.abc.net.au/news/2018-04-11/dani-stevens-quest-to-throw-70-metres-in-discus/9555326?pfmredir=sm

- There is some analysis on the video. What else do you think you could do with this video to obtain data to analyse and comment on?

So, you have a class of students and they need to collect biomechanical data.

Where do you start?

The ‘Jargon’ of Human Movement

Students must understand the fundamentals of defining joint movements using anatomical terminology.

If a students says “I bent my knees to lower my centre of gravity“

they should be saying:

“ I decreased the angle of my knee joint through flexion and this lowered my centre of gravity.

Check student learning through formative tests such as:

- https://quizlet.com/244874110/test
- https://www.proprofs.com/quiz-school/story.php?title=anatomical-planes-body-cavities-quiz

Teach students to analyse human movement in these stages:

- Stage 1 - Preparation
- Stage 2 - Observation
- Stage 3 – Evaluation and diagnosis
- Stage 4 - Intervention

Preparation - Knowing what to observe and how to do it

- Conduct a needs analysis eg: you're a javelin thrower and you're not getting enough distance.
- Gather knowledge of the activity eg: know information about the movement (grip, stance, angle of release etc)
- Develop observation strategy eg: where will you record or observe from?

Observation – Observing reliably

- Implement observation strategy in stage 1
- Gather information about movement from senses and video recordings
- Focus observations on something specific eg: phases of movement
- Where to observe – controlled environment, vantage points
- Number of observations undertaken

Evaluation and Diagnosis stage- Analysing what's right and wrong in a movement

- Evaluations and diagnosis of strengths and weaknesses
- Critical features versus ideal form (compare student to elite performer)
- Select best intervention to improve performance
  eg: If you drop your hip during foot-strike in long jump, you will improve your vertical displacement in take-off

Intervention stage – Providing appropriate feedback

- Give feedback that will aide to improve technique and performance
- Know when to give feedback eg: after all observations, after two, during observations etc
- Review the overall process

Let’s look at an example of how students can collect data on sprinting.

Sprint analysis examples

- https://www.bing.com/videos/search?q=Kinovea+with+What+You+Can+Do&&view=detail&mid=B5F434BAB5685D6E3450B5F434BAB5685D6E3450&&FORM=VDRVRV
- https://www.youtube.com/watch?v=LuV9LxlhaUo

Sprint analysis using linear motion

- A student might want to know how long it takes them to reach maximum horizontal velocity
- To do this , they record the position of their centre of gravity at equal intervals of time.
- Eg: Stop watch splits at each interval or video footage as they pass each interval (marker).

Student graphs their results. What can you calculate?

Figure 3.6 Hypothetical horizontal displacement of the centre of mass with time for a novice sprinter.

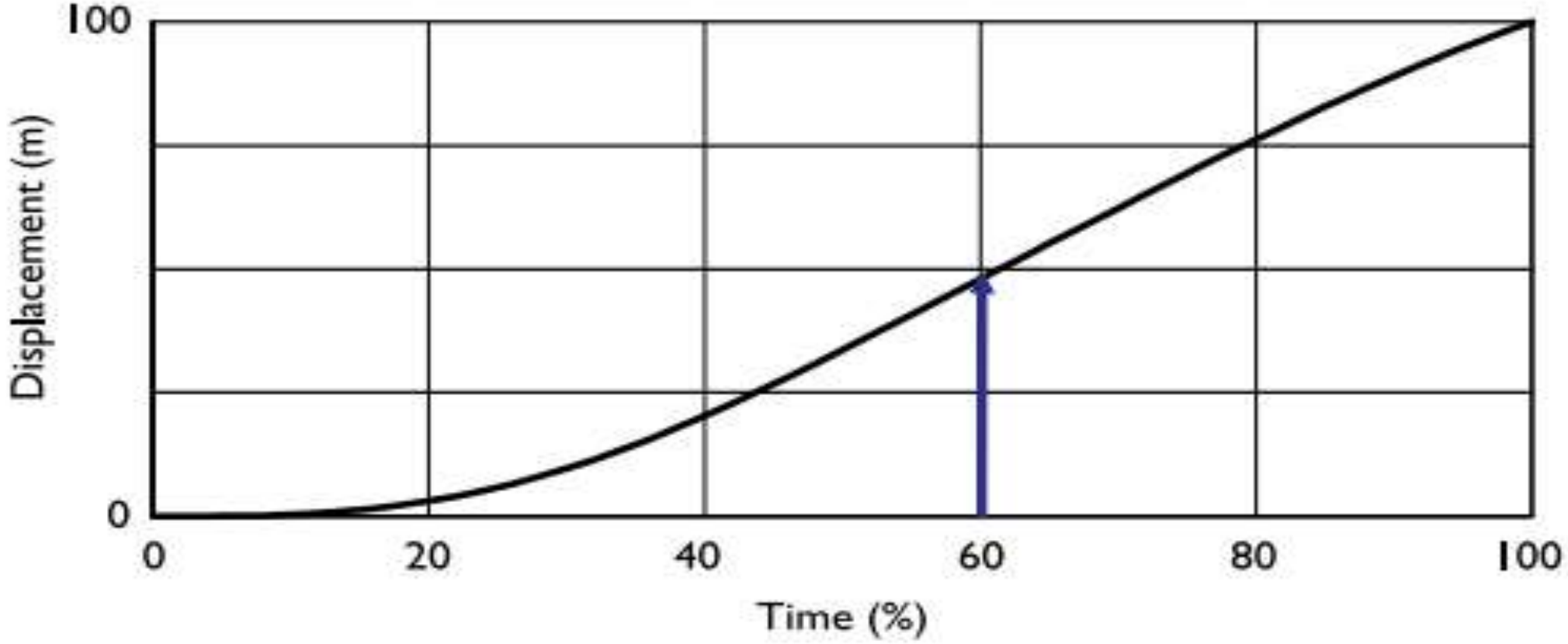
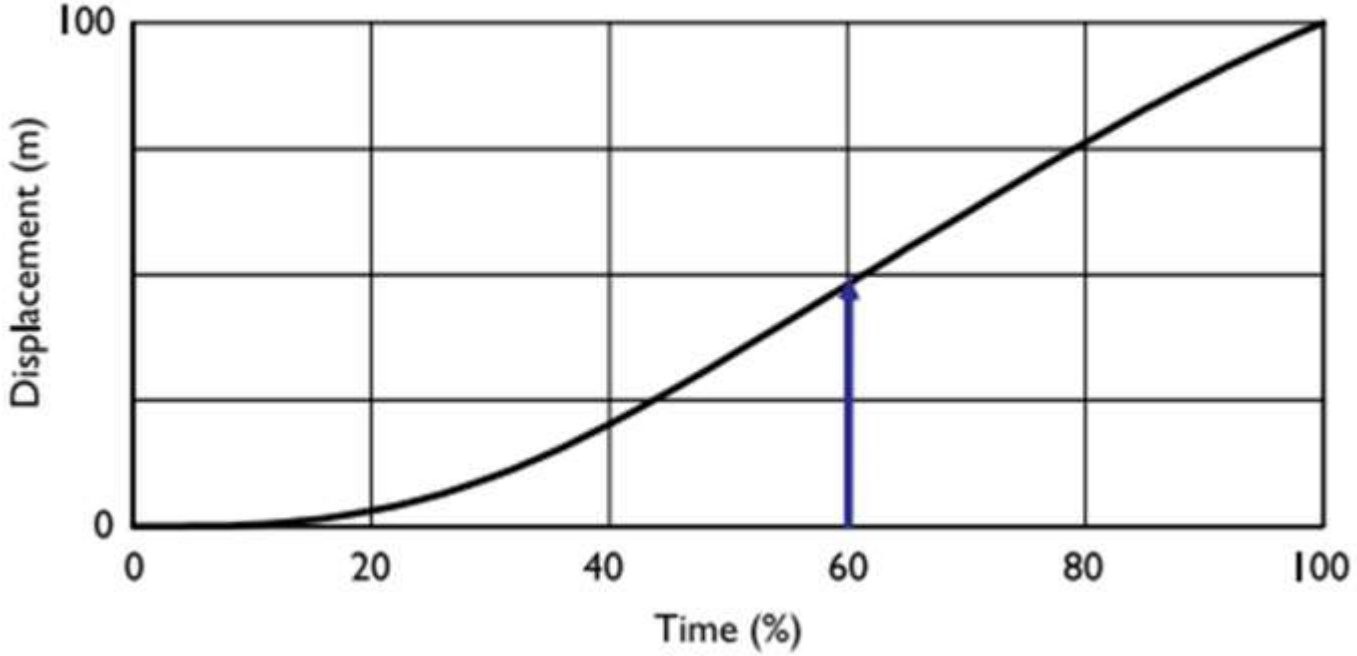
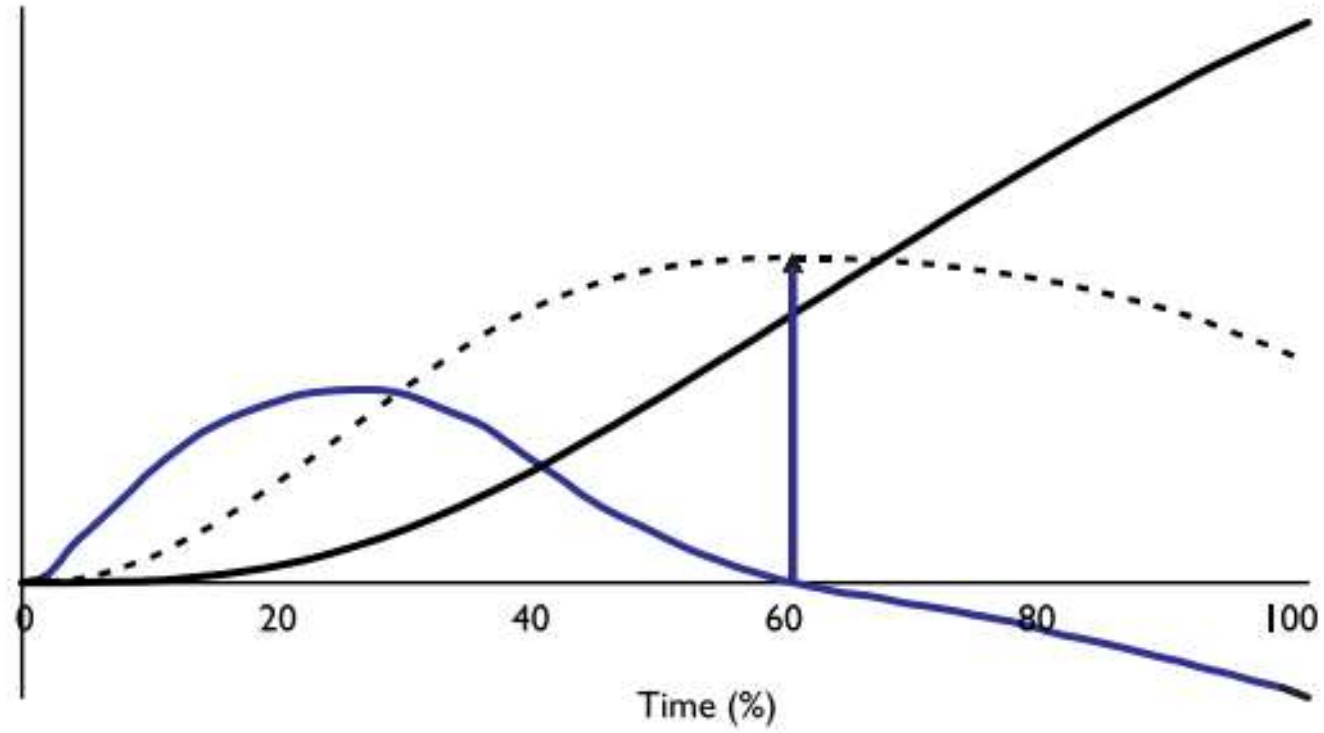


Figure 3.6 Hypothetical horizontal displacement of the centre of mass with time for a novice sprinter.



- When the curvature is positive, the acceleration is positive, and the gradient and velocity are increasing; this is why we called valley-type curvature positive.
- When the curvature is negative, so is the acceleration, and the gradient and velocity are decreasing; this is why we called hill-type curvature negative.
- Where the curvature and acceleration change from positive to negative, the acceleration is instantaneously zero; the velocity stops increasing and starts decreasing.
- Where the curvature and acceleration change from negative to positive, the acceleration is instantaneously zero; the velocity stops decreasing and starts increasing.

Figure 3.8 Hypothetical centre of mass displacement (continuous black curve), velocity (dashed black curve) and acceleration (blue curve) variation with % race time for a novice sprinter.



What technology is out there to record and analyse biomechanics?

1) Kinovea - free

- https://youtu.be/ctjSRrD-RSg

Kinovea Basic tools Part 1

youtube.comUvic Biomechanics

Kinovea Basic tools, Part 2

YouTubeUvic Biomechanics

Technology cont….

2) HUDL technique - pay

https://www.hudl.com/products/technique

Dartfish -pay

https://www.dartfish.com/trackandfield

Sporfie

- https://www.sporfie.com/

Collecting real data for biomechanics

Performance activity

Stage 3 Evaluate and justify (Nelson QCE 2019)

***Aim*:** To investigate how summation of momentum affects the distance a ball can be thrown

***Equipment*:** Tennis ball, tape measure

***Method*:** With a partner, complete the following, recording the distance of each throw:

Collecting biomechanical data

1. Sit with your back against a wall, arm by your side, and throw the tennis ball using only your wrist.
2. Sit with your back against the wall, and throw the ball using your wrist and elbow.
3. Kneel, then use your wrist, elbow and shoulder to throw the ball.
4. Stand up, keeping your feet together, and use your trunk, shoulder, elbow and wrist to throw the ball.
5. Stand, step forward and throw the ball using your trunk, shoulder, elbow and wrist.

Collating biomechanical data

Trial	Distance
1	
2	
3	
4	
5	

Analysing biomechanical data

Discussion:

1. In which trial did the ball cover the greatest distance?
2. Explain your results in relation to summation of momentum.
3. How is momentum conserved when each body segment has a different mass and moves with a different velocity?
4. Young children often throw using only their arm. Outline three coaching points you could use when teaching children to throw correctly.

Conclusion: What conclusion can be made about summation of momentum and the increased release velocity of a ball in an overarm throw?

Feedback or more information?

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Have you joined the 'Secondary HPE Teachers QLD' Facebook Page?

Have you joined the Senior Physical Education Network email group?

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