Unit 6: Sports Biomechanics in Action

Unit code: A/600/0043

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

The aim of this unit is to enable learners to undertake notational analysis of sport and exercise, comparing performance using either a numerical or technical model and provide feedback to an athlete or team to improve performance.

Unit introduction

In order to produce outstanding sporting performances, the athlete has to be physically, technically, tactically and psychologically prepared. This unit covers the technical and tactical aspects of the preparation of the athlete, but can also inform the physical element of preparation through analysis of movements the athlete performs during their performances.

Notational analysis enables the identification of the most frequent actions taking place in the sport and the contribution of athletes individually and as a team. It will allow for advanced tactical analysis of personal performances and that of the opposition. Identifying individual strengths and weaknesses of the athlete or team, and those of the opposition, is used as a major tool for constructing modern coaching programmes.

Analysis of technique has always been a complicated process and subject to interpretation, but with the development of high-speed cameras and video and computer technology, learners will be able to compare performances using either numerical or technical-based models.

Learners will be able to collect numerical data on distances, speeds, angles of limbs and projectiles to feedback to the athlete and optimise performance in many sports. They will be able to observe performance and compare technique against a preferred style or technical model.

Learners will also have the opportunity to collect data and using descriptive statistics, feedback appropriate information to the athlete or team to help them improve their performances.

The unit is designed to integrate ICT within its teaching and assessment. The knowledge and skills gained from this unit will help learners aiming for careers in coaching, fitness training and performance analysis.

Learning outcomes

On completion of this unit a learner should:

1   Be able to perform notational analysis for sport

2   Be able to compare a numerical model to sporting performance

3   Be able to compare a technical model to sporting performance

4   Be able to provide feedback on performance to an athlete or team.

Unit content

1 Be able to perform notational analysis for sport

Performance criteria: eg unforced errors, forced errors, shot success/failure, shot accuracy, crosses, catches, passing, interception rates, saves, tackles, headers, dribbling

Notational analysis: movement, eg work rate, positional play, distance covered including sprinting, movement patterns, breaking of rules/laws, performance criteria; statistics, eg mean, standard deviation, mode, median, range, percentages; data analysis, eg correlation test; data representation, eg databases, spreadsheets, tables, tally charts; graphical representation, eg pie charts, bar charts, line graphs

2 Be able to compare a numerical model to sporting performance

Numerical model production: eg literature based, elite-level athlete based, specific-athlete based, combination approach

Numerical component: eg linear motion (linear displacement, speed, linear velocity, linear acceleration), angular motion (angular displacement, angular velocity, angular acceleration), projectile motion (angle of release, angle of attack, height of release, velocity of release), measurement of movement (range of movement, centre of gravity, limb angles and goniometry)

Methodology: recording, eg two dimensional (2D), digital images; measuring, eg horizontal scaling, vertical reference, perspective error

3 Be able to compare a technical model to sporting performance

Technical model production: eg literature based, elite-level athlete based, specific-athlete based, combination approach, qualitative biomechanics, descriptive, subjective

Technical component: eg body position, footwork, balance, grip, stance, passing, kicking, shooting, throwing, catching, fielding, batting, striking, dribbling, stride length, stride frequency, run up, sprinting, take off, release phase, flight, landing, recovery phase, motion of centre of gravity

4 Be able to provide feedback on performance to an athlete or team

Feedback: confidentiality; appropriate language; strengths; areas for improvement; positive and negative feedback; clarity of information; written; verbal; evidence based; athlete/coach friendly; acknowledgment of biomechanical limitations; factors influencing performance, eg age, health, diet, previous training, motivation, confidence, ability level, group dynamics, group cohesion, temperature, time of day

Future action: goals (short-, medium- and long-term); SMART (specific, measurable, achievable, realistic, time-bound) targets; recommendations, eg priority of future coaching and training, team skills and drills, individual skills training, fitness training for specific components of fitness, technique coaching specific to movement, for example grip in throwing sports

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
P1 describe five relevant performance criteria for an individual or team-based sport		
P2 perform two notational analyses on a chosen sport, with some support [SM3]	**M1** compare the two notational analyses, using statistics, data representation and literature to explain the strengths and areas for improvement	
P3 produce a numerical model, using three numerical components, and compare it to a sporting performance, with some support [CT1, CT3, SM3]		
P4 produce a technical model, using four technical components, and compare it to a sports performance, with some support [CT1, CT3, SM3]	**M2** explain and justify the methodology for either the numerical or technical models	**D1** evaluate findings for either the notational analyses, numerical or technical models commenting on their influence on performance within the chosen sport
P5 provide feedback on performance, to an athlete, or team, using information gathered from one of the analyses performed, prescribing future action, with support. [TW2, EP1, EP3]	**M3** provide detailed feedback and prescribe future action for the athlete or team from either the notational analyses, numerical or technical models.	**D2** justify the prescribed future actions for either the notational analyses, numerical or technical models.

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

Learners should be encouraged to apply their theoretical models to real-life situations. For example, learners may support the theory of projectile motion by filming an athlete putting the shot. From footage collected, learners should be able to calculate the important components such as the correct height of release for optimal distance.

With reference to notational analysis, learners should be able to link with the centre's sports teams to gather raw data. Tutors could assign learners to collect different data. For example, learner A could collect passing data for a particular player, with learner B collecting tackling data.

Another approach would be to record a televised tennis match and gather raw data within the classroom. The information gathered could be put into spreadsheet(s) to generate statistics and graphical representation. This raw data may be used to drive mathematics or ICT sessions.

Although learners may have covered the basic biomechanical principles during their previous studies, there will be a need for theoretical input. For example, although the assessments are designed to be practical, it is important for tutors to dedicate adequate time to the theory of numerical and technical data collection. It is vital that learners are taught the techniques required to generate the data; for example how to measure the height of release, with consideration of scaling issues.

To support the theoretical work, learners should take part in as many practical sessions as possible. For example, learners could be shown how to collect a video image with consideration of image size, and should be encouraged to film a variety of sports. This will allow learners to feel comfortable with the practical aspects of filming but also with the underlying biomechanical principles.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Introduction and overview of the unit.
Assignment 1: Notational Analysis of Sport (P1, P2, M1). Tutor introduces the assignment brief.
Performance criteria: activities to identify and describe the relevant performance criteria for individual and team-based sports.
Movement analysis: observation of individuals and their movement patterns throughout a performance.
Statistics: investigation into how a data set can be represented using statistical descriptors.
Data analysis: use of a variety of statistical tests.
Data representation: investigation of different methods used to display data.
Assignment 2: Numerical Model (P3). Tutor introduces the assignment brief.
Numerical models: investigation of the different types of numerical model available to describe sporting performance.
Linear motion: practical examples of linear movement – includes learner practical activities.
Angular motion: practical examples of angular movement – includes learner practical activities.
Projectile motion: practical examples of projectile motion – includes learner practical activities.
Measurement of movement: practical measurements of human movement – includes learner practical activities.
Recording and measuring: learner practical data collection of the above.
Assignment 3: Technical Model (P4, M2, D1). Tutor introduces the assignment brief.
Technical model: investigation of the different types of technical model available to describe sporting performance.
Technical components: practical examples using video and computer technology.
Assignment 4: Feedback on Performance (P5, M3, D2). Tutor introduces the assignment brief.
Types of feedback: identification of strengths and areas for improvement.
Factors influencing performance: corrections made appropriate to the group.
Goals and targets: future performance goals and SMART targets.
Recommendations: for improved performance – includes time allocated to learner-initiated private study.
Review of reflective practice of unit and assessment.

Assessment

Criterion P1 is designed to give learners an opportunity to introduce themselves to the unit and to link into the other assessment criteria. They are able to investigate performance criteria, such as shot success, within a sport or activity of their choice. For P1, learners must describe the five performance criteria in relation to their chosen sport by describing why they are relevant. For example, it is clear that a goalkeeper in football would need a good catch rate whereas dribbling is more suited to a winger.

Through notational analysis, learners should be encouraged to investigate either a team-based or an individual-based sport, depending on their own interest or area of expertise. The evidence produced for P2 should clearly show that learners have performed two separate analyses on the same athlete or team (therefore on two separate occasions). Learners will need to show evidence of statistical work and data representation, which could include a series of tally charts, which are then used to produce a number of pie charts.

To help learners progress to grading criterion M1, it is advised that they analyse three components of the sporting performance, for example, success and failure rates for catching, saving and kicking for a football goalkeeper. It is important to state that learners can choose to investigate a particular player in a team rather than the team as a whole. Learners should be able to access their centre's own sports teams to aid their assessment. However, this may not be possible for some learners, therefore gathering data from professional athletes, for example from televised events, is a valid and appropriate method. For M1, learners need to take the data they have generated for P2 and compare the performances to draw out strengths and areas for improvement. For example, in terms of catching they may comment on a success rate of 50 per cent being similar to 52 per cent, therefore it is clear that the goalkeeper performs poorly when assessed against this criterion. Data manipulation can be taken a stage further through the use of difference tests. For example, a t-test may be used to seek out differences between performances in terms of distance gained through dead ball kicking.

Although different in nature, the numerical and technical models will be able to follow similar assessment processes (P3 and P4). When constructing their models learners will probably require a level of support in locating the appropriate measurable components or biomechanical parameters. For the numerical model (P3), learners must include three components; therefore they could consider the angle of release, angle of attack and height of release for a javelin thrower.

In contrast, for technical modelling (P4) learners must include four components. For example, with cricket they may want to concentrate on body position, footwork, balance and grip which are essential for batting. Within these two assessments, to aid their understanding and assessment presentation learners should use diagrams and figures at every opportunity.

For M2, learners need to explain and justify their methodology for either their numerical or technical model. This choice has been offered so that learners can extend their work in an area which offers the most interest to them. To meet M2 they will need to consider aspects such as camera position or horizontal scaling. Therefore at this stage, learners will need to consider biomechanical literature in conjunction with appropriate class notes. In addition, if learners have used a digital camera, the user's guide may be a useful resource.

Grading criterion D1 allows learners a level of choice. For D1, they will need to consider the bigger picture in relation to a sporting performance. Based on the goalkeeping example, learners should consider the impact of catching success on the game and team. In addition they should also consider the implications for the opposition and the possible future impact on the team's competition status.

To allow choice, learners will be able to provide feedback and suggest future action to the athlete or team for either the notational, numerical or technical assessments (P5).

However, as providing feedback and suggesting possible future action is often a challenging process, tutors may build this aspect into all the assessments to improve learners' skills. This approach would also allow learners to advance their work to meet the higher grading criteria. When providing the feedback for P5 learners will need to have at least considered some of the factors that may have influenced the performance. In addition, the feedback will need to be clear and athlete friendly. In terms of future actions, they do not have to produce a training schedule, but simply highlight the action required, for example, show a catching drill the goalkeeper could use.

For M3, the basic feedback and future actions for P5 will need some clear expansion. This can be achieved through the use of statistics and data representation, which could be given to the athlete or coach. In addition there will be goal-setting linked to future performance and competition targets.

For D2, learners need to link into the biomechanical, coaching and training literature to support the prescribed future actions. To justify their recommendations learners may need access to specific resources, for example goalkeeping coaching manuals. To show a depth of understanding they will need to show a high level of integration between biomechanical and sporting theory.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, M1	Notational Analysis of Sport	Having gained a work placement in a biomechanics laboratory, your first task is to conduct two live or video notational analyses of a sport covering at least five relevant performance criteria.	Presentation of data. Witness statement. Written report.
P3	Numerical Model	Next, compare a sporting performance using three numerical components.	Presentation of data. Witness statement. Written report.
P4, M2, D1	Technical Model	You then look at a technical model and compare a sporting performance using four technical components.	Presentation of data. Witness statement. Written report.
P5, M3, D2	Feedback on Performance	Finally, provide feedback on performance to an athlete or a team and provide future recommendations for further action.	Presentation or written report. Witness statement.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Sport and Exercise Sciences sector suite. This unit has particular links with the following unit titles in the BTEC Sport suite and the BTEC Sport and Exercise Sciences suite:

Level 2 Sport	Level 3 Sport	Level 3 Sport and Exercise Sciences
Technical Skills and Tactical Awareness for Sport	Technical and Tactical Skills in Sport	Research Methods for Sport and Exercise Sciences
Practical Sport	Talent Identification and Development in Sport	Research Project in Sport and Exercise Sciences
Development of Personal Fitness	Analysis of Sports Performance	Analysis of Sports Performance
Effects of Exercise on the Body Systems	Practical Individual Sports	Practical Individual Sports
	Practical Team Sports	Practical Team Sports

This unit links with the National Occupational Standards (NOS) for:

- Coaching, Teaching and Instructing at Level 3
- Achieving Excellence in Sports Performance at Level 3.

Essential resources

Learners will need access to facilities and environments suitable for practical activities. They will also need performers to observe, and resources for recording sports performances, including digital and/or video cameras.

Employer engagement and vocational contexts

This unit focuses on the practical application of biomechanical principles to help in the analysis of sporting performance. The use of notational analysis can aid a coach in identifying strengths and areas for improvement in either their team or individuals. Centres are encouraged to use their sporting teams and, where appropriate, academies of sport to give learners the opportunity to analyse the performances of athletes and teams in real-life settings. This could lead to employment within a coaching environment where the technical and tactical development of individuals is an important process.

Indicative reading for learners

Textbooks

Blazevich A J – *Sports Biomechanics: The Basics: Optimizing Human Performance* (A&C Black, 2007) ISBN 9780713678710

Bloomfield J, Ackland T R and Elliot B C – *Applied Anatomy and Biomechanics in Sport* (Blackwell, 1994) ISBN 9780867933054

Carr G A – *Mechanics of Sport: A Practitioner's Guide* (Human Kinetics, 1996) ISBN 9780873229746

Carr G A – *Sports Mechanics for Coaches, 2nd edition* (Human Kinetics, 2004) ISBN 9780736039724

Grimshaw P – *Sport and Exercise Biomechanics* (Taylor and Francis, 2006) ISBN 9781859962848

Hall S J – *Basic Biomechanics, 4th edition* (McGraw-Hill, 2002) ISBN 9780071240628

Hay J G – *The Biomechanics of Sports Techniques, 4th edition* (Prentice Hall, 1993) ISBN 9780130845344

Koh M and Tan J – *Understanding Biomechanics: for Physical Education and Sports* (McGraw-Hill, 2006) ISBN 9780071247733

McGinnis P M – *Biomechanics of Sport and Exercise, 2nd edition* (Human Kinetics, 2004) ISBN 9780736051019

Saunders R – *Sport Biomechanics into Coaching Practice* (John Wiley and Sons, 2006) ISBN 9780470849781

Journals

British Journal of Sports Medicine

Human Movement Science

International Society of Biomechanics in Sport

Journal of Applied Biomechanics

Journal of Biomechanics

Journal of Sports Sciences

The Journal of Sports Medicine and Physical Fitness

Websites

British Association of Sport and Exercise Sciences	www.bases.org.uk
British Broadcasting Corporation	www.bbc.co.uk
Peak Performance Online	www.pponline.co.uk
Top End Sports	www.topendsports.com

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are …
Creative thinkers	producing a numerical model, using three numerical components, and comparing it to a sporting performance, with some support
	producing a technical model, using four technical components, and comparing it to a sports performance, with some support
Team workers	providing feedback on performance, to an athlete, or team, using information gathered from one of the analyses performed, prescribing future action, with support
Self-managers	performing two notational analyses on a chosen sport, with some support
	producing a numerical model, using three numerical components, and comparing it to a sporting performance, with some support
	producing a technical model, using four technical components, and comparing it to a sports performance, with some support
Effective participators	providing feedback on performance, to an athlete, or team, using information gathered from one of the analyses performed, prescribing future action, with support.

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are …
Independent enquirers	deciding on the relevant performance criteria to investigate
Creative thinkers	trying out different methods of data collection
Reflective learners	comparing the success of the data collection methods
Team workers	collaborating with others to organise the collection of data from participating individuals or sports teams
Self-managers	organising their time and resources to collect data at the appropriate time and date.

Functional Skills – Level 2

Skill	When learners are …
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	using video analysis software to compare performances
Manage information storage to enable efficient retrieval	entering and manipulating descriptive statistics for use in the numerical model
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	using the internet and other biomechanical resources for secondary data
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	using the internet and other biomechanical resources for secondary data
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: • text and tables • images • numbers • records	entering raw data into spreadsheets for conversion to descriptive statistics
Bring together information to suit content and purpose	providing feedback to individuals and teams on their performances
Present information in ways that are fit for purpose and audience	presenting data to the individuals and teams on their performances
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	collaborating with sports teams and individuals
Mathematics	
Identify the situation or problem and the mathematical methods needed to tackle it	producing the numerical and technical models of performance
Select and apply a range of skills to find solutions	calculating the numerical solutions from the numerical model of performance
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	analysing the numerical and technical models of performance
Draw conclusions and provide mathematical justifications	producing feedback for performers using numerical data

Skill	When learners are ...
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	discussing the appropriate model to use when analysing performance providing feedback to individuals or teams on their performances
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching numerical and technical models of performance
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	completing reports or presentations that provide feedback to individuals or teams on their performances.