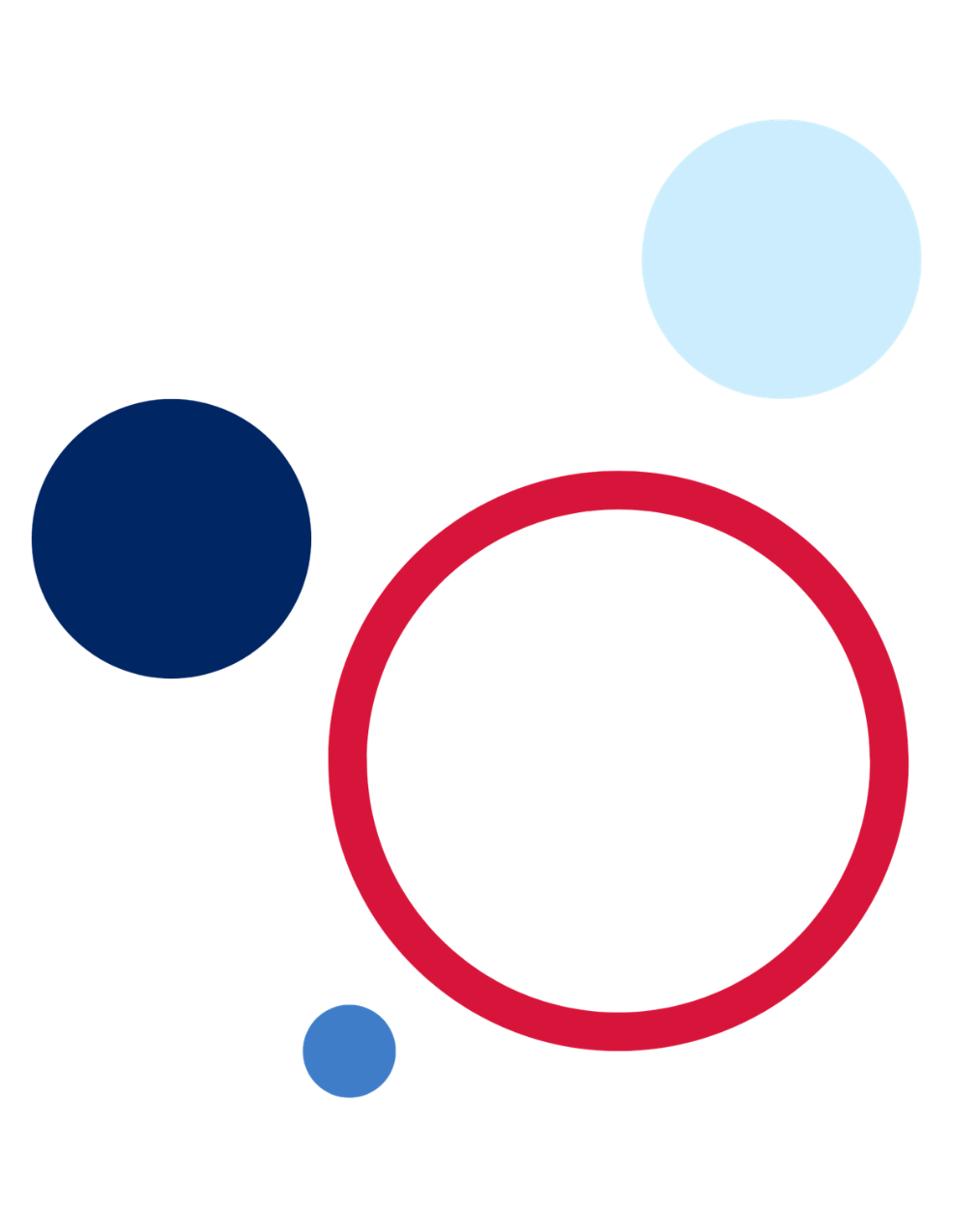
# Health and movement science Stage 6 (Year 11) – depth study – biomechanics



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This resource has been developed to assist teachers in NSW Department of Education schools to create learning that is contextualised to their classroom. It can be used as a basis for the teacher’s own program, assessment, or scope and sequence, or be used as an example of how the new curriculum could be implemented. The resource has suggested timeframes that may need to be adjusted by the teacher to meet the needs of their students.

## Overview

The following depth study is provided as a guide. External resources embedded throughout should not be considered endorsed.

Preview, evaluate and adjust all strategies, resources and teaching and learning approaches in full before use with students to determine suitability for student learning needs, stage of development and local school context.

This depth study is intended to be completed in Year 11 as part of Core 2 – The body and mind in motion. The depth study is not assessable.

Ten hours have been allocated to this depth study.

Before undertaking this depth study, students should have demonstrated basic or sound understanding of the:

* skeletal and muscular systems of the body and their interrelationship
* biomechanical principles including motion, balance and stability, fluid mechanics and force.

The **Year 11 Core 2 – biomechanics sample learning program** provides a series of lead in and preparation activities to build the required knowledge, understanding and skills. This sample learning program can be accessed on the [Planning, programming and assessing PDHPE 11–12 curriculum webpages](https://education.nsw.gov.au/teaching-and-learning/curriculum/pdhpe/planning-programming-and-assessing-pdhpe-k-12/planning-programming-and-assessing-pdhpe-11-12).

Opportunities for reflection and adjustments can be made depending on student interest.

## Purpose

This depth study provides students with opportunities to consolidate their knowledge and understanding of biomechanical principles to explain the vital role they play in safe and efficient movement.

Students will be guided through several steps of the depth study. Suggested questioning has been provided to help support student critical inquiry.

Through the depth study, students will develop foundational knowledge for syllabus content to be undertaken in Year 12 as part of Core 2 – Training for improved performance. In Year 12, students are required to explain how biomechanics can be used to train for sustained movement and improved performance.

Through this depth study, students will:

* analyse the relationships between muscles, bones, joints and biomechanical principles to consolidate an understanding of the implications of relationships on safe sporting movement and movement efficiency
* explain the interrelationship of the bones, muscles and joints for the execution of movements
* understand the biomechanical principles in play when completing certain sporting movements
* understand how biomechanical principles can ensure safe movement and improved efficiency
* compare the techniques of safe versus unsafe movements and understand the biomechanical principles influencing movement
* explore potential injuries in sports and account for the biomechanical issues that can contribute to this injury, for example, tennis elbow, golf elbow, stress fractures in back and shins
* suggest ways to train for improved efficiency
* develop a movement portfolio to document and guide their learning journey
* reflect upon chosen sporting examples
* apply their knowledge and understanding to various sporting examples.

## Syllabus

The following syllabus outcomes and content are addressed if all the teaching activities are completed. Teachers are to use their professional judgement to ensure that the suggested syllabus content is addressed.

### Outcomes

A student:

* analyses the systems of the body in relation to movement **HM-11-03**
* Analysis: analyses the relationships and implications of health and movement concepts **HM-11-06**
* Problem-solving: proposes and evaluates solutions to health and movement issues **HM-11-09**

### Content

**How do the systems of the body influence and respond to movement?**

* Outline the interrelationship between biomechanical principles and the muscles, bones and joints of the body for safe movement

Including:

* how biomechanical principles are applied to human movement, including motion, balance and stability, fluid mechanics and force
* how biomechanical principles can be used to enhance safe movements (for example, walking, squatting, lifting)
* how biomechanical principles can be used to increase movement efficiency (for example, movements to reduce injury, people with specific needs such as disability)

## Depth study instruction

Two different delivery models have been included for this depth study. Teachers can decide which delivery model suits their class context and student needs.

Delivery models include:

1. a guided approach – movement skill analysis (baseball pitch)
2. an independent or collaborative approach – independent, paired or group work and student choice from 3 areas of interest.

### A guided approach to the depth study

**Inquiry question** – What role do biomechanical principles play in ensuring the safety of participants and improving movement efficiency?

**Task: individually, investigate the baseball pitch using the questions and resources provided.**

**Evidence of learning:** movement portfolio.

To answer the inquiry question, students will use a movement portfolio to document their learning journey. Through the movement portfolio, students should demonstrate application of their understanding of biomechanical principles to safely and efficiently execute the sporting example. Evidence may include:

* filmed movement sequences and annotations
* pictures, diagrams and video
* reflections and record of discussions or answers to questions.

A movement portfolio can be created offline or using a range of digital platforms such as [Google slides](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/70#.XowcWFpFdG8.link), [Padlet](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/592), [Google classroom](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/27) or [Microsoft Teams](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/117#.XowdB8acB_4.link).

#### The baseball pitch

The following steps will guide the investigation and portfolio development.

Step 1 – interrelationship between muscles, bones and joints in the movement

Step 2 – biomechanical principles influencing movements

Step 3 – enhancing safe movement and efficiency

**Note:** the following is an example of how the 3 steps have been used to guide students through their learning journey. Sample questioning has been used within each step that links to the baseball pitch example. These could be adjusted to fit with an alternate sporting example. All tasks and questions should be documented in a student’s movement portfolio.

#### Step 1 – interrelationship between muscles, bones and joints in the movement

Students photograph or video themselves, or an athlete, performing a baseball pitch. Separate the movement into 3 distinct phases:

1. Preparation phase – this phase contains all the movements that prepare an athlete for the performance of the skills, for example wind up in the baseball pitch.
2. Execution phase – performance of the actual movement that often includes the release of an object, for example release of the baseball from the hand. In an alternate movement, this phase could include a point of contact with an object, for example contact of the cricket bat on the ball or a flight phase, for example long jump.
3. Follow through phase – refers to all the movements that occur after the execution phase. For example, follow through after throwing that slows the body’s momentum to prevent injury or to get ready for another movement or both.

For each of the phases, students:

* explain the interrelationship of the bones, muscles and joints and how they work together to execute this movement. Include bones, joint actions, major agonist, antagonist and different types of muscle contractions that might be evident throughout the movement
* record in their movement portfolio.

#### Step 2 – biomechanical principles influencing movements

Students watch the video [How to Throw a Baseball – Baseball Throwing Mechanics](https://www.youtube.com/watch?v=UHRU973uu2c) (6:01) by Ultimate Baseball Training. This video explores how biomechanics plays a part in movement.

Using their knowledge of the biomechanical principles (motion, balance and stability, fluid mechanics and force), students outline the principles being used in their baseball pitch photograph or video from Step 1. Some may not be applicable and therefore students use the most relevant. These are to be recorded in their movement portfolio.

Sample questions for a throw or pitch:

* Using the 3 phases from Step 1, outline the biomechanical principles influencing this movement.
* Explain how motion (speed, acceleration and momentum) is generated in a baseball pitch to ensure maximum velocity, for example building up momentum within the body. How can they do this with minimal run up?
* How does an athlete apply force to a ball in an overarm throw? How is this different to an alternate type of throw such as underarm or side arm throw?
* Explain how force can be generated through a baseball pitch to improve velocity of the ball.
* Explain differences between a front on, side on and a throw with a run up. For example, improved technique and increasing the time taken to generate the force through a run up, leg drive, hip rotation or follow through.
* Draw a diagram showing the direction and forces acting together to throw the ball.
* Why is balance and stability important? How does an athlete create balance and stability when executing the throw?
* Draw the phases from Step 1 and for each of the phases estimate the location of the centre of gravity.
* Are there differences between the 2 movements?

**Note: if students understand the basic biomechanical principles of the baseball pitch established in Step 2, it will allow students to build understanding on how to increase efficiency and ensure safe sporting movements.**

#### Step 3 – enhancing safe movement and efficiency

**Note:** efficiency for an athlete relates to energy conservation and protection against injury. Building understanding of biomechanical principles for key movements can ensure athletes can play for longer and protect key bones, muscles and joints. Step 3 continues applying knowledge of the baseball pitch to understand why biomechanically correct movements create safety and efficiency. Stimulus videos have been included. Students may wish to include these in their movement portfolio to demonstrate their understanding. Throughout Step 3 possible responses have been included following each guiding question.

Explain to students that efficient movement plays a part in reducing injuries. It is about achieving the best movement with minimum wasted effort or expense.

Propose what contributes to wasted effort and injuries.

**Sample answer:** lack of strength, incorrect technique, strain on muscles, ligaments and joints and repetition of the movements.

**Video 1 –** using the video [Baseball Velocity Pitching Series: Stride Shape | Video 2 (Pro Speed Baseball)](https://www.youtube.com/watch?v=2RowjJM1QLg) (5:04) as a guide, explain the biomechanical principles (force, balance and stability) behind the throw to maximise velocity and speed.

* The pitcher refers to ‘down and glide or come down and out’. What does this mean? What is the purpose?
* What is the pitcher trying to create? Use your understanding of force to explain your response.
* Why does the pitcher go ‘down first then out’?

**Sample answer:** going down (lowering the centre of gravity) and then striding out means the athlete is generating greater force from his gluteal and the movement is more efficient and fluid. The gluteal are the strongest muscles and, when shortened they apply a force which can be transmitted through the body. This greater force enables a faster stronger pitch.

* Why is kicking out before dropping down not biomechanically correct? Use your understanding of balance and stability.

**Sample answer:** the line of gravity becomes outside the base of support, placing the pitcher off balance and causing inaccuracy in the throw.

* What suggestions are made to improve this and why?

**Sample answer:** using strength or plyometric training for those muscles to produce more force and more explosive movement.

**Video 2 – watch the video** [Baseball Velocity Pitching Series: Core Power | Video 5 (Pro Speed Baseball)](https://www.youtube.com/watch?v=ioy64egDNu0) (6:51) from time stamp 0:**18 to 02:03.**

* What suggestions are made to improve technique?

**Sample answer:** stretch out the abdominals on take back.

* Why is this better biomechanically?
* What is the pitcher aiming to achieve?

**Sample answer:** the pitcher is wanting to use more muscles and use all the body forces in the execution of the throw. The longer a force is applied, the longer the body will spend accelerating and therefore the more the total velocity will change. When you rotate your body, you are increasing the time in which the force is applied by the combination of muscles, resulting in a greater impulse being applied to the ball. This will result in more momentum hence velocity of the ball will increase.

* Does technique play a part in efficiency?

**Video 3 – prior to watching the** [Arm Path for Pitchers that Cause](https://www.youtube.com/watch?v=kvDs7vUQbSc) SERIOUS injury (7:31) video, identify some common injuries in baseball pitching.

* What are some common injuries with your chosen movement?

**Sample answer:** joint not being able to survive the load such as the shoulder and elbow. Stress is high on these areas and tears in tendons, muscles or ligaments can occur. Injuries are often caused by the loading rate, which is how fast an athlete is trying to generate the force. If the technique is incorrect, the forces are applied to smaller areas creating an injury.

* Why do these injuries happen?

**Sample answer:** there are many reasons why injury can occur, however, one likely reason is if you throw side arm or not completely overarm because your techniques do not allow your trunk to lead your arm when you are throwing, then the athlete is generating force on the elbow and other small muscles. The forearm and some of the shoulder is creating the force which creates more strain on the tendons around the elbow. If you throw correctly and over your shoulder, all your muscles are moving in alignment. This means the force being generated is using all the muscles and so it shares the load, reducing the likelihood of that type of injury. Building muscles to avoid this type of injury is important, but it is vital that correct technique is used and warmed up properly. Often poor technique occurs because other muscles are overcompensating.

* What muscles, bones and joints would be affected?
* How can these injuries be reduced or prevented?

**Sample answer:** the coach talks about giving the body more time to go through the throwing path to build the force and transfer the energy, reducing load and generating the energy within the arm too quickly. This is achieved through leg drive and longer hip to shoulder separation. Doing the movement over a longer time allows the muscles to better protect themselves. By engaging more muscles, it builds up the force over a longer period, resulting in greater velocity and a reduction in injury. When the movement happens quickly and all the muscles are not engaged, over a shorter period of time, the joints find it harder to protect themselves, causing injury.

### An independent or collaborative approach to the depth study

**Inquiry question** – What role do biomechanical principles play in ensuring the safety of participants and improving movement efficiency?

**Task: individually, in pairs or small groups, students select or negotiate one of the following areas of interest. They will use the questions provided and any additional investigation or resources needed to answer the inquiry question.**

**Evidence of learning:** movement portfolio.

To answer the inquiry question, students will use a movement portfolio to document their learning journey. Through the movement portfolio, students should demonstrate application of their understanding of biomechanical principles to safely and efficiently execute the sporting example. Evidence may include:

* filmed movement sequences and annotations
* pictures, diagrams and video
* reflections and record of discussions or answers to questions.

A movement portfolio can be created offline or using a range of digital platforms such as [Google slides](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/70#.XowcWFpFdG8.link), [Padlet](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/592), [Google classroom](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/27) or [Microsoft Teams](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/117#.XowdB8acB_4.link).

**Use the guided questions outlined in each area of interest** to guide the investigation and portfolio development.

Step 1 – interrelationship between muscles, bones and joints in the movement

Step 2 – biomechanical principles influencing movements

Step 3 – enhancing safe movement and efficiency

#### Area of interest 1 – elite athletes

**Select one elite athlete from a sport or activity of your choice.**

* Identify the movements undertaken in their activity or sport which require proficiency of technique.
* Select one movement. Which muscles, bones and joints work to enable that movement to be completed?
* Which biomechanical principles are taking place during this movement?
* For your selected movement, what is considered correct technique and why?
* Compare the correct technique to the technique used by your selected athlete. What similarities and differences exist?
* Predict injuries that could come about through poor technique.
* Has your athlete experienced a significant injury, or an injury associated with their sport? What contributed to the injury? Were adjustments made to their technique? Why?
* Compare the correct technique or the athlete’s technique to a beginner executing the movement. This could involve one student recording themselves to perform the movement for the analysis.
* What are the similarities and differences?
* What are the biomechanical differences? Why is one better than the other?
* Is the movement execution safe? Explain your answer.
* What could the beginner adjust in their technique to increase efficiency?
* What needs to be done to make this adjustment, for example training, equipment change, growth, strength, practice.
* If the technique is not adjusted what potential injuries can occur?

#### Area of interest 2 – technique comparison

**Select one sport-based movement or movement skill which has at least 2 different techniques. Examples include one handed backhand vs 2 handed backhand in tennis, crouch versus standing start, a swimmer with bent arms versus straight arms, overarm versus sidearm throw in cricket, landing in gymnastics with straight versus bent legs, Fosbury flop versus a scissor kick in high jump.**

* Which muscles, bones and joints work to enable that movement to be completed?
* Which biomechanical principles are taking place during this movement?
* Compare the techniques. What similarities and differences exist?
* Is one technique better than the other? What makes you say this?
* Are both techniques biomechanically, correct? What are the biomechanical differences between the 2 techniques?
* Examine the safety for the muscles, bones and joints of the body for each technique.
* What are some common injuries related to the movement and why do they occur?
* What is biomechanically happening to cause these injuries? For example, tendonitis, tennis elbow, golf elbow, stress fractures in back and shins.
* Are there differences between the common injuries related to each technique?
* How can injuries be reduced through changes to the biomechanical technique?
* Explain which is the most efficient way to execute the sport-based movement or movement skill. Demonstrate understanding of:
* the biomechanical principles
* which technique is more energy efficient
* which technique is more accurate, quicker or consistent than the other.

#### Area of interest 3 – movement skill analysis

**Select one movement or movement skill from a sport or activity of your choice. Examples could include a** shot-put throw, 100-metre sprint start, rugby league tackle, a tennis serve, bowling in cricket, a basketball lay-up, rowing.

* How do you know the movement is efficient when you observe someone executing it?
* For your selected movement, what is considered correct technique and why?
* Break up the movement into phases (preparation, execution and follow through). What muscles, bones and joints work to enable that movement to be completed?
* What biomechanical principles are taking place during this movement?
* Compare the correct technique to a beginner executing the movement. This could involve one student recording themselves perform the movement for the analysis.
* What are the similarities and differences?
* What are the biomechanical differences? Why is one better than the other?
* Is the movement execution of the beginner safe? Explain your answer.
* How could the beginner adjust their technique to increase efficiency?
* What needs to be done to make this adjustment, for example, training, equipment changes, growth, strength, practice.
* If the technique is not adjusted what potential injuries can occur?
* What are some common injuries related to the movement and why do they occur?
* What is biomechanically happening to cause these injuries? For example, tendonitis, tennis elbow, golf elbow, stress fractures in back and shins.
* Explain how these injuries can be reduced through applying biomechanical principles to the technique.
* What is the most efficient way to execute the movement and why? Demonstrate understanding of:
* biomechanical principles
* sequence of how muscles and bones are used to generate force.

## Rubric for submission

Through the submission of the movement portfolio, students will show evidence of their:

* knowledge and understanding of the interrelationship of movement between bones, joints and muscles through the examination of sporting examples
* understanding of the relationship between biomechanical principles and improved execution of a sporting movement(s)
* ability to apply the skills of critical thinking and analysis when examining efficient and safe biomechanical technique in a sporting context
* ability to evaluate how biomechanical principles play a role in ensuring the safety of participants and improving movement efficiency
* ability to communicate ideas and information using relevant sporting examples.

## Support and alignment

**Resource evaluation and support**: all curriculum resources are prepared through a rigorous process. Resources are periodically reviewed as part of our ongoing evaluation plan to ensure currency, relevance and effectiveness. For additional support or advice contact the PDHPE curriculum team by emailing [PDHPEcurriculum@det.nsw.edu.au](mailto:PDHPEcurriculum@det.nsw.edu.au).

**Alignment to system priorities and/or needs:** [School Excellence Policy](https://education.nsw.gov.au/policy-library/policies/pd-2016-0468), [School Success Model](https://education.nsw.gov.au/public-schools/school-success-model/school-success-model-explained)

**Alignment to the School Excellence Framework**: this resource supports the [School Excellence Framework](https://education.nsw.gov.au/about-us/strategies-and-reports/school-excellence-and-accountability/school-excellence#:~:text=SPaRO%20platform.-,School%20Excellence%20Framework,-The%20school%20planning) element of assessment (formative assessment, summative assessment, student engagement).

**Alignment to Australian Professional Teaching Standards**: this resource supports teachers to address [Australian Professional Teaching Standards](https://educationstandards.nsw.edu.au/wps/portal/nesa/teacher-accreditation/meeting-requirements/the-standards/proficient-teacher) 5.1.2, 5.4.2.

**Consulted with**: PDHPE Community of Learners

**NSW Syllabus**: [Health and Movement Science 11–12 Syllabus](https://curriculum.nsw.edu.au/learning-areas/pdhpe/health-and-movement-science-11-12-2023/overview)

**Syllabus outcomes**: HM-11-03, HM-11-06, HM-11-09

**Author**: PDHPE Curriculum Team

**Publisher**: State of NSW, Department of Education

**Resource**: Depth study

**Related resources**: further resources to support Health and movement science Stage 6 can be found on the [Planning, programming and assessing PDHPE 11-12 curriculum webpage](https://education.nsw.gov.au/teaching-and-learning/curriculum/pdhpe/planning-programming-and-assessing-pdhpe-k-12/planning-programming-and-assessing-pdhpe-11-12) and the [HSC hub](https://hschub.nsw.edu.au/).

**Professional learning**: relevant professional learning is available on the [PDHPE statewide staffroom.](https://teams.microsoft.com/l/team/19%3a93bb42a54e4b4779b28ab5b737b9e642%40thread.tacv2/conversations?groupId=d759a943-a680-4d0b-bdfe-88a8998f709e&tenantId=05a0e69a-418a-47c1-9c25-9387261bf991)

**Universal Design for Learning**: [Curriculum planning for every student in every classroom](https://education.nsw.gov.au/teaching-and-learning/learning-from-home/teaching-at-home/teaching-and-learning-resources/universal-design-for-learning). Support the diverse learning needs of students using inclusive teaching and learning strategies.

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[Health and Movement Science 11–12 Syllabus](https://curriculum.nsw.edu.au/learning-areas/pdhpe/health-and-movement-science-11-12-2023/overview) © NSW Education Standards Authority (NESA) for and on behalf of the Crown in right of the State of New South Wales, 2023.

Pro Speed Baseball (10 September 2014) ‘[Baseball Velocity Pitching Series: Core Power | Video 5 (Pro Speed Baseball)](https://www.youtube.com/watch?v=ioy64egDNu0)’ [video], *Pro Speed Baseball*, YouTube, accessed 22 September 2023.

Pro Speed Baseball (11 September 2014) ‘[Baseball Velocity Pitching Series: Stride Shape | Video 2 (Pro Speed Baseball)](https://www.youtube.com/watch?v=2RowjJM1QLg)’ [video], *Pro Speed Baseball*, YouTube, accessed 22 September 2023.

TopVelocity.net (16 August 2018) ‘[Arm Path for Pitchers that Cause SERIOUS Injury’ [video], *TopVelocity.net*, YouTube, accessed 22 September 2023.](https://www.youtube.com/watch?v=kvDs7vUQbSc)

Ultimate Baseball Training (16 December 2016) ‘How to Throw a Baseball – Baseball Throwing Mechanics’ [video], *Ultimate Baseball Training*, YouTube, accessed 22 September 2023.

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