PROBLEM BASED LEARNING: A NETBALL / BASKETBALL SHOOTING PROBLEM FOR PROJECTILE MOTION

Problem Title	The effect of a defender on netball / basketball shooting

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Learning Outcome(s)	
1	Identify and define important parameters influencing projectile motion
2	Express a real-world problem in terms of projectile motion
3	Calculate projectile motion parameters
4	Compare values for two or more conditions
5	Discuss the concept of ecological validity in scientific testing

Concepts / Competencies expected to engage with	• Projectile motion • Introductory trigonometry • Ecological validity

Course Level	Level 4 / First Year (undergraduate introductory biomechanics)

This problem involves data analysis	**Yes**	~~No~~	~~Maybe~~

Approximate Length	3 hours

Class/Group Size	Any class size, ideally working in groups of 4-5 students. If recording video (rather than providing pre-recorded footage) all groups should be able to record simultaneously or within approximately 30 minutes.

Useful References *(In chronological order of expected use within the problem)*	**1.** Bartlett, R. (2014). *Introduction to sports biomechanics: Analysing human movement patterns* (pp. 139-145). Routledge. (*or any text detailing projectile motion*) **2.** Knudson, D. (1993). Biomechanics of the basketball jump shot—Six key teaching points. *Journal of Physical Education, Recreation & Dance*, 64(2), 67-73. https://doi.org/10.1080/07303084.1993.10606710 **3.** Payton, C. J. (2007). Motion analysis using video. In *Biomechanical evaluation of movement in sport and exercise* (pp. 17-28). Routledge. (*or any text detailing video recording and digitisation*) **4.** Gorman, A.D., & Maloney, M.A. (2016). Representative design: Does the addition of a defender change the execution of a basketball shot?. *Psychology of Sport and Exercise*, 27, 112-119. https://doi.org/10.1016/j.psychsport.2016.08.003

Mode of Instruction	Synchronous, face-to-face if recording video. Could be online and/or asynchronous if providing pre-recorded footage.

The Scenario:

Images: Alex Bogatyrev (left) / Shutterstock.com (both)

As a sport scientist working in a multi-sport organisation, the national netball or basketball coach approaches you with a question. They currently use defenders during shooting practice but are concerned about the extra demands this is placing on their defenders during a congested competition period. The coach wants to know whether removing the defenders from the practice environment will affect the trajectory of the shots. If so, they wonder if a mannequin defender could be used as a compromise.

The Question(s):

Students must choose one of the two sports (netball or basketball) and determine whether the presence of a defender (condition: defender / mannequin / no defender) influences parameters relating to the projectile motion of the ball. As an extension task, students may wish to further consider the relationship between release parameters and shot success.

Expected Outcome:

This is very much a generic outline and can be modified to suit the particular students and course, as well as time and resource constraints. However, students may answer the above questions and achieve the learning outcomes in the following ways:

Identify and define important parameters influencing projectile motion

Whilst the importance of whole-body kinematics should be acknowledged, students should be encouraged to focus on aspects relating to the projectile motion of the ball. Ignoring ball spin for simplicity, identified parameters should include ball release height, ball release speed, and ball release angle. Alternatively, students may identify the horizontal and vertical components of ball velocity instead of its angle and resultant speed. In order to calculate, compare, and interpret the parameters identified as important, students will need to agree upon a definition of each parameter. Discussion may also include the appropriate units for each parameter.

(*References 1 and 2 may help here*)

Express a real-world problem in terms of projectile motion

After identifying and defining the important ball release parameters, the students should be encouraged to reframe the coach's initial question with reference to the specific parameters and definitions. One example could be "Is there a difference in ball centre height, speed, or angle at the time of release when compared between a 'defender', 'mannequin', and 'no defender' condition?". This may be an appropriate time to discuss research questions and hypotheses, if desirable within the context of the course.

(*References 1 and 2 may help here*)

Calculate projectile motion parameters

At this point, students can either use pre-recorded video footage (or if necessary could be given pre-digitised coordinates) or ideally record their own within their group. The video recordings will include the same shooter attempting a number of shots from the same position in each of the three conditions. The camera set up and background (e.g. reference scale) should be appropriate for subsequent digitisation of the ball centre.

Students will digitise the ball centre in the first frame after release, as well as one (or a few) frame(s) after this, for each video. From the digitised coordinates, students will calculate their previously identified important parameters.

(*References 1 and 3 may help here*)

Compare values for two or more conditions

The calculated values can then be compared between conditions. Depending on the course, this may be graphically or statistically. Opportunities to discuss data visualisation techniques or appropriate statistical analysis will be available if suitable. At this point, students will also be able to answer the coach's initial question (*i.e.* a discussion of representative training design). Opportunities for discussion also include the generalisability of the results and any limitations with the investigation. It may also be useful to compare the results to previous literature on this topic.

(*Reference 4 may help here*)

Discuss the concept of ecological validity in scientific testing

Students can discuss the implications of their investigation for research practice. For example, is it necessary to record data in conditions representative of competition? Which aspects of the competitive environment are important to preserve / recreate, and which are of lesser importance? Discussion may also refer to the pros and cons of laboratory and field based testing.

(*Reference 4 may help here*)

Guided Questions (Hints):

These questions are intended to lead students towards the solutions if they are struggling or maybe even unsure where to start. If the mode of instruction is synchronous, these questions can be withheld by the instructor and provided as hints as needed to help students move towards a solution. If the mode of instruction is asynchronous, then the instructor may choose to share these questions with students as part of the problem.

Whilst students may be able to work through the problem in their own way / at their own pace, they can be guided towards the achievement of each learning outcome in turn via questions such as the following:

1. What could a shooter change about the way they release the ball to influence the outcome of the shot? Can you define each of these parameters?
2. What do you need to measure and calculate to answer the coach's question?
3. How can you calculate these parameters?
4. How do these values compare between 'defender', 'no defender', and 'mannequin' conditions?
5. What are the implications of these findings for training and research?