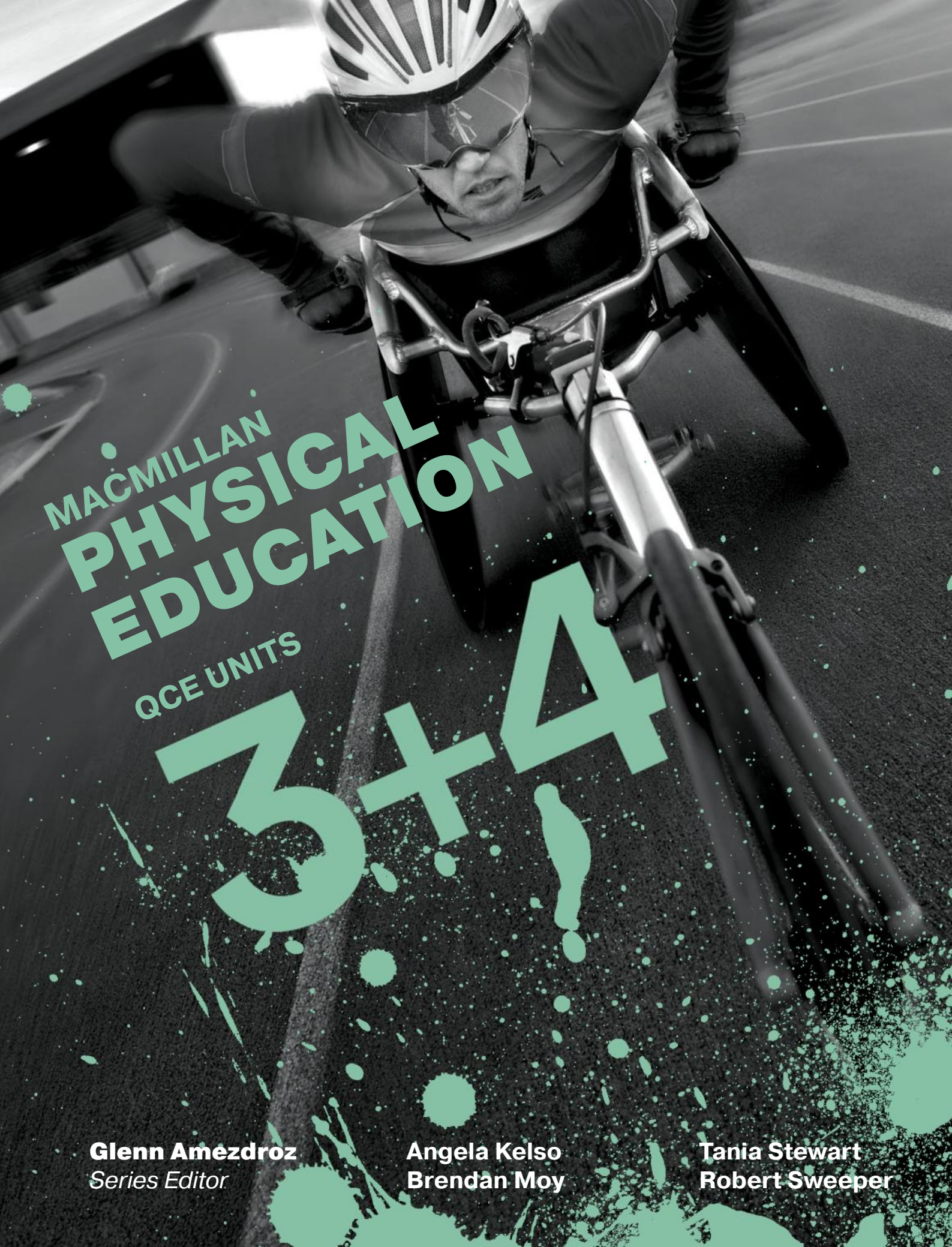

# MACMILLAN PHYSICAL EDUCATION

## QCE UNITS 3+4

**Glenn Amezdroz**
*Series Editor*

**Angela Kelso**
**Brendan Moy**

**Tania Stewart**
**Robert Sweeper**

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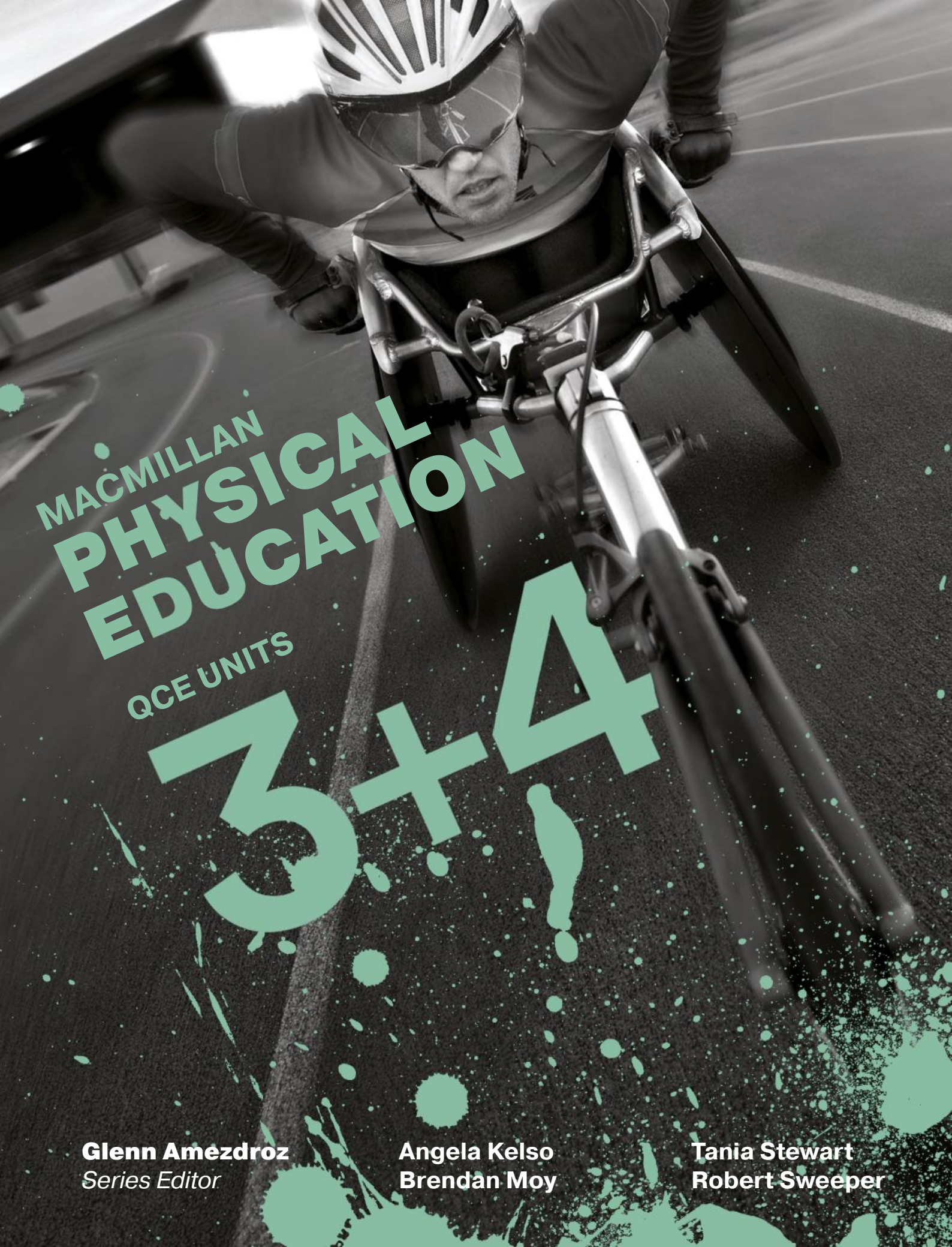

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**Macmillan Physical Education QCE Units 3 and 4**

**1st edition**

**Glenn Amezdroz**

**Angela Kelso**

**Brendan Moy**

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# ABOUT THE AUTHORS

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# AUTHORS' ACKNOWLEDGMENTS

**Glenn Amezdroz**
This book is dedicated to the memory of two inspirational people – my mother, Audrey, and my colleague, Mick Kelso, who sadly passed away during the writing of this edition. Use your memories of them to bring a smile to your face and keep them close to your heart.

**Angela Kelso**
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# INTRODUCTION

*Macmillan Physical Education QCE Units 3+4* deals with all objectives, topics and subject matter for Units 3 and 4 of the Queensland Physical Education 2019 General Senior Syllabus.

## Preparing for assessment

During the year, you will complete a total of four assessments — three internal and one external — that count towards your final mark in the Physical Education subject. These assessments require you to demonstrate your understanding of Physical Education concepts and your ability to develop effective strategies.

Your textbook includes several features designed to support you as you complete your assessments, helping you to achieve the best mark possible.

- The **Assessment Essentials** section is a toolkit of information relevant to your assessment tasks, with a focus on the appropriate use of data.
- **Worked examples** model the process of researching and completing the internal assessment tasks. These examples demonstrate the planning and execution of the project–folio and investigation–report assessments, paying close attention to the weighting of the assessment criteria.
- The **Unit 4 revision notes** at the end of the book help prepare you for the final external assessment task.

## Other key features

- Every chapter starts with a list of **key questions**, so that you understand what concepts you're about to study, as well as a chapter plan to guide you through the text.
- **Key terms** are highlighted in the text, with definitions provided in the margi.
- At the end of each numbered section of a chapter is a short set of **Check Your Understanding** questions, which focus on the major concepts introduced in that section.
- Every chapter ends with a **review** of the key information and a series of exam-style questions.
- **Sample responses** demonstrate the process of completing selected movement activities.

## Online support

Use the code on the inside front cover of your textbook to access the digital version of the text. Your online resources also include additional support materials.

- Short, interactive **review quizzes** for each chapter help you revise key concepts.
- The Download icon in the margin shows when a data recording template or other document is available for use with movement activities.

# CHAPTER MAPPING GRID

This table enables you to review and consolidate your learning from each part of the chapter plan against the syllabus objectives for each topic. Relevant subject matter is included to guide your review.

## Unit 3: Tactical awareness, ethics and integrity and physical activity

### Topic One

### Chapter One – Appraising dynamic systems

| Your chapter plan | Subject matter | Syllabus objectives |
|---|---|---|
| 1.3 Theoretical models of motor learning | Cognitive systems approach<br>Dynamic systems approach<br>Interactions between constraints<br>Nonlinear learning progression | 1, 4 |
| 1.2 Explicit and implicit learning | Explicit instruction<br>Implicit learning using outcome focused instruction<br>Engaging the brain v distracting the brain<br>Minimising conscious control of movement | 2, 3, 4, 5, 6, 7 |
| 1.3 Perception–action coupling | Representative practice<br>Perceptual reference points<br>Intention overrides perception and action<br>Inappropriate perception–action couplings | 1, 2, 3, 4, 5, 6, 7 |
| 1.4 Affordances | Key information in practice<br>Detecting affordances<br>Attuning to the environment | 1, 2, 3, 4 |

### Chapter Two – Examining tactical awareness

| Your chapter plan | Subject matter | Syllabus objectives |
|---|---|---|
| 2.1 Tactical awareness | Movement strategies<br>Making and executing tactical decisions<br>Principles of decision making – on the ball and off the ball<br>The interaction of constraints and tactical awareness | 1, 2, 3, 4 |
| 2.2 Tactically similar games | Principles of play – invasion games, net and court games<br>Setting up attack<br>Defending against attack<br>Creating, defending and exploiting space<br>Attacking the opposition space to score | 1, 2 |
| 2.3 Overcoming tactical limitations | Identifying tactical limitations<br>Identifying the reasons for tactical limitations – rate limiters<br>Devising a personal tactical strategy to overcome tactical limitations | 1, 2, 3, 4, 5, 6 |
| 2.4 Tactical awareness and the constraints-led approach | Features of the constraints-led approach<br>Principles of a constraints-led approach<br>Manipulation of environments<br>Design representative and variable practice environments<br>Matching task complexity to the ability level of the learner | 1, 3, 4, 5, 6, 7 |

| Your chapter plan | Subject matter | Syllabus objectives |
|---|---|---|
| 2.5 Emergent behaviours | Predicting emergent behaviours<br>Prescribed and emergent behaviours | 2, 3, 4, 5, 6, 7 |

### Chapter Three – Devising tactical strategies

| Your chapter plan | Subject matter | Syllabus objectives |
|---|---|---|
| 3.1 Developing tactical awareness by improving technique | Task simplification<br>Practice environments<br>Matching practice to learner ability level | 1, 2, 3, 4, 5, 6 |
| 3.2 Developing tactical awareness using task constraints | Presenting the tactical problem<br>Emphasising the solution<br>Emphasising affordances | 1, 2, 3, 4, 5, 6 |

## Topic Two

### Chapter Four – Exploring ethics and integrity

| Your chapter plan | Subject matter | Syllabus objectives |
|---|---|---|
| 4.1 Ethics and ethical dilemmas | Ethics and morals<br>Values<br>Ethical dilemmas<br>Ethics in sport and physical activity | 1, 3, 4 |
| 4.2 Fairness and fair play | What is fair play?<br>Formal and informal fair play<br>Gamesmanship | 1, 4 |
| 4.3 Integrity | Personal and sporting integrity<br>Integrity and community confidence | 1, 4, 5 |
| 4.4 External influences on games and sport | Governing bodies<br>Codes of conduct<br>Globalisation and media coverage in sport<br>Local community factors | 1, 4, 5, 6 |

### Chapter Five – Devising ethics strategies

| Your chapter plan | Subject matter | Syllabus objectives |
|---|---|---|
| 5.1 Ethical decision-making | Identifying a dilemma<br>The ethical decision-making framework | 1, 4 |
| 5.2 Ethics strategies | Devising and implementing an ethics strategy<br>Evaluating ethics strategies | 1, 4, 5, 6, 7 |
| 5.3 Gender and sport | Identifying the dilemmas<br>Integrity issues | 1, 4, 5, 6, 7 |
| 5.4 Ability and sport | Fair and inclusive competition<br>Team selection<br>Ability groupings<br>Use of age and weight categories | 1, 4, 5, 6, 7 |
| 5.5 Technology and sport | Making a decision about technology and sport<br>Evaluating the effectiveness of a strategy about technology and sport | 1, 4, 5, 6, 7 |
| 5.6 Corruption and sport | Making a decision about corruption and sport<br>Evaluating the effectiveness of a strategy about corruption and sport | 1, 4, 5, 6, 7 |

# Unit 4 Energy, fitness and training and physical activity

## Topic One

### Chapter Six – Investigating energy systems

| Your chapter plan | Subject matter | Syllabus objectives |
|---|---|---|
| 6.1 ATP and its role in physical activity | The chemistry of ATP<br>Breakdown and resynthesis | 1 |
| 6.2 Fuel sources for resynthesising ATP | Phosphocreatine<br>Carbohydrates<br>Fats<br>Proteins | 1, 5, 6, 7 |
| 6.3 Energy systems and the production of ATP | The three energy systems<br>ATP–PC system<br>Lactic acid system<br>Aerobic system<br>$VO_2$max and lactate threshold<br>Aerobic system in action | 1, 2, 3, 4, 5, 6, 7 |
| 6.4 The interplay of energy systems | ATP production during resting conditions<br>ATP production during exercise<br>How energy systems work together<br>The energy continuum<br>Energy systems in action | 1, 3, 4 |

### Chapter Seven – Assessing fitness requirements

| Your chapter plan | Subject matter | Syllabus objectives |
|---|---|---|
| 7.1 Relevance of fitness testing | Selecting a fitness test<br>Specific fitness tests | 1, 4 |
| 7.2 The components of fitness | The seven components<br>Fitness components and energy systems | 1, 3, 4 |
| 7.3 Aerobic capacity | Physical activities and aerobic capacity<br>Effects of aerobic capacity<br>Aerobic capacity tests | 1, 3, 4 |
| 7.4 Strength, endurance and power | Strength<br>Factors affecting the application of strength<br>Strength tests<br>Muscular endurance<br>Factors affecting muscular endurance<br>Muscular endurance tests<br>Power<br>Power tests | 1, 4 |
| 7.5 Flexibility, agility and speed | Flexibility<br>Flexibility tests<br>Agility<br>Agility tests<br>Speed<br>Factors affecting speed<br>Speed tests and anaerobic capacity | 1, 2, 3, 4, 5, 6 |

## Chapter Eight – Manipulating training principles

| Your chapter plan | Subject matter | | Syllabus objectives |
|---|---|---|---|
| 8.1 The principles of training | Individuality<br>Specificity<br>Variety<br>Intensity | Intensity zones<br>Progressive overload<br>Frequency<br>Duration | 1, 3, 4 |
| 8.2 Aerobic training | Continuous training<br>Benefits of continuous training<br>The FITT formula<br>Fartlek training | | 1, 3, 4 |
| 8.3 Muscular and joint-based training | Resistance training<br>Weight training<br>Developing weight training programs<br>Frequency and duration<br>Safety<br>Flexibility training<br>Dynamic stretching<br>Static stretching | | 1, 3, 4 |
| 8.4 Interval training | Designing interval training programs<br>Key variables in interval training<br>Interval periods<br>Long interval training<br>Intermediate interval training<br>Short interval training<br>High-intensity interval training (HIIT)<br>Circuit training<br>Circuit types | | 1, 2, 3, 4, 5, 6 |

## Chapter Nine – Designing training programs

| Your chapter plan | Subject matter | | Syllabus objectives |
|---|---|---|---|
| 9.1 Cycles of the training year | Periodised training plans<br>The preparatory (pre-season) phase<br>The pre-competition phase<br>Competition phase<br>The transition phase | | 1, 3, 4 |
| 9.2 Planning a training program | Review secondary data<br>Identify purpose<br>Games analysis<br>Select tests | Select methods<br>Plan length<br>Periodise sessions<br>Timetable sessions | 1, 2, 3, 4, 5, 6 |
| 9.4 Features of an effective training session | The warm-up<br>Warm up procedure (RAMP)<br>Effects of the warm-up<br>The conditioning phase<br>The cool down | | 1, 3, 4 |
| 9.5 Evaluating training programs | Post-testing<br>Review the purpose of the program<br>Review the game analysis<br>Review the test selection<br>Review training methods<br>Review training sessions and timetable<br>Review training principles<br>Program modification | | 1, 2, 5, 6 |

# ASSESSMENT ESSENTIALS

## Introduction

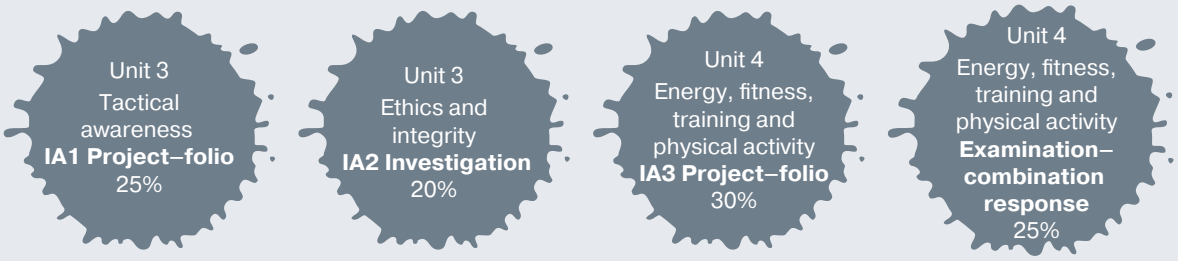
Units 3 and 4 of Physical Education (2019) require you to investigate concepts dealing with three topics:

- Tactical awareness and physical activity
- Ethics and integrity
- Energy, fitness, training and physical activity.

Judgments about your achievement will be made through evidence gathered in three different internal assessment (IA) tasks. The three tasks are:

- IA1 project–folio and IA2 investigation (Unit 3)
- IA3 project–folio (Unit 4).

You will also need to complete an external assessment (EA), which will be a combination examination with subject matter drawn from Unit 4.




An overview of assessment in Physical Education (2019).

The information in this section will help you prepare for your assessment tasks. You will also find material throughout your textbook to help you get ready for your internal assessments, including a modelled IA1 project–folio response (page 73) and an example of an IA2 investigation–report (page 140).

The end-of-chapter review questions will help you to prepare for the EA, as they are written to QCAA syllabus specifications. You will also find a set of exam revision notes on page 295.

# AE 1 Objectives and cognitions

One of the first things you should do this year is to download a copy of the Physical Education (2019) syllabus, which you can obtain by following the margin link, and read through the objectives. There are overall syllabus objectives, more specific unit objectives, and objectives for each assessment task.

PE Syllabus
http://mea.digital/qpe34_AE

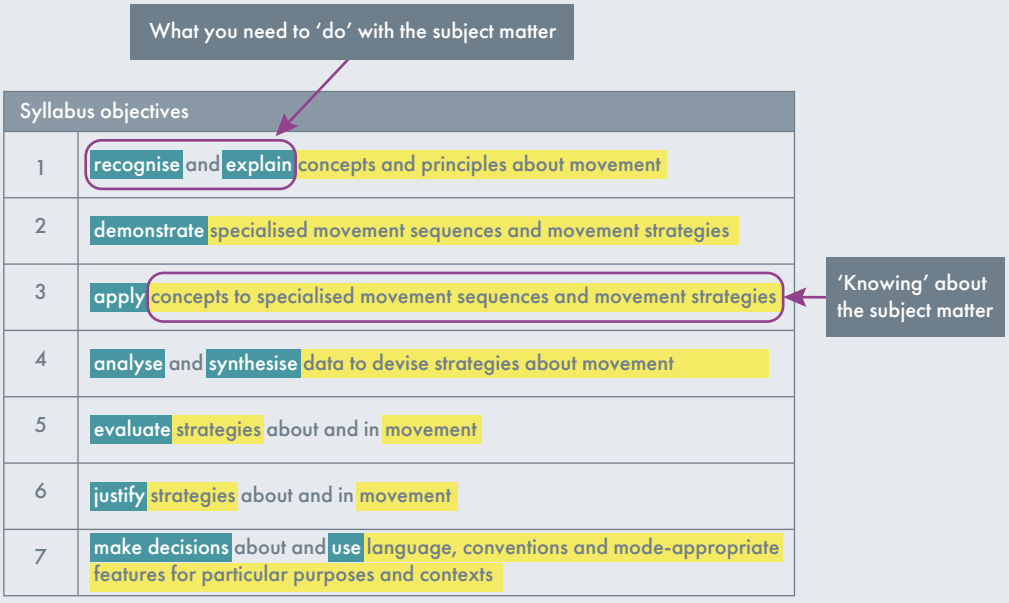
You will find that each objective for the syllabus, unit and assessment is written using a similar pattern – a 'cognition' or action indicating what you are required to do, followed by the element or specific subject matter, which indicates what you will need to know from a specific topic.

In other words, the objectives outline the opportunities you will have to learn in Unit 3 and 4. Understanding how these objectives are constructed will help you demonstrate what you know and can do in each of your assessment tasks.

Understanding how the objectives are aligned will provide you with opportunities for success.

In these objectives, you can identify the cognition and the specific subject matter that you need to master.

The cognitions are each defined in the Glossary pages in Section 7 of the QCAA Physical Education (2019) syllabus. Make sure you have a clear understanding of the meaning of each essential cognition or action, as understanding them will enable you to meet the expectations of the course, including the assessments.




| Syllabus objectives | |
|---|---|
| 1 | recognise and explain concepts and principles about movement |
| 2 | demonstrate specialised movement sequences and movement strategies |
| 3 | apply concepts to specialised movement sequences and movement strategies |
| 4 | analyse and synthesise data to devise strategies about movement |
| 5 | evaluate strategies about and in movement |
| 6 | justify strategies about and in movement |
| 7 | make decisions about and use language, conventions and mode-appropriate features for particular purposes and contexts |

The structure of each objective provides guidance to students and teachers about the required 'knowing' and 'doing' across the course of study, unit of work and assessment.

Source: Physical Education 2019 v1.1 General Senior Syllabus
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## Objectives, inquiry and the research process

Each of the syllabus, unit and assessment objectives is based on an inquiry process that will guide your research. The inquiry process in Physical Education (2019) uses three stages:

- engage and understand
- apply and analyse
- evaluate and justify.

In simple terms, you are required to gather data, devise strategies, then evaluate these strategies. Each of these stages use different cognitions which guide you through the processes of your learning.

## Knowing and doing

In **Objective 1**, you are required to *recognise* and *explain*. You should be able to identify and describe the correct terminology, as well as the concepts and principles discussed in each topic. As you read through the syllabus, note that the detail you are required to recognise and explain becomes more explicit and the information more 'fine grained' to guide your responses, especially in your assessment responses.

In **Objective 2**, you are asked to *demonstrate* different specialised movement sequences and movement strategies. This will be an active component of your study in Physical Education, where you display your expertise in each physical activity you are studying.

**Objective 3** leads you through the next stage of the inquiry process, analyse and apply. You are provided with an opportunity to *apply* the concepts and principles from the subject matter you are studying, within the context of the current physical activity.

Similarly, in **Objective 4**, your task is to *analyse* and *synthesise* information you have gathered. You can then break this into its component parts and use this information to develop new knowledge and produce specific strategies.

In the third stage of inquiry, evaluate and justify, **Objective 5** requires you to *evaluate* various strategies for movement. This provides you with an opportunity to make some decisions, using all your prior knowledge, data and research about the topic or issue being investigated. You can use all of this information to make a judgment of the strengths and limitations of your strategy.

**Objective 6** requires you to *justify* your strategies. You need to use evidence from primary and secondary data, gathered through your performance, observations and research, to support your judgment.

Finally, **Objective 7** is all about how you *communicate* the findings of your investigations. To score well in this objective, you need to give careful thought to such things as how you will:

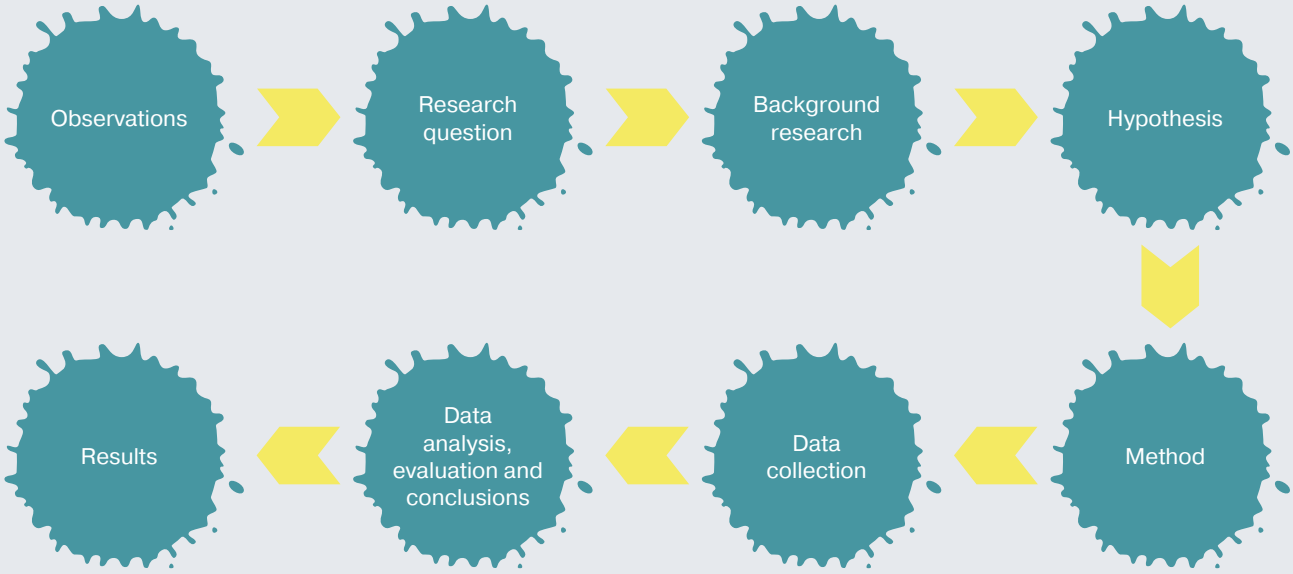
- present your data
- reference your findings
- use your writing skills
- represent diagrams and images in different media.

This objective is relevant to all three stages of inquiry.

# AE 2 Designing your research

Your project–folio and investigation–report tasks require you to conduct research. Dr Hugh Shannon from Queensland University of Technology has developed a series of steps to assist you to design and conduct your research.

## Steps in research




The steps of the research process.

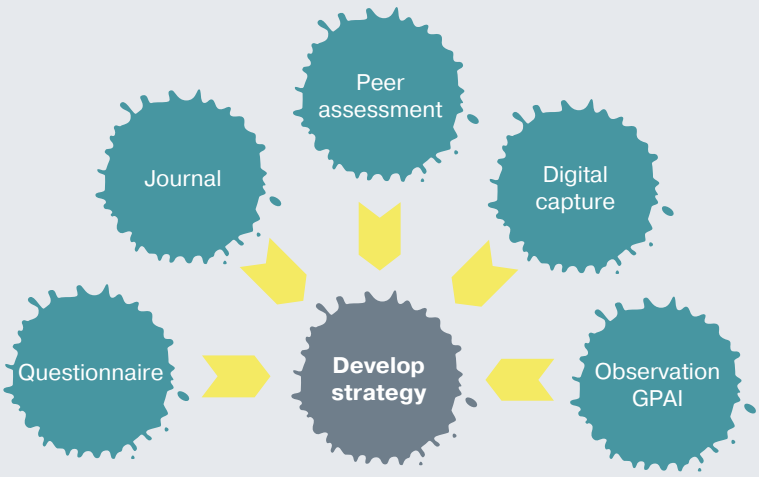
- **Observations:** Start by reflecting on what you want to investigate in your research. You might begin by reviewing some primary or secondary data, re-reading a chapter in your text or observing your peers engaged in physical activity. These reflections are an essential starting point in your research.
- **Research question:** The research question will guide the development of your project–folio or investigation. You can develop your research question by asking yourself 'What do I want to know?'. Your research question should be specific and should clearly identify the variable you are interested in investigating.
- A central goal in your research will be to quantify specific performance, tactical, ethical or physiological outcomes. These characteristics are known as *independent* or *dependent* variables. The independent variable is the one that is manipulated in your research, while the dependent variable is the *result* that the independent variable produces. You, as the researcher, control the independent variable, while the dependent variable is the result that you record. You might then carry out further data analysis.

- **Background research:** Your background research should help you to refine your research question further. You could do some additional reading, review your notes from class, or re-read the relevant chapter(s). A useful brainstorming technique is to create a mind map, placing the research question at the centre, and having different concepts branching from it.
- **Hypothesis:** The hypothesis that you develop should be based on an explanation of what you have found out so far in your research process. You can write the hypothesis as a statement or a question. It should provide you with some ideas for your research design and the methods you will use to collect primary data.
- **Method:** The next step is to design your research method. Any method that involves other participants must be ethical and involve their willing, informed consent. Participants' data must be kept confidential and de-identified, and participants must be free to ask questions and to withdraw from the research if they choose.
- **Data collection techniques:** For the project–folios for Units 3 and 4, you will be required to gather primary data and video evidence. You might design a game performance assessment instrument (GPAI) to measure the effect of the independent variable or design a checklist to assist you in your observation. For the investigation, you will need to use surveys, interviews and observations to gather your primary data.
- Valid and reliable data is essential to your research, otherwise you may produce false information. *Reliability* refers to the repeatability of a specific measure; you need to develop consistent recording methods. *Validity* is the degree to which your recording instrument measures what it is supposed to measure.
- **Data analysis, evaluation and conclusions:** In this section of the research process, you need to analyse whether the data supports your initial hypothesis. Data analysis will guide you to develop some conclusions regarding your initial research question, too. Don't be concerned if the data does not support your hypothesis, as this may reveal some new factor that you didn't anticipate. Findings that don't support an initial hypothesis can be valuable.
- **Results:** Your results provide you with opportunities to report your key findings, as well as the strengths and the limitations of the research you have conducted. After you have prepared the results, you will be ready to submit your final assessment material, having made decisions about how to communicate your findings.

# AE 3 Gathering primary and secondary data

Objectives 4 and 6 refer to the use of primary and secondary data. You can use this data to develop your strategy in the topic you are studying. If you improve your data collection techniques, it will enhance the accuracy, validity and reliability of your research findings.

Depending on your research design, you can develop different methods of gathering data. For the project–folio you will have to do some observation, using a GPAI. Your investigation might need you to make observations and use other methods of data-gathering, such as questionnaires, to develop your findings.




Primary data is used to develop a strategy.

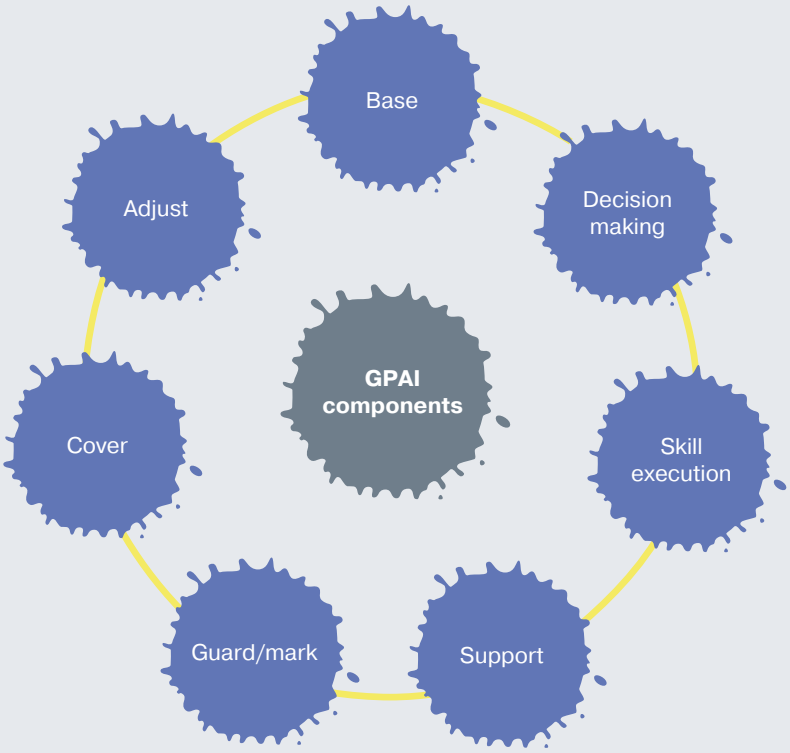
## Designing a GPAI

A GPAI is an effective and adaptable method to observe and record 'on-the-ball' and 'off-the-ball' movements, including game involvement and efficiency of performance in various physical activities. You can also design a GPAI to observe any dependent or independent variable you wish to observe.

It's best to start with a simple matrix, recording only what can be observed. Start by using a yes/no approach – is the variable present or absent, effective or ineffective, evident or not evident? As you become more familiar with observing and collecting primary data, you can develop more sophisticated instruments.

There are seven different game components that could be observed using a GPAI:

1. Base: how effectively players return to a tactically-appropriate 'base' position where they can most successfully contribute to team or game play.
2. Decision making: the effectiveness of decision making on or off the ball.
3. Skill execution: the execution of skill in a game, both in accuracy of performance and appropriateness of implementation.
4. Support: how well the player provides support for teammates.
5. Guard/Mark: player movement in marking other players in possession of the ball, or off the ball.
6. Cover: the defensive coverage or back-up provided.
7. Adjust: the player's ability to make adjustments in attack or defence, according to the dynamics of the game.




A game performance assessment instrument (GPAI) allows observation of seven different components of game play.

To construct and use a GPAI, develop a rubric (scoring guide) for each player you are observing. For each component of the rubric, mark instances of appropriate (A) or inappropriate (IA) evidence. Each component can then be tallied on a four-point scale, from most effective (4) to least effective (1).

The levels of performance indicate:

4 = very effective performance, almost always observable

3 = effective performance, usually observable

2 = moderately effective performance, present in more than half of observed attempts

1 = less effective performance, present in less than half of observed attempts.

| | Passing (skill execution) | | Ball control | | Decision making | | Support | |
|---|---|---|---|---|---|---|---|---|
| **Player position** | A | IA | A | IA | A | IA | A | IA |
| *Wing defence* | | | | | | | | |
| **Rating** | | | | | | | | |

An example of a GPAI for netball.

Source: Adapted from Pill, S (2014). ***Developing Netball Game Sense – Teaching movement and tactical skills***. South Australia: ACHPER.

This example requires observation of four different aspects of performance. You might begin with a simple GPAI, observing and recording only one aspect of performance. As you become more familiar with observing and recording, you could then add more features to your GPAI.

You could also share observations with classmates, recording one performance but capturing multiple sets of data about different components observed in the performance. You might also choose to complete the GPAI after you have performed, by checking and reviewing video capture of your performance.

## Designing questionnaires

Questionnaires are an effective way to gather data about individuals' responses to specific questions. You could use free software, such as SurveyMonkey, to develop your questions and distribute them to recipients.

There are several important considerations to developing an appropriate questionnaire. These include checking that:

- the survey questions are appropriate. The questions can be checked with your teacher or research partners in your class
- you are targeting the correct respondents to gather your data. It is best to use well-informed respondents
- respondents understand the questions
- the flow of the questions is adequate
- the respondents are willing to answer questions
- the answers are recorded correctly.

It is critical that your respondents understand the questions being asked. You should:

- avoid ambiguous wording
- ask one question at time
- be clear who the questions refer to – for example, an individual respondent, the team member, a spectator etc.
- avoid jargon or overly academic wording
- use language that is clear and straightforward
- avoid double negatives in your questions
- ensure that questions are culturally sensitive and appropriate.

It's important to try out your survey questions with a small group of potential participants to check your construction of the questionnaire. This will enable you to complete a final check of wording of your questions, formatting of text, the flow of questions and how long it takes to complete the survey.

# AE 4 Planning your project–folios (IA1 and IA3)

There are two project–folio tasks that you will complete, one in Unit 3 and one in Unit 4. The first folio will be based on Topic 1 in Unit 3 – Tactical awareness. This task contributes to 25% of your overall mark. The second will be based on Topic 1 in Unit 4 – Energy, fitness and training. This task contributes to 30% of your overall mark.

As these two tasks make up more than half of your overall marks for the year, it's vital that you plan and approach them effectively. Following this process will help you to maximise your marks.

**1 Identify the task**

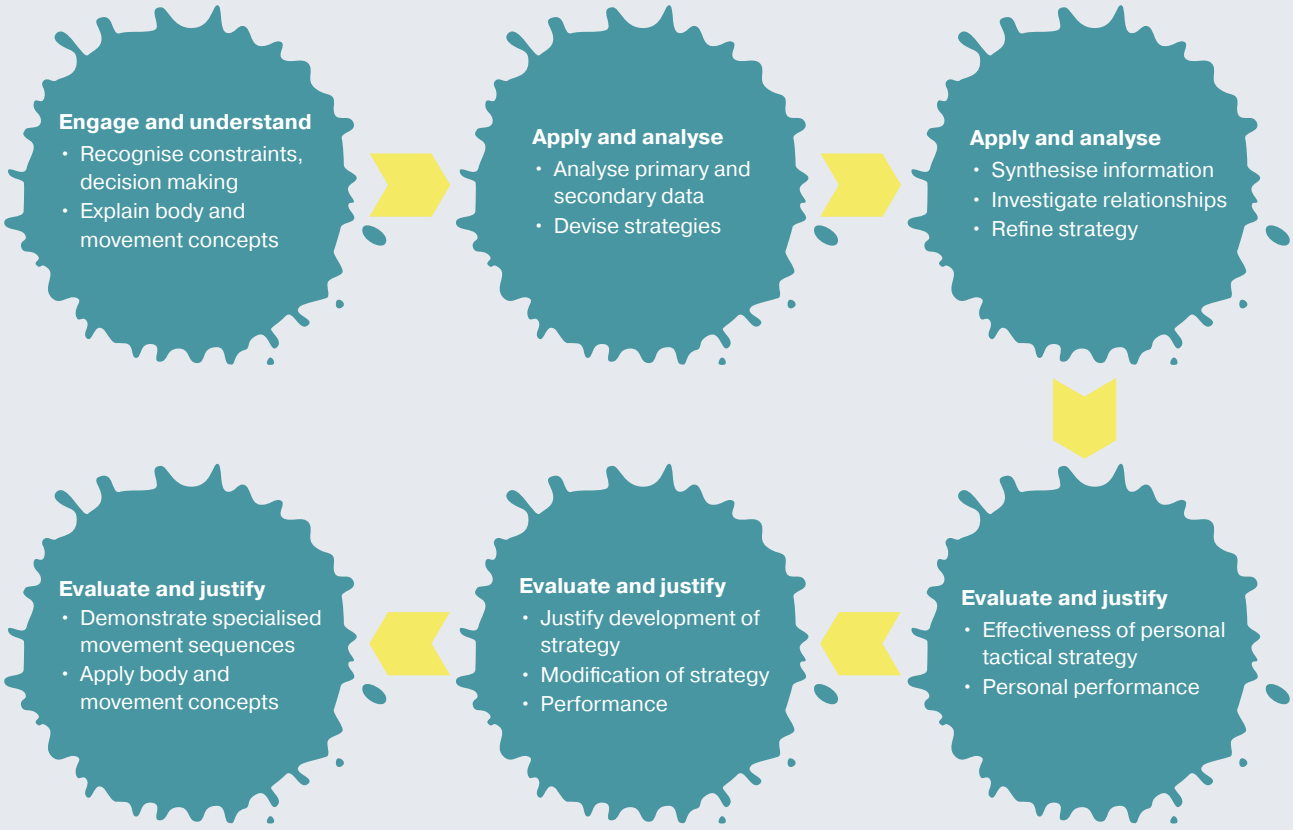
- **a** Carefully read the assessment objectives in the syllabus. Use a highlighter to indicate each of the essential verbs in each objective. These objectives describe what you will need to know and do.
- **b** Review the context of the task. The context will assist you to understand how the task aligns with the teaching and learning from the unit.
- **c** Read and highlight the key words in the task box. The task description outlines in some detail exactly what you are required to know and do.
- **d** Read and highlight the key words in the instrument specific marking guide (ISMG) so that you know exactly what evidence you need to provide. Review how marks are allocated for each of the criteria in the ISMG.

**2 Create a checklist**

- **a** The syllabus explains the specific requirements of the task. Use this information as a checklist to make sure that you complete all sections of the project–folio.
- **b** It might be helpful to develop a flowchart to sequence the steps and requirements, so that you clarify what evidence you are to provide. For example, in the project–folio for Tactical awareness, your flow chart might look like the one on the next page.
- **c** Using the cognitions and the elements of the objectives, begin to plan your research process, aligned to the inquiry stages. Start by developing your research question.

**3 Gather primary data**

- **a** *IA1: observations and GPAI:* You need to consider what you want to observe and how you will gather data most effectively. You may wish to review any digital capture that you have, develop a GPAI to observe your performance and decision making, or complete other observations of small-sided games to gather your data about task, learner and environmental constraints. Don't forget the primary data you gathered during the integrating movement tasks.
- **b** *IA3: field tests and laboratory tests:* You need to analyse primary and secondary data to consider relationships between the demands of the physical activity, the energy systems and components of fitness used, as well as your own personal performance. In this task, you will need data from your GPAI observations, as well as some fitness data, gathered from specific tests of physical activity. Again, the primary data from the integrating movement tasks will be useful.




A sample flowchart for IA1, the project–folio for Tactical awareness.

**4 Gather secondary data**

**a** This data will help you to justify the development of your strategies and can be used as evidence to support your strategy in each project–folio.

**b** Valid and reliable sources of secondary data might include scholarly sources in your library, journal articles, your textbook (including relevant case studies) and media articles.

**5 Structure your response**

**a** Objective 7 is about communication. The way that you structure your response is critical to your performance in this objective. Highlight the key words from the objective and ISMG to assist you in the planning and final presentation of your project–folios.

**b** You need to accurately use written, spoken and visual features in the project–folio, as it is a multimodal task. Be careful to use language to suit your technical audience, which will show you have acquired deep learning from your research.

**c** Pay attention to careful and accurate referencing and acknowledgment of any secondary data you may use to justify your strategy.

# AE 5 Planning your investigation (IA2) – research process

As part of your assessment, you will complete one investigation–report, based on Topic 2 in Unit 3 – Ethics and integrity. This task contributes to 20% of your overall mark. You can use a similar approach to the project–folios as you begin to plan and develop your investigation.

1 **Identify the task**
   - **a** Carefully read the assessment objectives in the syllabus. Use a highlighter to indicate each of the essential verbs in each objective. These objectives describe what you will need to know and do.
   - **b** Review the context of the task. The context will help you to understand how the task aligns with the teaching and learning from the unit.
   - **c** Read and highlight the key words in the task box. The task description outlines in some detail exactly what you are required to know and do.
   - **d** Read and highlight the key words in the ISMG so that you know exactly what evidence you need to provide. Review how marks are allocated for each of the criteria in the ISMG.

2 **Create a checklist**
   - **a** The syllabus explains the specific requirements of the task. You need to research an ethical dilemma in a class, school or community physical activity context. Following this analysis, you have to devise an ethics strategy using the ethical decision-making framework that provides you with a course of action. You will present the response in report format. You will need to consider and conduct research with all the stakeholders involved in the ethical dilemma.
   - **b** Use this information as a checklist to make sure that you complete all sections of the investigation.
   - **c** Develop a flowchart to sequence the steps and requirements. An example is shown below.

3 **Gather primary data**
   - **a** Your research might include observations recorded in a journal, using surveys or questionnaires, interviewing participants and possibly enabling video capture of different scenarios and events that you may wish to analyse in a later viewing.
   - **b** You may also choose to adapt a specifically-structured GPAI to assist you to observe behaviours relating to your ethical dilemma.

**4 Gather secondary data**

**a** This data will assist you to justify the development of your ethics strategy and can be used as evidence to support your strategy in the investigation.

**b** Valid and reliable sources of secondary data might include scholarly sources in your library, journal articles, your textbook (including relevant case studies) and media articles.

A sample flowchart for IA2, the investigation–report for Ethics and integrity.

**5 Structure your response**

**a** Objective 7 is concerned with communication. The structure of your response is critical to your performance in this objective. Highlight the key words from the objective and ISMG to help you in the planning and final presentation of your investigation.

**b** You need to use written and visual features accurately in the investigation. Be careful to use technical language to suit your audience, which will demonstrate your deep learning from your research.

**c** Pay attention to accurate referencing and acknowledgment of any secondary data you may use to justify your ethics strategy.

# AE 6 Synthesising your data

The synthesis of the information you gathered in your project–folios and investigation is an important step in the manipulation of your data. Synthesis will enable you to develop new understanding about your research question, by combining the different parts of the research process into a whole body of work.

## Developing new understanding

When data is synthesised, different elements are combined to form new ideas or information. During synthesis, information is put together to look for connections.

The following data was recorded from the observation of a modified, small-sided game, over a 5-minute passage of play. What new knowledge can be synthesised from this range of data?

| | Passing (skill execution) | | Ball control | | Decision making | | Support | |
|---|---|---|---|---|---|---|---|---|
| **Player position** | A | IA | A | IA | A | IA | A | IA |
| *Wing defence* | Total: 10 | Total: 2 | Total: 7 | Total: 2 | Total: 3 | Total: 6 | Total: 3 | Total: 4 |
| **Rating** | 4 Very effective | | 4 Very effective | | 1 Less effective | | 1 Less effective | |

1. What patterns can be observed from this data?
   *Passing (skill execution) and ball control are very effective for this observation. However, decision making and support of other players in the centre court are less effective. The player makes many ineffective decisions and finds difficulty in moving into space to support the player with the ball.*
2. What might this pattern of data indicate?
   *The player may need to practise creating space to receive a pass from a teammate or drive into space to support the ball carrier and provide options for a pass.*

You can see from this simple example how the observed performances of passing (skill execution) and ball control have been combined to assess the whole performance. The example also shows some new information about performance, including the less effective areas of decision making and support by the player.

# AE 7 Presenting your data effectively

Data can be presented in many ways in your project–folios or investigation. One of the first things you need to decide is whether your data will be included as a table, embedded in the text of your document, or placed in a graph or graphic organiser. Your main aim should be to work out how you can best represent the data that you have collected.

## Tables

It is important to clearly label your tables so that they are easy to follow. To improve the readability of your data:

- avoid lots of different abbreviations
- format your table titles so they are easy to follow
- present similar characteristics in the vertical columns. This will help readers make sense of your rows and columns in the table. The columns should contain the values of the variable(s) and other data calculations, including means if required. Each row should present a specific variable
- make sure readers don't have to refer to the text to interpret the data in your table. A table should stand alone, without the reader having to search for abbreviations, or additional clarification of terms to explain what the table is presenting.

| | Passing (skill execution) | | Ball control | | Decision making | | Support | |
|---|---|---|---|---|---|---|---|---|
| **Player position** | A | IA | A | IA | A | IA | A | IA |
| *Wing defence* | 𝍸 𝍸 Total: 10 | 𝍸 Total: 2 | 𝍸 𝍸 Total: 7 | 𝍸 Total: 2 | 𝍸 Total: 3 | 𝍸 Total: 6 | 𝍸 Total: 3 | 𝍸 Total: 4 |
| **Rating** | 4 Very effective | | 4 Very effective | | 1 Less effective | | 1 Less effective | |

A sample table for gathering data.

## Graphs

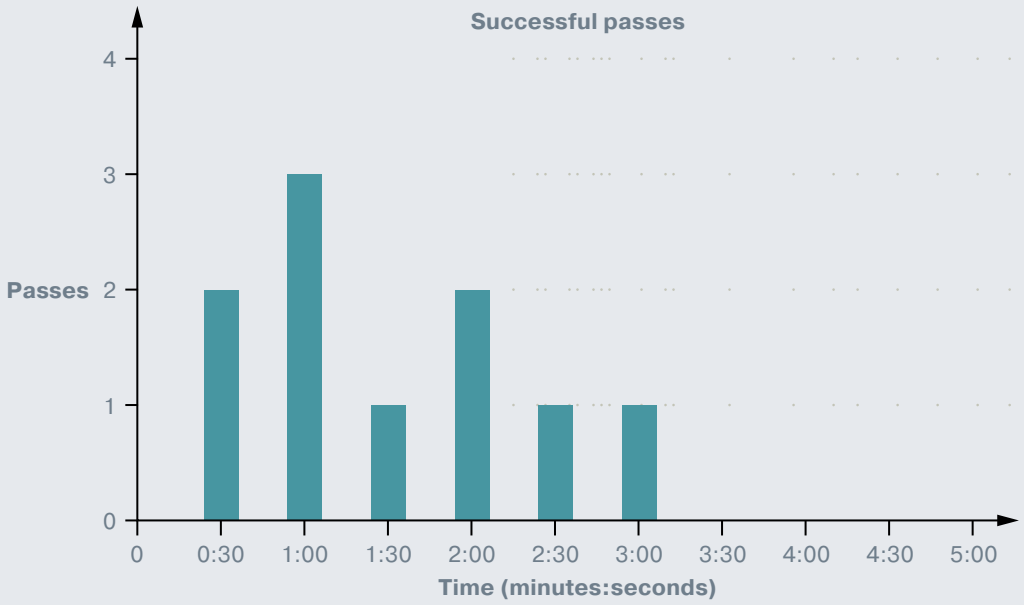
Consider an example of a 5-minute small-sided game, where the researcher tallied the number of successful passes to teammates for each 30-second interval. The following data was obtained:

| **Time** | 0:00 | 0:30 | 1:00 | 1:30 | 2:00 | 2:30 | 3:00 | 3:30 | 4:00 | 4:30 | 5:00 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Passes** | 0 | 2 | 3 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |

This data can be represented in different ways. Graphs have the advantage that you can easily identify patterns from them, and this can help you to decide a strategy for your research.

## Bar and column graphs

Bar and column charts are useful when you want to make comparisons between single responses; for example, between mean values or at an important time point in an observation. You can use different colours to represent each column, helping your readers make sense of the data.

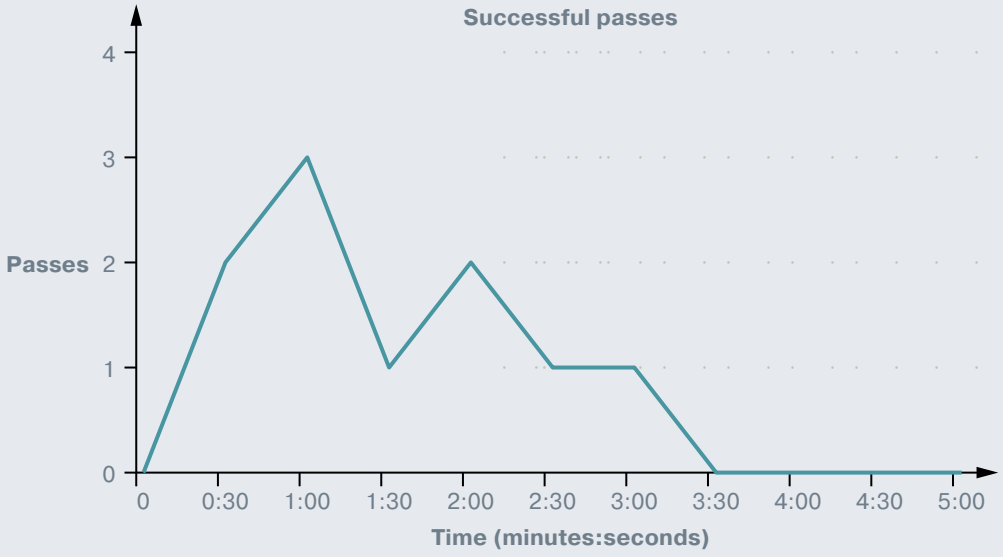



A simple bar or column graph.

## Line graphs

Line graphs can represent longitudinal data to show effects over time. To create these graphs, place time on the *x*-axis and the variable that you observe or measure on the *y*-axis.

If you want to show the effects of different variables, use different colours or styles of line for each of the variables.



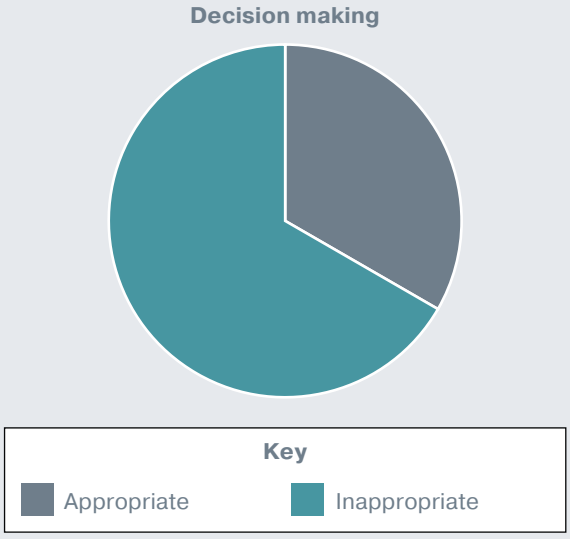

A typical line graph.

## Pie charts

Pie charts represent data as different proportions of a whole. Each segment of the pie represents a percentage or extent of the category as part of the whole.

To make your pie chart effective, limit it to no more than five different variables. Shade each segment in a different colour so you can easily see the separate categories.

Here's how the data observed about decision making in the 5-minute, small-sided game might look.




An example of a pie chart.

## Graphic organisers

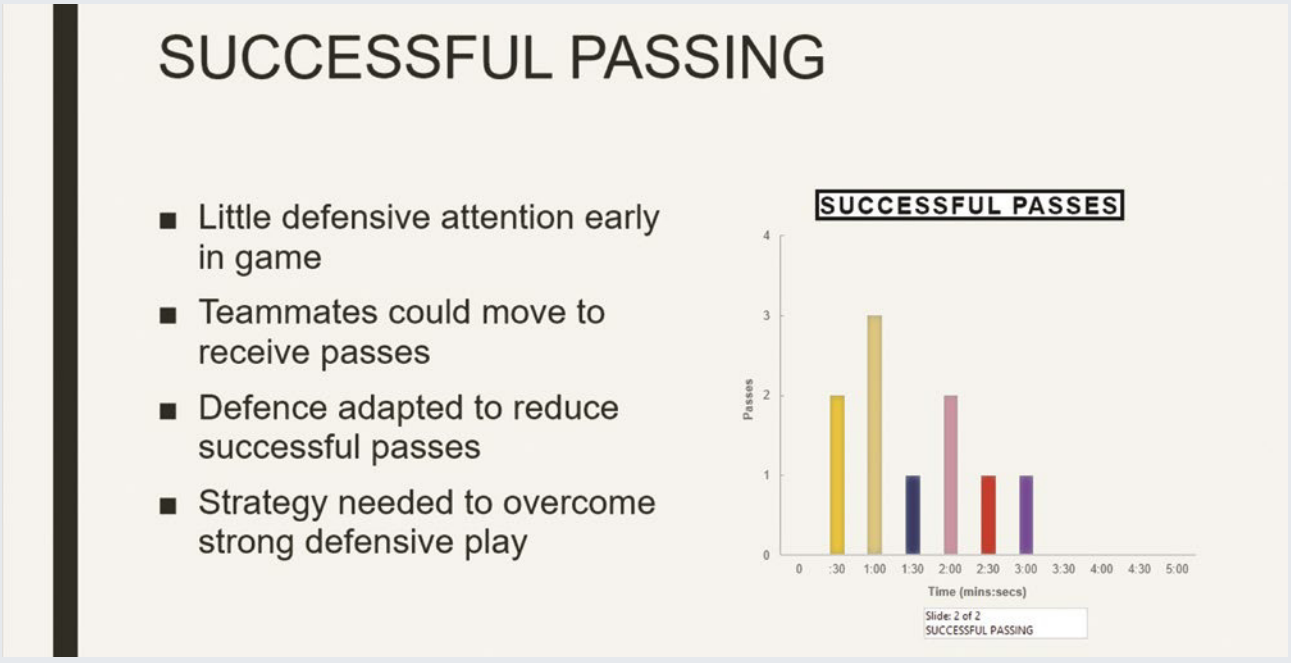
Graphic organisers show different processes or steps in procedures. They can be used in various sections of your project–folio or investigation–report to support your data and discussion.

A graphic organiser clearly shows the steps in a process.

## PowerPoint slides

If you choose to present your project–folio data on slides, make each slide as clear as possible. Here are some suggestions:

- Check your slide design to make sure slides are readable. Some layouts and colours look great on your screen, but cannot be easily read when printed or projected.
- Use concise wording and focus on what's important.
- Where possible, use dot points and limit slides to three or four bullet points.
- Also limit the amount of text on each line to five or six words.




An effective slide design.

# AE 8 Referencing

It's important to provide a full list of the references you used for all your secondary data sources. Your references need to use a consistent, comprehensive system; the most common choice is called the APA 6 system.

## In-text citation

In an author–date style, such as APA 6, in-text citation usually requires the last name of the author(s) and the year of publication:

> *Once the players had acquired the technical skill of controlling the ball within a game situation, the lesson could change focus to concentrate on improving their perception and decision making (Moy, 2016).*

You only need to include a page number when using a direct quote. Place a comma after the year. Use 'p.' for single page, 'pp.' for multiple pages.

When restating a passage of text in your own words, or briefly referring to an idea contained in another work, a page number is not required. However, it is when you are referring to a long work. This will help the reader to check or continue their own research.

## Reference list

A reference list is arranged alphabetically by author's last name. If a reference has no author, it is cited in the text by its title, and included in the alphabetical list using the first significant word of the title. If you have more than one item with the same author, list the items chronologically, starting with the earliest publication. Each reference starts on a new line, and has a hanging indent.

## Sample reference list

Amezdroz, G, Hosford, G, Kelso, A, Moy, B and Sweeper, R (2018). *Macmillan Physical Education QCE Units 1 + 2*. South Yarra, Victoria: Macmillan.

Metzler, MW (2000). *Instructional Models for Physical Education*. Boston: Allyn & Bacon.

Morgan, PJ, and Hansen, V (2008). The relationship between PE biographies and PE teaching practices of classroom teachers. *Sport, Education and Society* 13, no. 4: 373–91.

National Association for Sport and Physical Education USA (2009). *Opportunity to learn: Guidelines for high school physical education* (3rd ed.). Reston, VA: NASPE.

Newell, KM (1986). Constraints on the development of coordination. In *Motor development in children: Aspects of coordination and control*, ed. MG Wade and HTA Whiting, pp. 341–60. Dordrecht, Netherlands: Martinus Nijhoff.

For a further example, see the Reference list at the end of the sample project–folio response (p. 85).

UNIT 3

# Tactical awareness, ethics and integrity and physical activity

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Unit 3 examines tactical awareness, ethics and integrity in the context of specific physical activities. As well as demonstrating movement sequences and strategies, you will also observe, collect and analyse data to devise strategies relating to tactical awareness and ethics and integrity.

## Unit objectives

In Unit 3, you will:

1. recognise and explain tactical awareness and ethics and integrity concepts and principles in relation to selected physical activities
2. demonstrate specialised movement sequences and movement strategies in the selected physical activity
3. apply concepts to specialised movement sequences and movement strategies in the selected physical activity
4. analyse and synthesise data to devise strategies about tactical awareness and ethics and integrity
5. evaluate tactical, ethics and movement strategies
6. justify tactical, ethics and movement strategies
7. make decisions about and use language, conventions and mode-appropriate features for particular purposes and contexts.

## Physical activities

In Unit 3, Topic 1 – Tactical awareness, the physical activities you explore must come from the following categories:

- Invasion
- Net and court.

**Topic 1**
### Tactical awareness

1. Appraising dynamic systems
2. Examining tactical awareness
3. Devising tactical strategies

**Topic 2**
### Ethics and integrity

4. Exploring ethics and integrity
5. Devising ethics strategies

# 1 APPRAISING DYNAMIC SYSTEMS

**Figure 1.1** The environment is important in how people learn motor skills.

Two major theoretical models or approaches have been developed to explain how you learn motor skills. The two models are quite different; one of the major differences is whether they recognise that the environment affects learning.

In this chapter, you will examine the important role that the environment plays in how you learn motor skills. This will help you understand the reasons why key information from the performance environment should be included in practice.

## KEY QUESTIONS

**1.1** What are the key differences between the two major theoretical models of motor learning?

**1.2** What type of instruction leads to superior skill performance and learning?

**1.3** Why is it important to include key information from the performance environment in practice?

**1.4** How can you improve your ability to detect and exploit opportunities within a game?

## YOUR CHAPTER PLAN


1.1 Theoretical models of motor learning

1.2 Explicit and implicit learning

1.3 Perception–action coupling

1.4 Affordances

Chapter review

# 1.1 Theoretical models of motor learning

Motor learning is a study area of sports science concerned with how people learn motor skills through practice, instruction and feedback. There are two main theoretical models or approaches that have been developed to explain how we learn motor skills: the cognitive systems approach and the dynamic systems approach.

These approaches have formal names, but they reflect the way we learn everyday motor skills. You may have experienced one of these approaches when you learnt to ride a bicycle, surfboard or skateboard. For example, were you given a demonstration, instruction and feedback about how to ride by an 'expert', or were you given time to explore for yourself, make mistakes and learn from them?

## The cognitive systems approach

The cognitive systems approach was developed from **cognitive psychology**.

**cognitive psychology** a branch of psychology that proposes that behaviours of individuals result from their internal mental processes

The approach assumes that learning is *explicit* – that is, learning occurs at a conscious level and is controlled by your brain. It says that to perform or learn a movement, you must consciously think about what your specific body segments should be doing. According to this approach, the mind or brain is independent and superior to the rest of the body.

The cognitive systems approach uses the information processing model to explain how you learn motor skills. This model suggests that there are similarities between how the human brain processes information and how a computer processes information.

For example, imagine that you are playing tennis and see space at the front of your opponent's court. Your brain processes this information and chooses a movement in response, such as playing a drop shot. Your brain then retrieves from your memory the specific instructions needed for the drop shot – hitting the ball softly with control and accuracy. Finally, your brain sends these instructions to the muscles to carry out the drop shot. In summary, your brain perceives and consciously thinks before acting.

Cognitive systems approach and dynamic systems approach:
UNITS 1+2, pp. 22–25

According to the cognitive systems approach, when you learn a motor skill your improvements are linear. This means that learning occurs in a predictable sequence of single steps. Your performance continually improves with practice, sometimes progressing at a steady, regular rate, but at other times progressing very rapidly or very slowly.

If you were being taught a skill using this approach to learning, you would follow a sequence of steps from simple to complex, resulting in predictable outcomes.

**Figure 1.2** The cognitive systems approach states that your movements are consciously controlled by your brain.

For example, when learning to dribble a basketball, you would progress from practising dribbling in a stationary position, to practising while walking, then jogging, to dribbling in game movement patterns.

The main limitation of the cognitive systems approach is that it doesn't recognise the effect that the environment and the subconscious control mechanisms of the body, such as the nervous and musculoskeletal systems, can have on learning motor skills.

## The dynamic systems approach

**ecological psychology**
a branch of psychology that proposes that behaviours result from interactions between a person and their environment

**dynamic systems theory**
a learning theory that sees the learner as a dynamic system made up of many body parts that interact with a task and the environment

**ecological model**
a model of learning that describes how motor control systems interact with the environment

The dynamic systems approach is an ecological model of motor learning that developed from **ecological psychology**. It originated from attempts to address some perceived limitations of the cognitive systems approach. It thus assumes that learning is implicit – that is, learning occurs without conscious awareness – and recognises the role of the environment and the entire body in the acquisition of motor skills.

The dynamic systems approach explains the acquisition of motor skills using the modern motor learning theory of ecological dynamics. This theory combines ecological psychology and **dynamical systems theory**. According to ecological psychology, the continuous interactions between your body and the information you perceive from the environment shape your behaviour or how you move.

In other words, you perceive information from the environment through your senses, such as vision and touch. This sensory information is then used to determine your behaviour or movement. For example, elite sailors perceive information about the wind from looking at the ripples in the water. This perceptual information is then used to adjust their sails to make best use of the wind. The **ecological model** includes perception–action coupling (p. 15) and affordances (p. 21).

**Figure 1.3** The environment you learn in can shape your ability in particular ways; for example, to control a bouncing soccer ball in a tight space.

# Interactions between constraints

According to dynamic systems theory, you are a complex dynamic system made up of many interacting body parts (such as the senses, nerves and muscles) and many unique individual characteristics (such as height and physical fitness level). When your individual complex dynamic system interacts with a task and the environment, instability is created. This leads to the system self-organising into a stable state, and your movement subconsciously emerges.

For example, imagine you have to walk across a sealed road in the middle of summer, without any footwear. Your own personal running technique for this situation will emerge as a result of the dynamic interactions between:

- your individual learner characteristics (e.g. pain tolerance)
- the task (e.g. width of the road)
- the environment (e.g. temperature of the road).

Researcher Karl Newell called these three categories of interacting factors **constraints**. **Individual learner constraints**, **task constraints** and **environmental constraints** all affect how coordinated movement emerges.

Constraints: >
UNITS 1+2, pp. 39–44

**constraint**
a boundary that shapes each learner's movement by limiting available options

**individual learner constraints**
any personal characteristics of the learner that can influence movement

**task constraints**
boundaries applied to a game or activity that shape movement

**environmental constraints**
any characteristics of the physical and social environment that can influence movement

# Nonlinear learning progression

Research has shown that learning within the dynamic systems approach is complex and follows a nonlinear progression. This means that learning is variable and does not follow a predictable sequence of steps. For example, when learning to surf, you may experience a large improvement in performance followed by a sudden decline.

**Figure 1.4**
Bowlers can use various techniques to achieve the outcome of spinning a cricket ball.

You may also experience periods of little or no improvement or learning as you adapt to the constantly changing environment.

Learning this way can lead to multiple, unpredictable outcomes. Therefore, learning is about the result or outcome of a movement rather than how it is performed. This is because learners can use various ways to achieve an outcome.

## Check your understanding 1.1

1. Describe the cognitive systems approach and the dynamic systems approach to motor learning.
2. Explain how movement emerges according to the dynamic systems approach.
3. Identify the main criticism of the cognitive systems approach.

## CASE STUDY

**SECONDARY DATA**

This case study shows how motor learning concepts are applied to devise a tactical strategy.

### Jason Belmonte

Who'd have thought two hands are better than one in ten-pin bowling? Only an Aussie.

When a man's technique is so revolutionary that it threatens to change his entire sport – a sport that's been around a long time – and becomes its hope for the future, then he is a true innovator. Jason Belmonte wasn't always like that.

When he entered the higher ranks of ten-pin bowling as a rare two-handed bowler, he was a curiosity. The wisdom was that a good one-handed bowler would always be better. Otherwise, people would have bowled two-handed decades ago. But then Belmonte won the 2002 Commonwealth Games. Then he became the first man ever to score 300 at a World Ten-Pin Masters, in 2005. Then he quit the lucrative European tour and headed for the world headquarters of ten-pin bowling, the USA, where he has become one of its top competitors.

Not long after Belmonte was born, in 1983, his family bought the local bowling alley in Orange, NSW. For little Jason, the alley became his nursery. The rumble of bowling balls and reverberating rattle of ten-pins was the soundtrack of his life. Once he began to walk, he wanted to bowl. Of course, even the lightest of bowling balls is way too heavy for an 18-month-old, and the only way he could launch it down the lane and actually make the other end was to shove it two-handed. As he grew, he saw no reason to stop bowling the way he was used to. He was already beating local champs as a teenager with his action.

At 17, using his 'shovel', Belmonte became the first Australian junior to bowl a perfect 300 outside Australia. After his gold, silver and two bronze medals at the Manchester Games, the bowling world began to take notice. In 2004, he won the prestigious world 'Bowler of the Year' title.

In 2007, Belmonte was again invited to the World Ten-Pin Masters, where he'd finished fifth in 2005 (despite that perfect 300). This time he beat England's Paul Moor in the final, bowling another 300 along the way.

In 2008–09 he joined the Professional Bowlers' Association circuit in the USA. Two big wins gained him Rookie of the Year status. In November 2011, Belmonte won his second, third and fourth PBA titles, and was just pipped by the USA's Sean Rash as Player of the Year. He then came home to defeat Rash in the 2012 Australian Open final.

The Belmonte 'revolution' has led to scientific studies, which have discovered that he gets more spin on a ball than anyone has ever witnessed. His delivery, at around 600 spins per minute, gets around 17 per cent more rotation than a one-handed bowler is able to impart. Belmonte has resurrected the debate as to whether spin is what actually makes for a good bowler. Certainly, the torque he gets allows him to cling precariously to the gutter before the ball spits into the pocket, and according to well-credentialed coaches like the USA's John Jowdy, 'When it hits the pocket, it's curtains. That ball is very destructive.' He's right. The pins scatter and ricochet that little bit more violently, reducing the possibility of difficult spares.

The US Bowling Congress has studied Belmonte's bodily mechanics in an effort to teach two-handed bowling to coaches, many of whom have never encountered it, despite decades in the game. Right now, it seems there is no 'orthodox' way to do it. Belmonte has his right-hand pinky and his thumb in the holes. Other right-handers might have the fingers of their left hand in the holes. It's conceivable that balls will, for the first time ever, be designed differently to accommodate the new style as it catches on.

Belmonte's action is one of few instances in any sport (Dick Fosbury's flop is another) of a single competitor's action changing the approach of others, and affecting accepted notions of technique forever. For that reason alone, 'Belmo' is already a legend of the game.

Source: Robert Drane, 23 March 2013, *Inside Sport*

Note: Since this article was written, Jason has continued to win major bowling championships, including the 2017 Professional Bowlers Association World Championship.

### QUESTIONS

KEY OBJECTIVES
1, 3, 4, 7

1. Explain what is so unique about the bowling technique used by Jason Belmonte.
2. Identify and describe the individual learner, task and environmental constraints that have interacted to shape the emergence of Jason Belmonte's unorthodox technique.
3. Determine which theoretical model or approach best explains how Jason Belmonte learnt to bowl. Justify your choice using the theory that underpins that approach.
4. The US Bowling Congress suggest that there is no conventional way to teach two-handed bowling. Comment on how you would go about making it possible for children to learn two-handed bowling.

## Apply and analyse
interactions between constraints

**LEARNING EXPERIENCE**

KEY OBJECTIVES
1, 3

1. Identify and describe the individual learner, task and environmental constraints that have interacted to shape the serving technique described in the following statement.

   *As a child, I remember playing 3 v 3 volleyball at the beach every day during our family Christmas holidays at Noosa. The games were super-competitive as we played girls against boys and I was always determined to beat my brothers. My serve was my downfall as I did not have enough power or coordination to serve overarm, so I had to serve underarm. My weak, floating serve proved too easy for my brothers to return. I tried to place my serve away from them, but this did not work as they were able to dive and land in the soft sand. Before one holiday period I was extremely motivated to perform better. I experimented with putting some sidespin on my serve, something that I had seen my father do before. I practised for a few weeks before our holiday and was confident enough to use my new serve in our games. When I served this way, the spin made it difficult for my brothers to predict the direction of the ball. This ultimately gave me an advantage. I was inconsistent at first but over a few Christmas holidays I perfected the serve and it became my greatest weapon. To this day, I still use my sidespin serve when playing.*

2. Is this learning (behaviour change) explicit and explained by the cognitive systems approach, or is it implicit and explained by the dynamic systems approach? Justify your response.

# 1.2 Explicit and implicit learning

According to the cognitive systems approach, the way you learn motor skills is explicit, meaning that you learn through conscious cognitive processes involving the brain. In other words, you learn motor skills from explicit instruction which forces you to consciously think about the mechanics of a movement.

For example, let's say there is a shot-putter who consistently fouls by overbalancing and falling out of the front of the circle during their follow-through. To get the athlete to consciously think about the mechanics of the movement, a teacher could use an explicit instruction such as: 'As you push off with the right foot, lift your leg and pivot on your left foot. When the right foot lands, hop on the foot and continue spinning'.

In contrast, according to the dynamic systems approach, learning is implicit, meaning that learning is possible without consciously thinking about what the parts of your body are doing. In other words, it says that your body can work out movement solutions without using the conscious brain. In the same shot-put example, the shot-putter could solve the problem by working with the environment at a subconscious level, without being explicitly instructed. For example, the shot-putter could practise in an environment that had a much smaller than usual shot-put circle. Through interacting with this environment, the athlete could gain more information from their senses about their body positioning in relation to the circle, and a problem-solving movement may emerge implicitly. Many of our motor skills are learnt and controlled implicitly (without conscious thought).

**Figure 1.5** 'Throw as if you are skipping a rock on water' is an analogy for learning the Frisbee forehand flick.

Explicit instruction does lead to learning, but research has found that the best skill performance and learning happens when instruction distracts the learner's conscious mind or minimises their conscious control of movement. Skills learnt implicitly are less likely to break down when you are tired or under competitive pressure, as you are less susceptible to 'choking' or overanalysing the execution of a skill. Skills learnt this way are also retained for longer.

Your conscious control of movement can be minimised in two ways. One way is through instruction that focuses on the result of a movement and the other is to use an **analogy**, also known as a biomechanical metaphor.

**analogy**
a verbal representation of a task using a simple biomechanical metaphor to help explain a movement

Focusing on the result of a movement allows your body to explore and find its own way to achieve the outcome. For example, a sprinter might simply be instructed to run in a straight line.

Analogies are useful because they simplify the mechanics of a movement. They involve less explicit verbal instruction and less conscious processing by the learner. For example, a common analogy for learning to throw a Frisbee using a forehand flick would be: 'throw as if you were trying to skip a flat rock on water'. Research has shown that analogies can help you learn relatively quickly and make you able to produce the learnt motor skills even when you're under pressure. The dynamic systems approach recommends using analogies to reduce explicit learning and encourage implicit learning.

## Check your understanding 1.2

1. Recall the advantages of learning motor skills implicitly.
2. What are two ways to minimise conscious control of motor skills?
3. Explain how the use of an analogy minimises conscious control of movement.

## Explicit and implicit learning

**Category:** Invasion
**Physical activity:** Basketball

**INTEGRATING MOVEMENT**
KEY OBJECTIVES 2, 3, 4

**Purpose**

1. This activity involves experiencing one explicit and one implicit learning process using basketball shooting.
2. If you are studying basketball, the data you collect could be used to support your project–folio assessment.

**Preparation**

**Time:** one lesson

**Location:** basketball courts

**Equipment:** basketballs, digital capture devices

**Setup**

1. Get into pairs (with members A and B).
2. One student (A) practises basketball shooting while their partner (B) instructs and observes. Partners then swap roles.
3. Each student will experience being instructed explicitly and implicitly.

**Performance**

- Each student takes 10 basketball shots from the free-throw line while their partner instructs using the following instructions:
    1. Support ball with the hand of your non-shooting arm
    2. Keep shooting forearm vertical before shooting
    3. Shoulder, elbow and wrist should be in line with the rim before shooting
    4. During shooting, ball should move from below the chin in an upward and forward direction
    5. Extend elbow fully at the ball release
    6. Follow-through by snapping wrist forward, so that the shooting hand is facing downward
    7. Release ball with your fingertips
    8. Hold follow-through (keep wrist firm) until the ball reaches the rim
- Each student takes 10 basketball shots from the free-throw line while their partner instructs them using the following analogy: *Shoot the ball as if you are trying to put biscuits into a biscuit jar on a high shelf.*

**Data recording**

1. B should digitally capture data of A performing both sets of basketball shots and vice versa.
2. After the performance, provide your partner with the video of their shots.

**Tasks**

1. Identify which instruction method represents explicit learning and which represents implicit learning.
2. Explain which type of instruction is associated with cognitive systems approach. Justify your reasoning.
3. Explain which type of instruction is associated with dynamic systems approach. Justify your reasoning.
4. Evaluate the effectiveness of each instruction method in developing your basketball shooting performance. Justify your conclusion.

## Evaluate and justify
explicit and implicit learning

**LEARNING EXPERIENCE**

KEY OBJECTIVES
4, 5, 6

A 2009 study by researchers at Hong Kong Polytechnic University compared the basketball shooting performance of two groups of undergraduate students. One group received explicit technical instructions and the other group received a single analogy instruction. After 3 days of practice (8 blocks of 20 trials per day), the shooting performance of all participants was tested. No performance differences were found from the testing, indicating similar amounts of learning for both groups.

Participants then performed a test made up of two blocks of 20 trials, but this time, they had to perform the secondary task of counting backwards in threes from 1000 throughout the test. During this test, shooting accuracy dropped significantly for the group that had practised with explicit instruction, but the performance of the analogy group was unaffected.

1. What was found out about the type of instruction and learning when both groups were tested after 3 days of practice?
2. Explain how the analogy instruction group could maintain their shooting accuracy while performing the secondary task.
3. Evaluate whether or not these findings support the theory that when you learn with an analogy, you exert less conscious control over your movements than when you learn by explicit instruction. Justify your response using findings from the study.
4. Respond to the following statement: 'Providing people with a large number of explicit instructions is not necessary for them to master some kinds of motor skills'. Justify your response using the findings from the 2009 study.

**Figure 1.6** Australian goal shooter Helen Housby can shoot a netball with little conscious control of her movements.

# 1.3 Perception–action coupling

It is important to recognise the role of the environment in motor learning. You can do this by incorporating key information from the performance environment into skills practice. It works like this. When you learn a motor skill, what you do (your action) is tightly coupled or coordinated with the key information you see in the environment (your perception), and what you see is a result of what you've done. This relationship is known as **perception–action coupling**.

**perception–action coupling** the direct link between the process of interpreting or giving meaning to information from the environment and an action

For example, think about trying to return a smash in a game of tennis:

- Just before your opponent hits the smash, you see that they have opened their stance to allow them to hit the ball across the court (perception).
- You react by moving towards the direction the ball is going to be hit (action).

This ability to perceive and react to an opponent's movements does not develop automatically, it comes from years of practice in representative environments such as competitive and 'backyard' type games. Practice must provide you with the opportunity to learn to coordinate your actions with what you perceive. To achieve this, it is important to include in practice the key information you would normally see in the performance environment, such as opponents, teammates, a moving ball, an 18-yard box or a referee. The more the practice environment mirrors the performance environment, the greater the transference of skill.

Be aware that perception–action coupling keeps happening all the time during a sport, as one action is perceived and becomes the input for a new action. For example, following on from the tennis example above where you move into position to receive the smash, you might then see your opponent suddenly notice what you are doing (perception), change their body position and hit the ball down the line to win the point (action).

This coordination of action with perception is an important part of skill development. Elite sportsmen and sportswomen have the ability to 'read' their opponent, predict what they are going to do, and then successfully execute a response. This gives them a significant advantage in a contest.

For example, Australian rugby sevens' star Charlotte Caslick has the knack of being in the right place at the right time on a rugby field. It is her instinctive ability to read opposition players and predict what they are going to do that enables her to move into position early to field a kick, take an intercept, or to make a crucial tackle.

**Figure 1.7** Kalyn Ponga is another athlete with the uncanny ability to 'read' his opponent.

## Perceptual reference points

One of the ways perception and action work together is when an athlete uses a perceptual reference point during their performance. A perceptual reference point is something they can see consistently in the performance space that the athlete can use to coordinate their action.

QUT's Institute of Health and Biomedical Innovation. http://mea.digital/qpe34_1

In 2014, researchers at the Queensland University of Technology found that the presence of an umpire and stumps makes a significant difference to the accuracy of a fast bowler's run-up. The umpire provides bowlers with a way to judge depth perception so they can estimate where they need to land their feet. So to improve the perception–action coupling of fast bowlers, this research has recommended having an umpire and stumps at the bowling crease during cricket practice.

**Figure 1.8** Australian cricketer Ellyse Perry uses the umpire as a visual reference point when bowling.

## Intention overrides perception and action

The same perceived information in the performance environment can lead to different actions, depending on the context. Consider a game of netball. If you perceive that an opposition player is going to throw a long looping pass to the player you are marking, your intentions will determine how you react to this information.

If your team was behind by 1 point with 15 seconds to play you may tend to take a risk and leave your opponent to intercept the pass. However, if your team was in front by 1 point with 15 seconds to play you may play safe and stay with your opponent to prevent them scoring. These different actions also demonstrate the importance of keeping score during practice.

## Limiting perception

**Category:** Net and court
**Physical activity:** Volleyball

**INTEGRATING MOVEMENT**
KEY OBJECTIVES
1, 2, 3, 4

### Purpose

- This activity involves receiving a volleyball serve with and without the presence of key information.
- This activity can be adapted to a throwing and catching activity, with the receiver facing the thrower and facing the opposite direction to the thrower.

### Preparation

**Time:** one lesson

**Location:** volleyball court

**Equipment**: volleyballs, material to cover volleyball net

Sample response
pp. 299–300

### Setup

1. Form teams of four players.
2. Set up the volleyball court as normal. Hang a cover over the entire width of the net, preferably extending right down to the ground and to the side lines, so that the players receiving a serve cannot see the other side of the court or the players serving to them.
3. Four players take up receiving positions on one side of the court. Another four players position themselves in preparation for serving behind the baseline at the opposite end of the court.

### Performance

1. The servers take turns to serve a total of 12 balls.
2. The receivers attempt to successfully 'return' the serve by passing the ball to a fellow team member to catch.
3. The two teams then swap roles, i.e. servers become receivers and receivers become servers.
4. Take the cover off the net and repeat the procedure.

### Data recording

1. Record the number of successful 'returns' of the serve each team made (that is, the number of times a team member successfully caught the ball passed by the serve receiver) when the net was covered.
2. Record the number of successful 'returns' of the serve each team made when the net was uncovered.

### Tasks

1. Analyse the data by comparing the number of successful 'returns' of serve when the net was covered and when it was uncovered.
2. What information was your movement coordinated with when the net was covered?
3. What information was your movement coordinated with when the net was uncovered?
4. Comment on the impact that limited perception had on your personal ability to return the serve. Justify your reasoning.

## Inappropriate perception–action couplings

Sometimes, athletes can undertake practice tasks that make them develop inappropriate perception–action couplings. For example, consider a goalkeeping practice task in which the goalkeeper saves balls fired from a machine. In this task, the goalkeeper is learning to coordinate their movements with the information they perceive from the machine or the flight of the ball upon release. However, in an actual game the goalkeeper must coordinate their movements with the information they perceive from the positioning and movements of their opponent's kicking leg and non-kicking leg.

**Figure 1.9**
This goalkeeping practice task actually develops inappropriate perception–action couplings.

### Check your understanding 1.3

1. List the key information present in the performance environment of the selected physical activity for this unit.
2. Explain why, during practice, the physical action should not be separated from the environment in which it is performed.
3. What is meant by the phrase 'read your opponent'?

## Evaluate and justify
evaluating common practice tasks

LEARNING EXPERIENCE

KEY OBJECTIVES
4, 5, 6

1 Evaluate these common practice tasks in terms of their effectiveness in developing your ability to coordinate your movements with key information from the performance environment. In your response refer to:
   - what information your movement is coordinated with in the practice task
   - what information your movement is coordinated with in the performance environment

   **a** dribbling a soccer ball around stationary markers
   **b** digging or passing a volleyball back and forth in pairs
   **c** tackling a stationary tackling bag
   **d** kicking for goal in Australian rules football without an opponent on the mark.

2 Perception can drive the action, but action can also drive perception. That is, the information you see can determine what you do and what you do can determine what information you see. Write a paragraph to support the argument that batting in a cricket net does not allow you to develop appropriate perception–action couplings in terms of 'what you do can determine what information you see'.

**Figure 1.10** Genuine games are a better way to practice skills than many practice tasks.

## Inappropriate perception–action coupling

**Category:** Invasion
**Physical activity:** All

**INTEGRATING MOVEMENT**
KEY OBJECTIVES
2, 3, 4, 5, 6

### Purpose

1. This activity involves experiencing and evaluating how effectively practising without opponents develops appropriate perception–action couplings.
2. This activity can be adapted to suit any Invasion physical activity. The data you collect could be used to support your project–folio assessment.

### Preparation

**Time:** one lesson

**Location:** outdoor or indoor space

**Equipment:** balls, line markers, digital capture devices

### Setup

1. Form teams of four players, plus a fifth participant who will record data.
2. As a group, design an attacking sequence incorporating an attacking move to use in a game. The sequence must be appropriate for the activity you're studying. For example, in touch football, perform three quick rucks to position your attack into the centre of the field, followed by one player sweeping from the right side to the left side of the field to create an overlap.

### Performance

1. Each group practises their attacking sequence without opponents for 10 minutes.
2. Each group then tries to use the same attacking sequence playing with opponents in a game.

### Data recording

1. The data-recording member on each team should use digital capture to record their team's performance.
2. After the game, each team should view and analyse the video of their performance.

### Tasks

1. Evaluate how successfully your team's performance of the attacking sequence transferred from practice to the game. Give evidence to support your response with specific reference to perception–action coupling or 'reading' the play and reacting.
2. What information was your movement coordinated with in the practice task, and in the game?
3. Choose a common isolated drill practice task used to develop a motor skill in your selected physical activity. Evaluate the task in terms of developing your ability to coordinate your movements with key information from the performance environment. Modify the task to improve appropriate perception–action couplings and justify how the modifications will better prepare you for the performance environment.

# 1.4 Affordances

It is important to include key information in practice so you can learn to read the play and detect opportunities for action. For example, including defenders in touch football practice allows you to learn to detect gaps between defenders to run through.

An **affordance** is the information in the environment that presents you with an opportunity to act or exploit. It is important to understand that an affordance is relative to your capability. For example, a small gap between defenders is only an affordance if you are fast enough to run through it. If you are too slow to run through it, the gap is not an affordance. In this case speed is a rate limiter that restricts performance.

**affordance** information in the environment that presents or affords you with an opportunity to act or exploit

The more you practise in environments that include key information from the performance environment, the better or more attuned you become at detecting affordances. Continuing from the example above, practising touch football with defenders present allows you to explore opportunities to run through gaps between defenders. Over time you should become better at detecting the size of gap that you can successfully run through.

**Figure 1.11** Australian professional basketballer Ben Simmons is attuned to detecting affordances for a lay-up.

## Check your understanding 1.4

1. Define the term affordance.
2. Give an example of an affordance in the physical activity you are studying for this unit.
3. How do you become better attuned at detecting affordances?

## Apply and analyse affordances

**LEARNING EXPERIENCE**

KEY OBJECTIVES
3, 4

**1** Give an example of an affordance for the following actions:

- **a** playing a tip shot rather than a spike in volleyball
- **b** taking a shot for goal in soccer
- **c** attempting an intercept in netball
- **d** driving to the hoop in basketball
- **e** throwing a long pass in touch football
- **f** climbing a rock wall
- **g** making a 'dummy handpass' in Australian rules football
- **h** rucking in touch football

**2** Propose possible rate limiters that prevent a player from throwing a long pass to an unmarked teammate in basketball.

## Detecting affordances

**INTEGRATING MOVEMENT**

KEY OBJECTIVES
2, 3, 4

**Category:** Net and court
**Physical activity:** Badminton

### Purpose

**1** This activity involves detecting and exploiting affordances within a game of badminton.
**2** The data collected in this activity could be used to support your project–folio assessment.

### Preparation

**Time:** one lesson

**Location:** badminton courts

**Equipment:** shuttlecocks, badminton rackets, digital capture devices

### Setup

**1** Set up the badminton courts as normal.
**2** Form groups of four students per court.
**3** Each pair of students will play two games of singles, while the other pair observes and documents their performance. Then players swap with observers.

### Performance

**1** The first pair plays a modified game of badminton singles to 7 points with one rule change and one scoring change:
*Rule change:* One player must touch the back-boundary line with one of their feet after playing their shot. The only exception is directly after they serve. Opponent plays normally.
*Scoring change:* Any player can score 3 points if the rally is won by the shuttlecock landing in the front court (the area between the net and short service line).

2 Play a second game with the rule change applying to the other person.
3 Swap players with observers and repeat the process.

### Data recording

1 Record the total number of attempts individual players made to score 3 points.
2 Record the total number of successful attempts individual players made to score 3 points.
3 After all games are played, provide the other players with your video capture of their performance.

### Tasks

1 What information in the badminton environment presents or affords the opportunity to play a drop shot?
2 How is this affordance exaggerated within the modified badminton game to enable easier detection?
3 Analyse the data and conclude if the information presented was an affordance for you to successfully perform the drop shot. Justify your response using primary data.
4 Determine possible rate limiters that restricted your ability to successfully perform the drop shot when the opportunity was presented.

**Figure 1.12** What affordances exist within a standard badminton game?

# Chapter review

## Key questions and responses

**[1.1] What are the key differences between the two major theoretical models of motor learning?**

The cognitive systems approach says that in learning motor skills, the brain is like a control centre that makes decisions and passes instructions to the rest of the body. The dynamic systems approach answers some criticisms of the cognitive systems approach. Its main difference is that it says the environment and the entire body are involved when you learn motor skills.

**[1.2] What type of instruction leads to superior skill performance and learning?**

Research has found that you learn and perform skills best if you receive instruction that minimises your conscious control of movement. This can be done in two ways: by using instructions that focus on the result of a movement or by using an analogy. This allows you to learn skills implicitly. Skills that you learn implicitly are less likely to break down when you are tired or under competitive pressure, and you also keep them for longer.

**[1.3] Why is it important to include key information from the performance environment in practice?**

It is important to incorporate key information from the performance environment in practice because what you do (your action) is tightly coupled or coordinated with what you see in the environment (your perception). Without appropriate perception–action coupling, practice is less likely to give you skills that are effective in a performance environment.

**[1.4] How can you improve your ability to detect and exploit opportunities within a game?**

It is important to include key information from the performance environment in practice to allow you to learn to read the play and detect affordances or opportunities for action. An affordance is relative to your capability. Practising in representative environments that contains key information improves your ability to detect affordances.

# Exam-style questions

## Section A: Multiple-choice questions

KEY OBJECTIVES
1

**1** The dynamic systems approach recognises that movement is shaped by both the:
- **a** environment and the brain.
- **b** environment and the senses.
- **c** environment and the entire body.
- **d** physical and social environments.

**2** Since learning is nonlinear, physical education teachers should accept that:
- **a** mistakes are an important part of learning.
- **b** performance continually improves with practice.
- **c** all students can develop the same 'ideal' technique.
- **d** teaching should follow a series of steps from simple to complex.

**3** Your personal fitness level is an example of:
- **a** a task constraint.
- **b** a tactical constraint.
- **c** an environmental constraint.
- **d** an individual learner constraint.

**4** Which of these statements is an example of an instruction that supports the implicit learning of a flat Frisbee throw?
- **a** keep your head down
- **b** make the Frisbee fly like a flying saucer
- **c** point your feet in the direction of the throw
- **d** bend your arm and pull your wrist as far back as it will go

**5** Conscious control of movement can be minimised through:
- **a** explicit instruction.
- **b** performance-related feedback.
- **c** instruction with a focus on the result of a movement.
- **d** instruction with a focus on the internal control of a movement.

**6** Including key information from the performance environment during practice allows you to learn to:
- **a** detect affordances.
- **b** enhance constraints.
- **c** focus on important aspects of the task.
- **d** coordinate your actions with the task constraints.

**7** Which of these practice tasks would develop appropriate perception–action couplings for the performance environment?
- **a** spiking a stationary volleyball
- **b** a boxer hitting a punching bag
- **c** shooting a netball without any defenders present
- **d** practising Australian rules football 'moves' against opposition players

8 Batting against a bowling machine is an unsuitable practice environment because:
   - **a** it over-simplifies the task of batting.
   - **b** it develops inappropriate perception–action couplings.
   - **c** the task only gives you practice against one type of delivery.
   - **d** the bowling machine becomes a predictable environment for practice.

9 Which of the statements below best describes affordances?
   - **a** An affordance is an action that is related to your ability.
   - **b** An affordance is the interplay between the task, the individual and environment.
   - **c** an affordance is information in a game that presents you with an opportunity to act.
   - **d** Practising in simple, unopposed environments improves the detection of affordances.

10 Which of the following statements is an example of a possible affordance for rucking the ball in touch football?
   - **a** space out wide
   - **b** a set defensive line
   - **c** an acting half with poor speed
   - **d** a large gap between defenders

## Section B: Short-response questions (150–250 words)

KEY OBJECTIVES
1, 4, 7

1 Using the physical activity you are studying for this topic, present a detailed example that shows how the interaction of constraints can produce different tactical responses or movement strategies to the same game situation.

2 Referring to Figure 1.13 on the next page:
   - **a** Identify the key elements present when someone plays a tennis volley during a game, but which are missing from the practice environment.
   - **b** Appraise the value of the practice task to say whether it develops appropriate perception–action couplings. Refer to the specifics of the practice task to help demonstrate your knowledge and understanding. For example, what perceptions is the player coordinating their actions with? What does the player see after they have acted? How does this compare with the game of tennis?
   - **c** Appraise the value of the practice task for learning to detect affordances or read the play. In your response refer to the specifics of the practice task to help demonstrate your knowledge and understanding. For example, what are the affordances for playing a volley in tennis? What affordances are present in the practice environment?
   - **d** Propose modifications to the practice task to address the problems you identified and to improve the chance of skill transfer to the performance environment.

**Figure 1.13**
Practising the tennis volley against a wall.

## Section C: Extended response to stimulus (400 words)

KEY OBJECTIVES
4, 5, 6, 7

Learning a sport in the backyard is a good example of how the physical and social environment can shape an individual's unique skill. Consider this statement from a backyard learner:

*As an 8-year-old I used to play soccer with my dad in the small 10 metre x 10 metre backyard of our house. Because of the size of the field, I found it difficult to get past Dad and score. At the time, I was also a lot slower than him, which meant that I did not have the speed to dribble into space. To be successful, I needed to develop dribbling tricks that relied on deception rather than speed. Therefore, during games I found myself experimenting with heaps of tricks. By the time I turned 9, I could consistently trick Dad, particularly with my version of the 'Cruyff Turn'. To this day, my greatest attribute when playing soccer is my ability to beat a defender 1 on 1 in a tight space.*

**a** Identify the behaviour this soccer player has learnt in this environment.
**b** Determine the individual learner contraints, task constraints and environmental constraints (boundaries) that interacted to shape the emergence of this behaviour.
**c** Argue a case for which theory of learning motor skills you believe best explains how learning occurred in this example. In your response refer to:
- explicit and implicit learning
- linear and nonlinear learning progression
- the advantages of learning this way in terms of perception–action coupling and the detection of affordance.

# 2 EXAMINING TACTICAL AWARENESS

**Figure 2.1**
Tactical awareness allows performers to identify and exploit opportunities.

To be a successful performer in any game, it's important that you can execute effective techniques. However, just as important is your ability to read a game, identify opportunities and decide on appropriate tactics to exploit those opportunities. These abilities are referred to as your tactical awareness.

In this chapter, you will examine the concept of tactical awareness and explore how you can improve your tactical awareness in the physical activity selected for this topic. You will be introduced to a physical education teaching approach called the constraints-led approach. This approach can effectively help you learn movement strategies that will improve your tactical awareness and optimise your performance.

## KEY QUESTIONS

- **2.1** What is tactical awareness and why is it important?
- **2.2** What criterion is used to classify games into different categories?
- **2.3** What steps are required for you to improve your tactical awareness?
- **2.4** How can the constraints-led approach help you develop movement strategies and increase your tactical awareness?
- **2.5** How do task constraints allow different behaviours to emerge during practice and performance?

## YOUR CHAPTER PLAN


2.1 Tactical awareness
2.2 Tactically similar games
2.3 Overcoming tactical limitations
2.4 Tactical awareness and the constraints-led approach
2.5 Emergent behaviours
Chapter review

# 2.1 Tactical awareness

In sport, successful individuals and teams not only have high levels of **technical ability**, they also have high levels of tactical awareness. Tactical awareness can be defined as a player's ability to:

- read the game play
- identify tactical problems or opportunities
- choose appropriate tactics to solve the problem or exploit the opportunity
- execute their choice using their technical ability.

**technical ability**
the ability to execute a movement or technique

For example, a soccer player in possession of the ball may identify the tactical problem that all their teammates positioned forward of the ball are marked by the opposition. Therefore, rather than risk losing possession by passing forward, a tactically aware player would choose to pass backwards to an unmarked teammate.

As each player might only have possession of the ball for a short time in a game, tactical off-the-ball movements are very important for the team's success. For example, in a game of netball, a player might identify the problem of a teammate who has the ball being under defensive pressure. If they were tactically aware, they would decide to move to a position to support their teammate by providing them with an option to pass forward, backward or across. On the other hand, a tactically aware defensive opponent would mark the supporting player while maintaining their team's defensive shape.

## Making and executing tactical decisions

The success of your tactical decisions or **movement strategies** depends on much more than just your ability to execute a technique. It includes your ability to:

- read the play
- respond
- react
- recover.

Movement strategies:
UNITS 1+2, pp. 13–15

**movement strategies**
a variety of approaches, tactics or strategies that help an individual or team successfully achieve a movement outcome or goal

Tim Hopper, an associate professor of physical education at the University of Victoria, Canada, refers to these four elements as the **principles of decision-making**.

**principles of decision-making**
the processes involved in the execution of a tactic or movement strategy

Consider the movement strategy of attacking the second serve in a game of tennis.

- To successfully execute this movement strategy, you first need to read the cues of the server and the flight of the ball so you can anticipate the speed, direction and length of the serve (**read**).
- In response to reading this information, you move into an appropriate position on the court to return the serve (**respond**).
- The interactions between your body, the environment and the task constraints associated with returning the ball determine the attacking shot that emerges, such as a crosscourt forehand (**react**).
- Finally, after playing the shot, you start moving towards the net in case your opponent returns the ball (**recover**).

This process is continually repeated throughout a game.

**Figure 2.2** To successfully block a volleyball hit, the blocker must *read* the cues of the hitter, *respond* by moving into an appropriate position to block, *react* to block the ball and then *recover*.

## Apply and analyse
principles of decision-making

LEARNING EXPERIENCE
KEY OBJECTIVES
1, 3, 4

Apply the four principles of decision-making to explain the process involved in successfully executing the following movement strategies.

1. Driving through the defence to the basket in basketball
2. Defending in a 2 v 1 situation in touch football
3. Moving your badminton opponent around the court
4. Defending against an opposition attack using a block in volleyball

# The interaction of constraints and tactical awareness

Your tactical awareness is how you respond to a tactical problem presented during a physical activity. Your response emerges from the interaction of constraints.

Consider a professional tennis player who has a risk-taking personality (individual learner constraint) receiving a second serve when down match point (task constraint) in front of a vocal home crowd (environmental constraint). These constraints would interact to produce a particular movement strategy or tactical response to this game-based problem. In this case, the player's response might be to attack the second serve by playing a risky shot to win the point and satisfy the crowd, such as a forehand winner down the line.

## Check your understanding 2.1

1. Explain the difference between technical ability and tactical awareness.
2. What are the four principles of decision-making?
3. Explain why it would be difficult to predict a player's tactical response to a problem.

## Apply and analyse
interaction of constraints and tactical awareness

LEARNING EXPERIENCE

KEY OBJECTIVES
1, 3, 4

Consider your performance in the selected physical activity for this topic. Analyse and explain how the following constraints have shaped how you tactically play the game.

1. An individual learner constraint (such as your physical fitness, height or motivation level)
2. A physical environmental constraint (such as a slippery playing surface, high winds or hot temperature)
3. A social environmental constraint (such as an aggressive coach or your peers' expectations)
4. A task constraint (such as a rule, scoring procedure, game situation or opposition strategy)

You can use your analysis in this activity to inform and shape your project–folio assessment task.

# 2.2 Tactically similar games

Games that have the same objectives are tactically similar, so you can group them together into the same category. There are four categories of tactically similar games:

- Invasion
- Net and court
- Striking and fielding
- Target.

In Unit 3, Topic 1 – Tactical awareness, we will specifically look at Invasion and Net and court games.

## Invasion games

Games such as futsal, netball, soccer, touch football, water polo and Australian rules football are classified as Invasion games. They all have the same objectives – to invade an opponent's territory and score, and to prevent opponents from freely invading your own territory and scoring.

**principles of play** fundamental movement strategies used by individuals or teams to effectively adapt to any tactical situation in authentic performance environments

To achieve these objectives, teams or players use general **principles of play**. For Invasion games, these are:

- setting up an attack
- defending against an attack
- creating, defending and exploiting space
- attacking the opposition goal and scoring.

Each of these general principles of play leads to specific tactics or movement strategies that use the skills needed for your team to achieve the desired game objective.

For example, in netball, to achieve the game objective of invading an opponent's territory and scoring, you would use the general principle of play of setting up an attack. To set up an attack, you and your teammates could use the specific movement strategy of maintaining possession of the ball by providing forward, backward and lateral options for the ball carrier to pass to.

**Figure 2.3** Water polo is classified as an Invasion game.

# Net and court games

Badminton, tennis and volleyball have the same objective – to hit an object into a court space so an opponent is unable to return it. These games are classified as Net and court games.

To achieve this objective, teams or players use general principles of play. For Net and court games these are:

- setting up an attack
- defending against an attack
- creating, defending and exploiting space
- attacking the opposition court and scoring.

Each of these general principles of play leads to specific tactics or movement strategies that use the skills needed for you or your team to achieve the desired game objective.

For example, in badminton, to achieve the game objective of hitting the shuttlecock into a court space so an opponent is unable to return it, a general principle of play would be to create space. To create space on the court you could adopt the specific movement strategy of making your opponent move towards one sideline to create space on the opposite side of the court.

If you are studying a Net and court activity for this unit, identify that activity's specific tactics and movement strategies before starting work on your project–folio assessment.

## Check your understanding 2.2

1 What criterion is used to put games into categories?
2 Explain the difference between a principle of play and a movement strategy. Give an example of each from the physical activity selected for this topic.
3 Which category of games would basketball be in?

## Engage and understand
movement strategies

LEARNING EXPERIENCE
KEY OBJECTIVES 1, 2

To do well in the project–folio assessment, it is very important that you understand the specific movement strategies for your selected physical activity.

Carry out some research using secondary sources to identify common movement strategies for your selected physical activity. List each movement strategy under one of the following headings:

- principles of play (attacking)
- principles of play (defending).

You may have to search for movement strategies using the terms 'principles of play' or 'tactics and strategies'.

Keep your notes about the secondary sources you researched. They will be directly relevant to your project–folio assessment.

# 2.3 Overcoming tactical limitations

To perform your best in any physical activity it is important that you develop both your technical ability and your tactical awareness. To improve your tactical awareness, you must overcome your tactical limitations. This can be done by following a three-step process:

**Step 1:** Identify your tactical limitations.

**Step 2:** Identify the reasons for your tactical limitations.

**Step 3:** Devise a personal tactical strategy to overcome your tactical limitations.

## Identifying tactical limitations

The first step in developing your tactical awareness is to identify any tactical limitations in your performance in the selected physical activity. This can be done by observing and analysing your performance, and identifying which movement strategies you demonstrate, and which need developing.

For example, in a game of touch football you might not carry out the movement strategy of maintaining the defensive line and moving forward with your teammates. In other words, you could have a tactical limitation that you rush up too quickly in defence, allowing the opposition to exploit the gap you create in the defensive line.

**Figure 2.4** When you are attacking in touch football, rucking between defenders so that you commit two opponents is an important movement strategy.

## Identifying tactical limitations

**Category:** Invasion; Net and court
**Physical activity:** The selected Invasion or Net and court game

INTEGRATING MOVEMENT

KEY OBJECTIVES
1, 2, 3, 5, 6

### Purpose

1. This activity is designed to identify your tactical limitations in the physical activity selected for this topic.
2. The primary data you collect can be used to support your project–folio assessment task.

### Preparation

**Time:** two lessons

**Location:** depends on physical activity

**Equipment:** depends on physical activity; digital capture devices; tactical awareness checklist

### Setup

1. This is a whole-class activity.
2. Set up the field, court or pool for an authentic version of the selected physical activity. Rules must be strictly enforced by a referee. Games should be competitive and players must be actively engaged (i.e. keep score).

### Performance (lesson 1)

1. Each student participates in an authentic version of the physical activity for 20–30 minutes.
2. Your performance is documented using digital capture.

### Data recording (lesson 2)

1. Download and print the appropriate tactical awareness checklist from your online resources.
2. Observe footage of an elite performer in the physical activity (such as a recording of a match). While observing, record the elite performer's tactical awareness by placing a tick in the 'Elite' column of the checklist if they demonstrate the movement strategy listed.
3. Observe the digital capture of your own performance in the physical activity. While observing, record your tactical awareness by placing a tick in the 'Personal' column of the checklist if you demonstrate the movement strategy listed.

   **Note:** the checklist of specific movement strategies does not list every movement strategy, and you can add to them.

### Tasks

1. Choose three specific movement strategies that you need to develop. Ensure you choose at least one attacking movement strategy and at least one defensive movement strategy.
2. Assess the negative impact that these tactical limitations have on your performance. Justify your assessment using specific evidence from the digital capture of your personal performance.
3. Propose how your performance will be improved through the development of your chosen movement strategies. Justify your proposals using specific evidence from the digital capture of the elite performer.

## Identifying the reasons for tactical limitations

**rate limiters**
factors that influence how an individual learns and potentially restricts their performance in a specific context

< Rate limiters:
UNITS 1+2, pp. 43–4

You have now identified your tactical limitations. The next step in the process of developing tactical awareness is to identify the reasons, or the most relevant **rate limiters**, that cause you to have these limitations. You have to understand rate limiters and how they influence tactical awareness if you want to improve your performance.

For example, a tactical limitation in your basketball game might be that you consistently shoot unsuccessfully from positions on the court that only have a low chance of success, when better options to pass the ball exist. You could also describe this tactical limitation as a movement strategy that needs developing; that is, you need to develop the movement strategy of shooting from high percentage positions on the court.

Your reasons for this tactical behaviour could be that you have poor decision-making and a lack of perceptual awareness when under defensive pressure. Or you might have a psychological reason, such as you don't care if you miss. Once you identify the rate limiters at work, you can come up with a strategy to overcome them and improve your performance.

So to develop your tactical awareness, it is very important that rate limiters are accurately identified. Some of the rate limiters that are most likely to restrict your tactical performance include:

- poor technique
- lack of perceptual awareness (don't look)
- poor or rushed decision-making
- lack of motivation
- poorly scaled equipment (net height, size of ball)
- your teammates' lack of ability.

## Apply and analyse
identifying rate limiters

**LEARNING EXPERIENCE**

KEY OBJECTIVES
3, 4

Look back to the Integrating Movement activity 'Identifying tactical limitations' on page 35.

For each of the three tactical limitations or movement strategies you identified in that activity, propose the one or two most relevant rate limiters responsible for that behaviour. Do this by placing a tick in the appropriate column.

| Rate limiters | Tactical limitation or movement strategy that needs developing | | |
|---|---|---|---|
| | *1* | *2* | *3* |
| Poor technique execution | | | |
| Lack of perceptual awareness | | | |
| Congestion<br>(teammates, opposition) | | | |
| Poor or rushed decision-making | | | |
| Physical<br>(height, limb length, strength, speed, flexibility) | | | |
| Mental<br>(confidence, non-risk taking personality) | | | |
| Task<br>(weight, size, or height of equipment, rules, playing dimensions) | | | |
| Environmental<br>(coach/teacher instruction, cultural, teammates' ability) | | | |
| Other | | | |

# Devising a personal tactical strategy to overcome tactical limitations

You have now identified your tactical limitations and the reasons or rate limiters responsible for those behaviours.

The final step in developing tactical awareness is to devise a personal tactical strategy to overcome the impact of these rate limiters. Your personal tactical

strategy could be a modified practice or learning environment. You could design a practice environment that overcomes the impact of rate limiters and allows the behaviour associated with the movement strategy to emerge. This would improve your tactical awareness and optimise your performance.

Consider the earlier basketball example, in which your tactical limitation was that you consistently shoot unsuccessfully from low percentage positions on the court. If the most relevant rate limiter in this basketball example is that you don't care if you shoot and miss, a task constraint could be introduced to overcome this rate limiter. For example, you could bring in a new rule that if you shoot and miss, your team loses 1 point. With this rule, you would be more concerned about your shooting accuracy and make better tactical decisions. If you think that you will miss a shot, you may look for passing options and you might start to shoot only when you think that there is a good chance of success.

You could design or modify a practice environment to overcome a rate limiter as a possible personal tactical strategy to use in your project–folio assessment.

However, if, for example, your rate limiter in basketball is a lack of perceptual awareness when under pressure, then the learning design to solve the tactical limitation is completely different. A task constraint to overcome this rate limiter and shape your behaviour could be that you are given 3 seconds of immunity from defenders when in possession. This would allow you the time to look for better passing options and make a better decision about whether to shoot or pass.

From investigating these two possible rate limiters, you can see how important it is to accurately identify the causes of your tactical limitations.

**Figure 2.5** Having time and space when in possession of the basketball will result in better tactical decisions.

## Check your understanding 2.3

1. Recall the three-step process that can be used to develop tactical awareness.
2. Why is it important to identify rate limiters when you are trying to improve your tactical awareness?
3. Describe a personal tactical strategy that you could use to overcome the impact of a rate limiter and improve a tactical limitation and optimise performance.

# 2.4 Tactical awareness and the constraints-led approach

Tactical awareness is an essential component for you to be a successful performer in games and sports. To optimise your performance, it is important to improve any tactical limitations that you have identified. One effective method to improve your tactical limitations is to practise in environments that challenge you to solve tactical problems and channel you towards possible solutions or movement strategies.

Over the years, different approaches to teaching physical activities have been used to develop tactical awareness, such as teaching games for understanding. While based on different principles, these approaches often look similar in practice, because they all challenge learners to solve common tactical problems by getting them to actively explore representative practice environments. These environments are modified using boundaries or task constraints to emphasise tactical aspects of the game and to shape learners' behaviour. For example, playing tennis on a long and narrow court to emphasise space at the front and back of the court, shapes the emergence of a lob and drop shot.

Many of these teaching approaches are based on the cognitive systems approach (see Chapter 1), which says that you gain tactical awareness through cognitive processes (thinking), often by answering guided questioning during and after playing a modified game.

In contrast, a constraints-led approach to teaching physical activity is an alternative approach that is becoming popular in both physical education and elite coaching. It's also the approach emphasised in this Physical Education course.

## Features of the constraints-led approach

The main feature of the constraints-led approach is that its learning design and delivery is based on the contemporary motor learning theory of ecological dynamics. Importantly, the constraints-led approach recognises that when you learn, there are dynamic interactions between you, the task and the environment. Questioning is not an essential part of the learning process in the constraints-led approach, as movements can emerge subconsciously without conscious thought or understanding.

This approach has only recently become more widely recognised in physical education. Until recently, it had been used by elite coaches, performance analysts and sport scientists, rather than physical education teachers. But research supports that the constraints-led approach is very effective in motor skill development.

The constraints-led approach can be applied beyond games to performance activities such as swimming, track and field, sailing and diving. For example, a 2013 study carried out by Queensland University of Technology researchers used the constraints-led approach to help train elite springboard divers. The researchers made practice more representative of the performance environment.

**Figure 2.6** The constraints-led approach recognises the dynamic interactions between the individual, the task and the environment in learning.

Previously, divers were given the chance to pull out of a dive during preparation if their movements did not 'feel right'. This option was then denied to them during practice. This constraint enabled the divers to learn to adapt their diving movements under variable take-off conditions. That is, they learned to successfully perform their dive regardless of how they felt during preparation. This translated to improved performance during competition.

The constraints-led approach can be applied during practice to develop technical ability as well as tactical awareness. For example, researchers used a constraints-led approach to develop players' skills in hitting a baseball by setting up a barrier for players to hit over. Their study showed that this was an effective practice method. Other research studies have shown that manipulating constraints can improve tennis groundstrokes, breaststroke performance and hurdling technique.

**Figure 2.7** Using the constraints-led approach improved the performance of elite springboard divers.

# CASE STUDY

## Adam Gilchrist and the squash ball trick

Australian cricketer Adam Gilchrist scored a century in the 2007 ICC Cricket World Cup final. It was a terrific performance, but for some onlookers there was a confusing moment. During his time at bat, Gilchrist raised his left hand to the crowd, showing them that there was a large lump on his palm, under his glove. What did he have in there?

The answer, it turned out, was a squash ball.

In an interview with the International Cricket Council, Gilchrist explained that his batting coach back in Perth had advised him to hold a squash ball within the glove of his bottom hand during batting practice, and he had continued doing so during the game. The purpose of this, Gilchrist said, was so that he would 'try not to grip the bat too much with those last two, maybe three, fingers'.

The 'squash ball trick' apparently worked; Gilchrist scored 149 runs off 104 balls, taking Australia to a solid victory in the final against Sri Lanka.

**SECONDARY DATA**

This case study provides an example of how constraints are applied to develop technique or technical ability.

### QUESTIONS

KEY OBJECTIVES
1, 3, 4

1. What type of constraint is the squash ball in this example?
2. How did the squash ball change Adam Gilchrist's batting technique?
3. Compare this approach to changing technique with what a cognitive systems approach would suggest.

# Principles of the constraints-led approach

There are four key principles behind the constraints-led approach. These are 'learning design principles' – that is, they're principles that teachers or coaches follow when designing practice environments and delivering instruction. When teachers and coaches follow these principles, the constraint led approach is authentically implemented.

The four principles are:

1. Use task constraints to manipulate the environment.
2. Design representative and variable practice environments.
3. Match task complexity to the ability level of the learner.
4. Facilitate implicit learning.

## Use task constraints to manipulate the environment

In the constraints-led approach, the teacher or coach manipulates practice environments using task constraints to emphasise tactical aspects of the game and to help shape your behaviour. Task constraints can be used to:

- overcome rate limiters
- present a tactical problem
- emphasise the affordance and/or solution to the tactical problem.

For example, imagine that you're learning futsal (indoor soccer), and that your tactical limitation is that you surrender possession when under defensive pressure. The reason for this behaviour or rate limiter is that you rush your pass without looking for opportunities. How could your teacher or coach manipulate the practice environment using a task constraint to help you address this limitation?

First, they could attempt to overcome the rate limiter of you not looking before passing by introducing a rule or task constraint that allows you more time and space to look for a solution when in possession of the ball. For example, the rule change could be that after your first touch you are allowed 3 seconds of immunity – so for 3 seconds you cannot be tackled by defenders, who must retreat 1 m from the ball.

Second, the teacher or coach has to manipulate the practice environment to present the tactical problem of passing under pressure. They introduce a second task constraint or rule that allows you a maximum of three touches of the ball after you gain possession. Even though there's less defensive pressure on you due to the immunity rule, the tactical problem of being under pressure and having to pass still exists.

The third step is to emphasise the solution or affordance to the problem. In this case, the affordance is an unmarked teammate to pass to. To emphasise the affordance and channel you towards this behaviour, the teacher or coach adds extra 'floating' players to the game, who only play on the attacking team.

There are many ways a practice environment can be manipulated to help someone develop tactical awareness using task constraints, such as by changing:

- rules
- scoring procedure
- team size
- field dimensions
- equipment
- game situation
- opposition strategy.

**Figure 2.8** Changing the scoring procedure is an example of a task constraint that develops tactical awareness.

## Design representative and variable practice environments

The next learning design principle of the constraints-led approach has two elements – representative and variable practice.

First of all, to optimise skill transfer, the practice environment should be representative. That means it should contain the key information of the performance environment, such as opponents, goals, net, side lines and an umpire. This allows you to learn to coordinate your movements in response to what you perceive or see (perception–action coupling), and learn to detect affordances for action. It also allows you to practise perception, decision-making and technique together, in the environment in which you will have to perform.

The second point is that the conditions you practise under should be variable and you should practise a variety of techniques to achieve the same outcome. For example, in tennis practice you should play against a variety of opponents, in a variety of game situations, using a variety of shots. This practice environment will prepare you to be able to adapt to the variability and the unpredictability of the performance environment.

**Figure 2.9** This session of goalkeeping practice is not optimising skill transfer, because it is missing key information of the performance environment, such as real defenders and attackers.

**Figure 2.10** Playing baseball with a cricket bat is an example of task simplification. The bigger bat makes hitting the baseball easier and so helps overcome the rate limiter of poor coordination or technique.

## Match task complexity to the ability level of the learner

The performance environment is often too complex for many individuals to develop their skills. To optimise learning, it's important to match the complexity of the practice task to the learner's ability level. The teacher or coach can apply *task simplification*, where the task or movement pattern is made simpler but still includes the key perceptual information from the performance environment.

Simplifying the task allows you the time and space to read the play, decide what to do, and have the chance to do it. Task simplification is an effective strategy to overcome rate limiters, such as poor technique and lack of perception, and thus allows you to develop your tactical awareness.

Here are some examples of task simplification in different activities:

- Invasion (Australian football, basketball, futsal, netball, soccer, water polo): adding in floating players who only attack; rule changes that give immunity from being tackled or pressured when in possession of the ball; putting in restriction zones where attackers outnumber defenders.
- Invasion (touch football): adding in bibbed players who can attack but can't defend; a rule change that makes the defence retreat 10 m from the ruck.
- Net and court (badminton, tennis): using bigger racquet head, bigger court, or lower net height.
- Net and court (volleyball): allowing underarm serve; using lower net height, lighter ball, or bigger court.

## Facilitate implicit learning

To **facilitate** implicit learning, a teacher or coach should use a 'hands-off' approach. They need to stand back and allow you the freedom and time to actively explore the environment. If you are given time, your own unique solution to a task can implicitly emerge. Using this approach, you will make mistakes, but you will also have the opportunity to learn from your mistakes.

**facilitate**
make something easier or less difficult

The teacher or coach should tell learners *what* to do (i.e. the problem or task), but not *how* to do it (i.e. the solution). In tennis, for example, your coach could tell you to try to win the point from your first serve in tennis. They would not tell you to aim to hit the ball into the corner of the service box.

Instructions related to technique should focus on the *outcome* of a movement, such as to dive over the pool noodle, or a representation of the movement using an **analogy**, such as 'dive into the water looking like a rocket'. The coach or teacher can answer questions to guide the process, but only after learners have been given enough time to explore the practice environment. See pp. 11–12 in Chapter 1 for more about implicit learning.

**analogy**
a verbal representation of a task using a simple biomechanical metaphor to help explain a movement

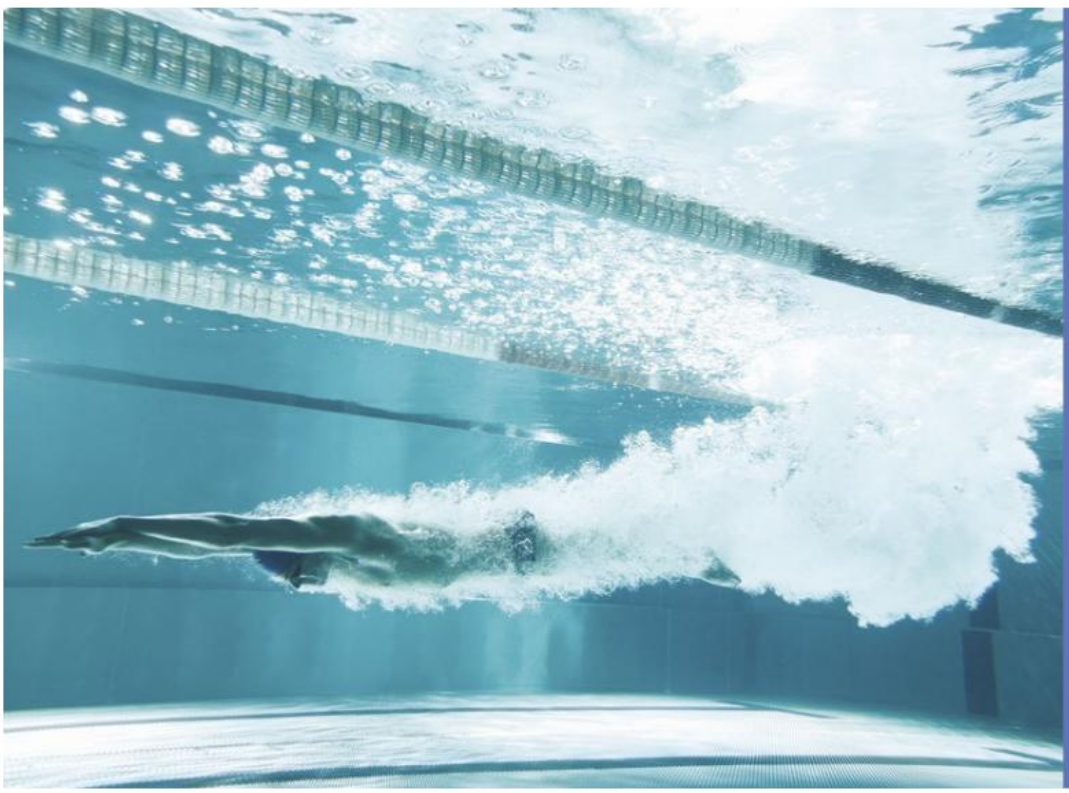


**Figure 2.11**
'Dive into the water looking like a rocket' is an example of learning using an analogy.

## Check your understanding 2.4

1. What is the main feature of the constraints-led approach?
2. Describe the four learning design principles of the constraints-led approach.
3. What is the learning goal of task simplification?

## Investigating the constraints-led approach

**Category:** Invasion; Net and court
**Physical activity:** The selected Invasion or Net and court game

**INTEGRATING MOVEMENT**
KEY OBJECTIVES
4, 5, 6, 7

### Purpose

1. This activity is designed to investigate how the constraints-led approach can facilitate tactical awareness.
2. The primary data you collect can be used to support your project–folio assessment.

### Preparation

**Time:** one lesson

Sample response: pp. 300–301

**Location:** depends on physical activity

**Equipment**: depends on physical activity; digital capture devices

### Setup

1. This is a whole-class activity.
2. Set up the field, court or pool for a modified version of the physical activity selected for this topic.
3. As a class, select a task constraint (a new rule) from the list below, which must be implemented correctly.

   **Invasion** (Australian football, basketball, futsal, netball, soccer, water polo)

   - Small-sided game with two floating players that can only attack; if the player with the ball is tagged they lose possession.

   **Invasion** (futsal, soccer)

   - Small-sided game with two floating players that can only attack; the attacking team has a maximum of seven touches before losing possession.

   **Invasion** (touch football)

   - The player with the ball must be tagged twice, by two different defenders, before they are required to stop to play the ball. The tagged player can keep running after the first touch but cannot pass.

   **Net and court** (tennis, badminton):

   - One player must touch any side line with their foot after playing their shot. Their opponent plays normally.

   **Net and court** (volleyball):

   - Within each team, three players wear red bibs and three players wear green bibs. The colour that takes the first touch when the ball clears the net are the only players that can return the ball. For example, if green takes the return of serve, only green players can take the remaining two touches.
4. Rules must be strictly enforced by a referee. Games should be competitive and players actively engaged (i.e. keep score).

5 The teacher uses a 'hands-off' approach, allowing the players the freedom and time to actively explore problems and for solutions to implicitly emerge. Instruction and feedback is limited to telling students what to do, not how to do it.

6 Determine how and where to set up digital capture devices for data recording. This will depend on the physical activity and how many students are performing at any one time.

### Performance

1 Participate in the modified version of the physical activity selected for this topic.

2 The modified game should be played for 15–20 minutes.

3 Your own and/or your team's performance is documented using digital capture.

### Data recording

After your modified game is played, observe the recording of your own and your team's performance, and document your observations.

Observed on-the-ball and off-the-ball tactical behaviour (i.e. what movement strategies are being developed?)

| *Attack* | *Defence* |
|---|---|
| | |

### Tasks

1 Evaluate the modified game by stating how effectively it meets each of the learning design principles of the constraints-led approach.
   - **a** Does it use task constraints to manipulate environment?
   - **b** Is the design representative and variable?
   - **c** Does it match how complex the task is to the ability level of the learner?
   - **d** Does it facilitate implicit learning?

2 List the attacking and defensive movement strategies that were emerging through participation in the modified game. Which of these movement strategies emerged unexpectedly?

3 How did the task constraint work to shape the emergence of movement strategies, i.e. did the task constraint present the tactical problem and/or emphasise the affordance or solution?

4 Evaluate how well the constraints-led approach can work to develop your personal tactical awareness by developing specific movement strategies. Justify your response using a specific example of how the modified game shaped your tactical behaviour.

# 2.5 Emergent behaviours

As mentioned earlier, a key element of the constraints-led approach and dynamic systems theory is that certain behaviours or actions emerge from situations. Behaviours aren't set or pre-determined, but emerge as a response to the situation and as a result of the interactions between individual learner, task and environmental constraints.

Emergent behaviours can be hard to predict, and this complicates the teaching and learning process.

## Predicting emergent behaviours

Consider a task constraint that changes basketball scoring to 3 points for successful shots taken from inside the key, and 1 point for successful shots taken from outside the key. The obvious, expected emergent behaviour from the attacking team would be that they take shots from inside the key. You could therefore argue that this task constraint is designed to develop players' ability to perform a lay-up, slam dunk or a shot close to the basket.

In reality, predicting what attacking behaviour emerges because of a task constraint is more complicated. This is because a task constraint will shape the behaviour of individual players in both attack *and* defence.

Consider our change to the basketball scoring system. How would it affect the defence? One possibility is that the defence may concentrate close to the basket to prevent 3-point shots. This would make it difficult for an attacker to position themselves inside the key, forcing them to shoot from outside where there is more time and space. Taking this into account, you could now argue that this task constraint is actually designed to develop players' ability to shoot long.

The emergence of many behaviours that are difficult to predict is typical of the complex nature of learning with the constraints-led approach. Behaviour is difficult to predict due to the dynamic interactions between the learner and the environment. In our basketball example, a player's shooting response is a consequence of the complex interaction of their shooting ability, the coach's instructions, the positioning of opponents (defenders) and teammates in relation to the basket, the shooting ability of teammates and the game context.

**Figure 2.12** An individual's behaviour during a game is difficult to predict due to the dynamic interactions between the individual and the environment within the game.

## Evaluate and justify
predicting emergent behaviour

**LEARNING EXPERIENCE**

KEY OBJECTIVES
5, 6

Predict how you think each of these task constraints would shape the emergence of an attacking player's and defending player's tactical behaviour during a game of soccer. Justify each prediction.

1. Game rules: opposition free kick if the ball goes over the side line
2. Scoring procedure (points): 3 goals if you score from a shot outside the 18-yard box
3. Team size (number of players): 11 v 8
4. Field dimensions: long and narrow field
5. Equipment: futsal ball (does not bounce high)
6. Game situation: opposition in possession, they are 1 goal in front, 60 seconds to play
7. Opposition strategy: always kick ball long in attack

## Predicting emergent behaviour

**INTEGRATING MOVEMENT**

KEY OBJECTIVES
2, 3, 4

**Category:** Invasion; Net and court
**Physical activity:** The selected Invasion or Net and court game

### Purpose

This activity is designed to investigate the unpredictability of emergent behaviour.

### Preparation

**Time:** one lesson

**Location:** depends on physical activity

**Equipment:** depends on physical activity; digital capture devices

### Setup

1. This is a whole-class activity.
2. Set up the field, court or pool for an authentic version of the physical activity selected for this topic. Task constraint (game scenario) must be correctly in place.
3. Rules must be strictly enforced by a referee. Games should be competitive, and players actively engaged (i.e. keep score).
4. Your teacher adopts a 'hands-off' approach, allowing the players the freedom and time to actively explore problems and for solutions to implicitly emerge. Teacher instruction and feedback is limited to telling students what to do, not how to do it.

### Performance

1. Teams or individual players (tennis, badminton) are given the task constraint that the class has come up with. For example:
   - *Basketball:* scores are level, and your team is in possession with 35 seconds to play in the game.
   - *Touch football:* your team is 1 try up, in possession with 45 seconds to play. Your team has had a player sent off.

   There are many possible game scenarios that could be applied to this activity. Take the time as a class to talk and come up with a simple scenario that would meaningfully affect play.
2. Each team or individual player (tennis, badminton) gets the opportunity to play out the same task constraint under game conditions.
3. Before your turn at the game, you or your team must plan your response to the situation.
4. Implement your plan in the game.

### Data recording

Use digital capture to record the effectiveness of your team's or your personal planned response to the prescribed game scenario.

### Tasks

1. Were you able to implement your plan in full? Explain why or why not, using specific evidence from the game.
2. Did your plan change during the course of the game? Explain why or why not, using specific evidence from the game.
3. Explain why it is difficult to implement a set plan in such game situations.

## Prescribed vs emergent behaviour

**prescribe**
lay down rules, direct or dictate

Sometimes a task constraint or rule can punish, reward or **prescribe** a tactical behaviour. This is *not* an effective way to learn. This is because the rule forces you to behave a particular way rather than allowing you to explore the environment and discover the tactical behaviour for yourself (implicitly).

Consider a touch football example. Suppose your team has difficulty implementing the movement strategy of penetrating forward through the defence using individual skills. Your coach decides that you need to learn a switch pass and a wrap to achieve this. The coach therefore introduces a rule or task constraint that if a team performs a switch pass or a wrap during a game, they are awarded an extra touch in the set of six.

This task constraint rewards you for performing a switch pass or a wrap. The problem is that this may result in you performing the switch pass or wrap at inappropriate times, just to gain an extra touch, e.g. when a 2 v 1 exists. This task constraint actually takes away the decision-making associated with the individual skills, and results in you attempting the wrap and switch more than normal. While you may learn *how* to perform the wrap and switch technique, you aren't learning *when* to use it in a game context.

A better way to learn how and when to use a switch pass or wrap would be to play games of 3 v 3 touch football on a narrow field. In this environment, the switch and wrap should implicitly emerge, because the environment would shape creative play. Another option would be to play a game of touch football where the maximum touches in a set is two. This would shape players' behaviour to be creative, in order to break the defence.

## Check your understanding 2.5

1. Give an example of a task constraint and the behaviours that might emerge if it is introduced to a practice session.
2. Why is it difficult to predict what player behaviour will emerge in a game as a result of a task constraint?
3. What is the difference between behaviour that is prescribed and behaviour that is emergent?

## Evaluate and justify
prescribed vs emergent behaviour

LEARNING EXPERIENCE

KEY OBJECTIVES
4, 5, 6

1. In a game of basketball or netball involving novices, a common problem is that players attempt to lob passes to their teammates over their opponent's heads. These lob passes are often intercepted. A reason for throwing such high passes is that their teammates stand behind their defenders and not in space. To eliminate these risky lob passes, a PE teacher introduces a rule that a team loses possession if a pass is made above head height. With the new rule, teammates start to move into space to receive the ball and all passes thrown are below head height.
   a. What behaviour was prescribed by the new rule?
   b. What tactical behaviour or movement strategy emerged implicitly as a result of the new rule?
2. A group of water polo players are holding on to the ball too long and slowing the speed of the attack down, resulting in the defence having time to set, and making it difficult to score. Devise a task constraint to allow problem-solving behaviour to emerge implicitly. Remember that you don't want to prescribe behaviour that takes away players' decision-making.

# CASE STUDY

**SECONDARY DATA**

This case study provides an example of how task constraints are introduced to a game in order to shape players' behaviour.

## New rules revealed: Nine changes for 2019

The AFL will introduce nine new rule and interpretation changes for 2019, including starting positions for centre bounces and revamped rules around kick-ins from behinds. …

It is hoped the package of changes will produce more free-flowing, instinctive football, and more space and one-on-one contests.

### Some of the changes

*Traditional playing positions at centre bounces*

- Clubs must have six players inside both 50m arcs, with one player inside the goalsquare.
- Four midfield players must start inside the centre square with the two wingmen stationed along the wing.

*Kick-ins*

- At kick-ins, a player will no longer need to kick to himself to play on from the goal square.
- Following a behind, the man on the mark will be brought out to 10m from the top of the goal square, rather than the existing five metres.

*Marks and free kicks in defence*

- When defenders mark or receive a free kick within nine metres of their own goal, the man on the mark will be brought in line with the top of the goalsquare.

Source: Nick Bowen, 11 October 2018, www.afl.com.au

### QUESTIONS

KEY OBJECTIVES
3, 4, 7

1. Choose one of the three rule changes presented in this extract. Explain how this rule change prescribes player behaviour, and how behaviour may implicitly emerge from the opposition or teammates in response.
2. Argue how these three rule changes will achieve the outcomes of producing free-flowing, instinctive football, and more space and one-on-one contests.
3. Identify a traditional rule or a rule change in the physical activity you have selected for this topic. Determine how this traditional rule or rule change affects player behaviour and how behaviour emerges from the opposition or your teammates in response.

# Chapter review

## Key questions and responses

**[2.1] What is tactical awareness and why is it important?**

Tactical awareness is a player's ability to read game play, identify tactical problems or opportunities, choose appropriate tactics to solve the problem or to exploit the opportunity, and carry out their choice using their technical ability. Your tactical awareness is how you respond to a tactical problem presented during a physical activity. Your response emerges from the interaction of constraints.

**[2.2] What criterion is used to classify games into different categories?**

Games that have the same objectives are tactically similar, so they can be put into the same category. To achieve these game objectives, players use general principles of play. For Invasion games and Net and court games, these are:

- setting up an attack
- defending against an attack
- creating, defending and exploiting space
- attacking the opposition goal and scoring.

**[2.3] What steps are required for you to improve your tactical awareness?**

To perform your best in any physical activity you have to develop your tactical awareness. To develop your tactical awareness, you have to identify your tactical limitations and the reasons for these limitations. Then you can devise a personal tactical strategy to improve your tactical limitations.

**[2.4] How can the constraints-led approach help you develop movement strategies and increase your tactical awareness?**

The constraints-led approach is an approach to teaching physical education that facilitates the development of tactical awareness. It challenges you to individually solve tactical problems by actively exploring representative practice environments. The practice environment can be modified using boundaries or task constraints to emphasise tactical aspects of the game and to help shape your behaviour.

**[2.5] How do task constraints allow different behaviours to emerge during practice and performance?**

It is difficult to predict what behaviour will emerge in response to task constraints due to the dynamic interactions between the individual learner, the task constraint, and the environment. Sometimes a task constraint or rule can prescribe a tactical behaviour. This is not an effective way to learn. This is because the rule forces you to behave a particular way rather than allowing you to discover the tactical behaviour implicitly for yourself.

# Exam-style questions

## Section A: Multiple-choice questions

KEY OBJECTIVES 1

**1** Your ability to read the game, identify an opportunity, and execute a movement to exploit that opportunity is an example of your:
- **a** perception.
- **b** technical ability.
- **c** tactical awareness.
- **d** decision-making ability.

**2** The order of steps in carrying out a tactic or movement strategy is:
- **a** read, react, respond, recover.
- **b** react, respond, read, recover.
- **c** read, respond, react, recover.
- **d** read, respond, recover, react.

**3** Which category of games is hockey in?
- **a** Target
- **b** Invasion
- **c** Net and court
- **d** Striking and fielding

**4** Creating, defending and exploiting space is an example of a:
- **a** game objective.
- **b** principle of play.
- **c** movement sequence.
- **d** movement strategy.

**5** A volleyball player serving to their opponent's weakest passer is an example of a:
- **a** game objective.
- **b** principle of play.
- **c** movement sequence
- **d** movement strategy.

**6** It is important to identify the rate limiter associated with a tactical limitation because the rate limiter:
- **a** restricts technical ability.
- **b** can improve performance.
- **c** is the cause of the problem.
- **d** can improve technical ability.

**7** Which of the statements below about the constraints-led approach is correct?
- **a** Questioning is an essential component of the constraints-led approach.
- **b** The constraints-led approach was not originally based on a learning theory.
- **c** The constraints-led approach can facilitate improvements in both technical ability and tactical awareness.
- **d** The constraints-led approach is very different in practice to teaching games for understanding.

**8** Competing against a variety of opponents is associated with which learning design principle of the constraints-led approach?
- **a** facilitate implicit learning
- **b** use task constraints to manipulate the environment
- **c** match task complexity to the ability level of the learner
- **d** design representative and variable practice environments

**9** According to the dynamic systems approach, it is difficult to predict a player's behaviour in a game because:
- **a** learning is linear.
- **b** learning is explicit.
- **c** learning is nonlinear.
- **d** task constraints are difficult to enforce.

**10** Which of the following is an example of a behaviour that is prescribed by the touch football rule that the defence must retreat 10 m after a touch is effected?
- **a** players retreating 10 m in defence
- **b** teams rucking the ball directly up the field
- **c** the defending team sending a 'shooter' in defence
- **d** the acting half running towards a retreating defence

## Section B: Short-response questions (150–250 words)

**1** Choose one specific movement strategy, associated with your selected physical activity for this topic, that you need to develop.

KEY OBJECTIVES
1, 4, 7

- **a** Use secondary data to explain the movement strategy in detail.
- **b** Use primary and secondary data to outline how it can or does influence your performance.
- **c** Describe the principles of decision-making that are involved in you successfully executing the movement strategy.
- **d** Explain how the movement strategy is a personal response emerging from the interaction of constraints.

**2** Evaluate your personal performance in the selected physical activity for this topic in terms of your technical ability and tactical awareness. Justify your evaluation using specific examples.

## Section C: Extended response to stimulus (400 words)

KEY OBJECTIVES
4, 5, 6, 7

Your teacher will choose a common traditional drill used to develop technical ability or tactical awareness in your selected physical activity for this topic. Evaluate the drill in terms of how much it improves your game performance. In your response, highlight the specific positives and negatives of the learning design of the drill. Justify your response by referring to the four learning design principles of the constraints-led approach.

# 3 DEVISING TACTICAL STRATEGIES

**Figure 3.1**
Devising tactical strategies is important in optimising your performance.

Over the last two chapters, you have examined key motor learning concepts and principles that can support learning design in the teaching of physical education and in sports coaching. Now it is your opportunity to apply this theory to your practice.

In this chapter, you will examine personal tactical strategies that you can devise to develop your tactical awareness in the physical activity selected for this topic.

## KEY QUESTIONS

**3.1** What personal tactical strategies can you devise to develop your technique and tactical awareness?

**3.2** How can you use task constraints to develop your tactical awareness?

## YOUR CHAPTER PLAN


3.1 Developing tactical awareness by improving technique

3.2 Developing tactical awareness using task constraints

Chapter review

# 3.1 Developing tactical awareness by improving technique

Sometimes in sport or physical education, you may have to play complex team games before you are technically ready. In these situations, your poor technique or coordination is a rate limiter that restricts your tactical performance in a game.

For example, if you can't accurately hit a shuttlecock over the net with a badminton racquet, your opportunity to learn tactics or movement strategies, such as moving your opponent around the court to create space, is restricted.

In effect, your inability to effectively hit the shuttlecock is not only a technical limitation but also a tactical limitation. So, the first step in developing your tactical awareness and optimising your performance could be to improve your technique. In this case, an effective personal tactical strategy would be to design and implement a learning environment aimed at improving your technique.

You could do this in two ways. You could directly apply the principle of task simplification to an existing learning environment, or you could design and implement a practice environment containing constraints that are specifically designed to improve your technique.

## Task simplification

Task simplification is an effective personal tactical strategy to develop tactical awareness through improving technique.

Task simplification is an effective way to overcome rate limiters that restrict your technical performance, such as poor coordination or inappropriately sized sports equipment. To use task simplification, you must design a simplified version of the task that still contains the key perceptual information from the performance environment.

For many players, the small hitting surface of a badminton racquet is a rate limiter that restricts their ability to effectively hit the shuttlecock. To use task simplification to help overcome this, you could replace the badminton racquet with a half court tennis racquet. The bigger racquet head would simplify the hitting action, which should allow you to develop an improved hitting technique.

When practicing in modified representative games, this improved ability to hit the shuttlecock allows you the opportunity to look beyond the task of clearing the net. You could begin to explore movement strategies such as moving your opponent around the court to create space. Over time, as your technique and coordination improves, you could change from using the half court tennis racquet to using a badminton racquet.

**Figure 3.2** The size of equipment can be a rate limiter that restricts technical and tactical performance.

## Apply and analyse
task simplification

LEARNING EXPERIENCE

KEY OBJECTIVES
1, 3, 4

Apply the principle of task simplification to devise a personal tactical strategy to improve your technique and coordination in the following scenarios.

1. You consistently spike the volleyball into the net because you are not very tall, restricting your ability to learn the movement strategy of spike placement.
2. Your small hands make it difficult for you to control the basketball, restricting your ability to accurately pass long to teammates in space.
3. You have difficulty passing the volleyball to a setter when receiving a powerful overhand serve, restricting your ability to learn different attacking movement strategies.
4. You have difficulty bouncing an Australian rules football, restricting your ability to learn the movement strategy of penetrating forward through the defence.

**Figure 3.3** Young children are often forced to play games with inappropriately sized equipment.

# CASE STUDY

## Equipment scaling for children's sport

**SECONDARY DATA**

This case study provides an example of how task simplification can improve performance.

A study by Queensland University research academics looked at the impact of scaling the size of a basketball to suit the size of 11-year-old players' hands. The researchers identified that the size 4 basketball matched the hand size of junior players in the same way a size 7 ball matches an adult's hand size.

When the smaller basketball was used for game play, the researchers found that the junior players' technique improved. Specifically, players tended to produce more 3-point shot attempts and more steals or intercepts than when playing with the significantly bigger size 6 basketballs currently used in many junior competitions.

**QUESTIONS**

1. Identify the rate limiter that restricted the technique of junior basketball players.
2. Explain how the principle of task simplification was applied in the research study to overcome the rate limiter.
3. Evaluate the effectiveness of the smaller basketball in developing players' technique and tactical awareness. Justify your response using specific evidence.

# Practice environments

A second personal tactical strategy for developing tactical awareness through improving technique is to use specifically designed practice environments. You can design these environments based on the learning design principles of the constraints-led approach, so that you use:

- task constraints to manipulate the environment
- representative and variable practice environments
- task complexity that matches the ability level of the learner
- learning methods that facilitate implicit learning.

**Figure 3.4** In water polo, learning your shooting technique in a representative and variable environment presents you with many tactical problems to solve.

If you follow these learning design principles, you will optimise how well you can transfer your technique from practice to the performance environment. This is because you are learning techniques in an environment like the one where they are performed. Using representative and variable practice environments also allows you to coordinate your technique with what you would normally see in the performance environment, and adapt your technique to changing conditions.

Learning your technique in such a variable and unpredictable environment also presents you with many tactical problems to solve, which develops your tactical awareness. For example, learning the technique of dribbling a basketball with opponents and teammates present means you learn to read the play, choose a response and carry it out using your technique.

## Matching practice to learner ability level

While it is important to make sure that practice is representative and variable, it should also match your ability level. The more representative the practice task, the more unpredictable and variable it is, so the more difficult it can be for you. For example, it would be difficult for an inexperienced player to learn how to pass accurately to a teammate in an authentic 5 v 5 game of basketball or even a modified 3 v 3 game. This is because team games involve many complex interactions between players. Therefore, highly representative and variable team games are not the solution for improving technique.

Many teachers and coaches use isolated drills to try to improve individual technique. However, we know that there is very poor transfer of skills practised in a drill to the performance environment. This is because repetitive and predictable drills (for example, learning to pass by throwing a netball back and forth to a partner while stationary) separate the technique from the environment in which you have to perform. The absence of defenders and teammates in drills means you don't get any opportunity to coordinate your actions with what you see. Therefore, such drills have very low representativeness and variability, which can make them too simple for the learner; an isolated drill is not the solution for improving technique.

The best way to learn techniques is to use tasks that are somewhere between an isolated drill and a complex representative team game. You have to consider the technical ability of the learner when you decide how representative and variable to make the practice tasks. You can do this by modifying isolated drills to make them more representative and variable, so the learner will be better able to transfer their technique to the performance environment. In other words, try turning a drill into a simple game. You may already have experienced this when, for example, you have honed your technique through solitary practice of simple games like throwing a ball at a target or hitting a ball against a wall. Another approach to consider is that complex games can allow better development of technique if they are made *less* representative and variable. For example, 3 v 1 and 4 v 2 games may better match your technical ability level than games of 6 v 6.

To develop your technique, start with practice environments that have low levels of variability and representativeness. Then you can modify practice to gradually increase variability and representativeness, in line with the growing technical ability of the individual learner. A suggested progression for technique development is:

- Develop the coordination of each player's individual technique with the physical environment, using 1 v 0 games.
- When that has been mastered, progress to the coordination of a player's individual technique with teammates, using 2 v 0, 3 v 0 and 4 v 0 games.
- When that has been mastered, progress to the coordination of a player's individual technique with defenders, using 4 v 1, 4 v 2 and 3 v 2 games.

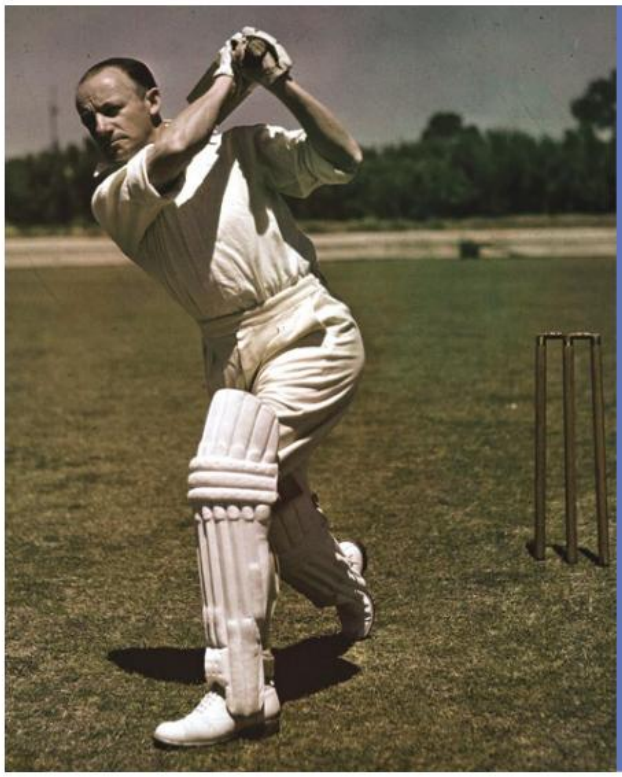


**Figure 3.5** Don Bradman honed his batting technique using a simple game of hitting a ball that rebounded at varying angles from a corrugated water tank.

For example, you can make repetitive throwing and catching drills more variable by varying the distance, direction and trajectory of passes. You can make these drills more representative by having players pass to a moving target, from one end of the field to the other, or across all sides of a grid.

You can make these games cooperative, or they can be made competitive, for example by challenging teams to beat their own time, or complete as many passes as possible in 10 seconds, or to beat their opponent to the end of the field and back.

Initially these games can be played in environments with 'traffic' rather than defenders – that is, with other players completing the same task in the same area but not acting as defenders. When players' technique improves, you can start using defenders in the practice environment.

## Check your understanding 3.1

1. Use an example to explain how a poor technique can be a rate limiter that restricts your tactical performance in a game.
2. Identify the two personal tactical strategies that can be used to develop your tactical awareness by improving your technique.
3. Explain why neither isolated drills nor complex team games are effective ways of improving your technique.

## Improving technique using practice

**Category:** Invasion; Net and court
**Physical activity:** The selected Invasion or Net and court game

**INTEGRATING MOVEMENT**
KEY OBJECTIVES
2, 4, 5, 6

### Purpose

1. This activity is designed to investigate improving your technique through practice.
2. The primary data collected in this activity can be used to support your project–folio assessment task.

Sample response
pp. 302–304

### Preparation

**Time:** one lesson

**Location:** depends on activity

**Equipment:** depends on activity

### Setup

1. This is a whole-class activity.
2. As a class, select from the following list the appropriate isolated drill for the game you are studying. Each drill is aimed at developing the technique specified in brackets.
   - Touch football (rucking): In groups of three, perform a 'three-person rucking pattern', going up the field and back in a straight line, playing the ball at markers spaced 10 m apart.
   - Invasion (shooting): Individually practise shooting for goal from one set position without any defender present.
   - Tennis, badminton (serving): Repetitively practise serving at one specific target on the court, without an opponent present.
   - Volleyball (digging): In pairs, with players 5 m apart, player A tosses the ball to player B, who digs or passes the ball back. Repeat 10 times then swap.
3. Set up the playing area according to the specified drill.

### Performance

1. Participate in the isolated drill.
2. Your teacher should follow the traditional approach to teaching drills: demonstration of the ideal model, followed by repetitive practice while providing instructions directing how you should control parts of your body.

### Data recording

After you participate in the isolated drill, complete the data table.

| | | | | |
|---|---|---|---|---|
| **1 How much did the practice environment look like the actual game, that is, how representative was it?** For example, did it include key physical elements such as opponents and teammates, player movements, passing movements, line markings, goals? | | | | |
| 1<br>nothing like the game | 2<br>very little like the game | 3<br>somewhat like the game | 4<br>mostly like the game | 5<br>identical to the actual competitive game |
| **2 How variable was the practice environment?** For example, did it use a variety of game conditions, movement patterns, opponents and teammates? | | | | |
| 1<br>very repetitive | 2<br>very little variety | 3<br>some variety | 4<br>mostly variable | 5<br>highly variable |
| **3 How well did the practice task complexity match the technical ability of the players?** | | | | |
| 1<br>far too simple or far too complex | 2<br>poorly matched | 3<br>matched to some extent | 4<br>closely matched | 5<br>perfectly matched |

### Tasks

1. Analyse the primary data you recorded. Assess how suitable the drill practice environment was for developing the specified technique for transfer to the authentic game. Justify your response using primary and secondary data.
2. In groups of four, devise a personal tactical strategy, in the form of a practice environment, that would help the specified technique to transfer better to the actual game. The practice environment must be based on the learning design principles of the constraints-led approach. In other words, you must turn the isolated drill into a simple game. This can be done by making the drill more variable and representative, and making sure that the task complexity matches the technical ability of the players and using an analogy or instructions that focus on the outcome of an action to facilitate implicit learning. Justify your modifications to the drill using evidence from primary and secondary data.
3. Try out your modified personal tactical strategy. Observe your modified practice environment and gather primary data by filling in another copy of the data table.
4. Analyse this new set of primary data. Assess how suitable your modified practice environment was for developing the specified technique for transfer to the game. Justify your response using primary and secondary data.
5. Predict how improvement of this technique could allow you the opportunity to learn tactics or movement strategies associated with the physical activity.

# 3.2 Developing tactical awareness using task constraints

The constraints-led approach is ideal for developing your tactical awareness during physical education. This approach challenges you to solve common tactical problems by exploring representative practice environments. The practice environment is carefully manipulated using task constraints that present you with tactical problems to solve and narrow your search towards particular solutions or movement strategies.

## Presenting the tactical problem

To learn a movement strategy, the learning environment should present you with the tactical problem to which the movement strategy is the solution.

For example, for you to learn the movement strategy of maintaining your team's possession by passing to a teammate who is under less pressure, the environment should put you under defensive pressure – otherwise, why would you consider passing?

Tactical problems can be made more obvious by manipulating the environment using task constraints. In this example, you could have a rule that if you are tagged when in possession of the ball, you lose possession. This rule should produce an environment in which you are constantly forced to solve the problem of maintaining your team's possession when under pressure by defenders.

**Figure 3.6** Matilda's defender Clare Polkinghorne is presented with the tactical problem of maintaining her team's possession while under defensive pressure.

## Emphasising the solution

As well as presenting you with the tactical problem, the learning environment should also narrow your search towards the selected movement strategy or solution to the tactical problem. This can be done by emphasising the affordance for the selected solution; that is, you can emphasise the key information in the environment that presents you with an opportunity to carry out the particular movement strategy.

For example, for you to carry out the movement strategy of maintaining possession by passing to a teammate who is under less pressure, you must be able to detect the affordance that there is an unmarked teammate. The unmarked teammate presents you with a possible solution to the tactical problem of maintaining possession when under defensive pressure.

To narrow your search towards this selected solution or movement strategy, the affordance is emphasised using task constraints. In this example, you could put in two 'floating' players who play only as attackers. This should produce an environment in which you can easily detect unmarked teammates to pass to, thus narrowing your search towards the selected solution or movement strategy.

Table 3.1 summarises this example, which happens in netball and some other Invasion games. It also gives a second example from touch football.

| Physical activity | Tactical problem | Task constraint used to present the tactical problem | Desired movement strategy (solution) | Affordance | Task constraint used to emphasise affordance |
|---|---|---|---|---|---|
| Invasion games (netball etc.) | To maintain possession when you are under defensive pressure in possession of the ball | If you are tagged you lose possession | Maintain possession by passing to a teammate who is under less pressure | An unmarked teammate to pass to | Two 'floating' players who play only as attackers |
| Invasion games (touch football) | Well organised defence that leaves no gaps in the defensive line | Narrow field | Attack the ruck defence | Retreating, disorganised ruck defence | After a touch the defence must retreat 10 m |

**Table 3.1** Using task constraints to present tactical problems.

You don't always have to use task constraints to present the tactical problems that are to be solved using a desired movement strategy. You can learn movement strategies by simply using task constraints to emphasise the key information or affordance you need to carry out that strategy.

For example, a badminton player may learn the movement strategy of hitting the shuttlecock away from their opponent, simply by being presented with the affordance of extra space on the court. Table 3.2 summarises this badminton example and a second example from volleyball.

**Table 3.2** Task constraints used to emphasise the affordance for the desired movement strategy.

| Physical activity | Desired movement strategy (solution) | Affordance | Task constraint used to emphasise affordance |
|---|---|---|---|
| Badminton | Hit away from opponent | Space on the court | One player must touch the side line with their foot after each shot |
| Volleyball | Serve away from opposition's best passer (libero) | Opposition's best passer is identifiable and isolated on the court | Opposition's best passer wears a red bib and they must make the first touch when returning the serve, otherwise the serving team wins the point |

You can also learn movement strategies by simply using task constraints to increase how frequently the affordance appears in the game. For example, consider a 6 v 4 touch football game. The numerical advantage of one team would mean the affordance of a 2 v 1 situation would happen more often in the game. This would give attacking players on the larger team the opportunity to learn the movement strategy of drawing a defender and passing.

## Apply and analyse
emphasising affordances

**LEARNING EXPERIENCE**

KEY OBJECTIVES
1, 3, 4

1. Choose three movement strategies relevant to the physical activity selected for this topic. For each movement strategy, identify the affordance for that action – the key information in the environment that presents you with an opportunity to execute the movement strategy.
2. Design a task constraint that would emphasise each affordance and narrow your search within the learning environment towards the selected movement strategy.

## Check your understanding 3.2

1. Explain why the constraints-led approach is an ideal teaching approach to use in physical education to develop your tactical awareness.
2. Recall the two key aspects that need to be built in to the design of a learning environment to allow you to learn a movement strategy.
3. Explain how task constraints can narrow your search towards a selected solution to a tactical problem.

**Figure 3.7**
A volleyball player may learn the movement strategy of blocking by frequently being presented with the affordance of an opponent moving to spike the ball.

## Developing tactical awareness using task constraints

**Category:** Invasion, Net and Court
**Physical activity:** The selected Invasion or Net and court game

**INTEGRATING MOVEMENT**
KEY OBJECTIVES
2, 4, 5, 6

### Purpose

1. This activity is designed to investigate how the constraints-led approach can develop your tactical awareness in the physical activity you are studying.
2. The primary data you collect in this activity will support your project–folio assessment task.

### Preparation

**Time:** four or five lessons

**Location:** depends on activity

**Equipment:** depends on physical activity; digital capture devices

### Setup

1. This is a whole-class activity in which you will play five consecutive games. Each game is modified using the task constraints listed in the section that follows, headed 'Constraints-led practice environments'. All games are separate – only one task constraint is incorporated into each game.

2 Set up the playing area for each modified version of the selected physical activity.
3 Put task constraints correctly in place.
4 Rules must be strictly enforced by a referee. Games should be competitive and players actively engaged (i.e. keep score).
5 Your teacher must adopt a 'hands-off' approach, allowing you the freedom and time to actively explore problems and for solutions to implicitly emerge. The teacher's instruction and feedback is limited to telling you what to do (the rules), not how to do it.
6 Important: the games can be simplified if necessary, using the ideas presented in this and the previous chapters.

**Constraint-led practice environments**

**Invasion** (Australian rules football, basketball, futsal, netball, soccer, water polo):

**a** *Rule change*:
- if the player with the ball is tagged, they lose possession (Australian rules football, basketball, netball, water polo)
- the attacking team has a maximum of seven touches in total before losing possession (futsal, soccer)

**b** *Scoring procedure (points)*: triple points for scoring from close proximity to the goal
**c** *Team size (number of players):* two 'floating' players who only play on the attacking team
**d** *Field dimensions:* long and narrow playing area
**e** *Opposition strategy:* one team repeatedly attacks directly up the middle of the playing area, i.e. they don't use the width of the field

**Invasion** (touch football):

**a** *Rule change:* after a touch, the defence must retreat 10 m
**b** *Scoring procedure (points):* normal touch football rules apply except that a marker is placed on the middle of the try line. Tries scored to the left of the marker are worth 1 point, tries scored on the right side of the marker are worth 3 points. First team to 7 points wins
**c** *Team size (number of players):* two players from each team wear a different coloured bib to their teammates, indicating that they cannot defend, but they must always stand in the defensive line. They can attack as normal
**d** *Field dimensions:* 15 m wide × 60 m long
**e** *Opposition strategy:* one team utilises a shooting defence (one defender rushes up to tag the player receiving the ball from acting half)

**Net and court** (tennis, badminton):

**a** *Rule change:* one player must touch either side line with their foot after playing each shot. Opponent plays normally
**b** *Scoring procedure (points):* if a player wins the rally before the ball crosses the net three times, they are awarded 3 points (i.e. from serve or return of serve). First to 11 points wins
**c** *Team size (number of players):* 2 v 1 (on singles court)
**d** *Field dimensions:* long and narrow court
**e** *Opposition strategy:* opponent attacks your 'weak' backhand

**Net and court** (volleyball):

**a** *Rule change:* your opposition's best passer (libero) wears a red bib meaning that they must make the first touch when returning the serve. If they don't, the serving team scores

**b** *Scoring procedure (points):* if a team wins the rally before the ball crosses the net three times, they are awarded 3 points (i.e. serve and return of serve)

**c** *Team size (number of players):* two players in each team wear a bib and are not allowed to play at the ball directly from the opposition. That is, they cannot take the first touch, but can take the second and/or third touches

**d** *Field dimensions:* lengthen court by 2 m

**e** *Opposition strategy:* opposition plays safe by always serving underarm to the middle of the court

### Performance

**1** Participate in all five modified games in your selected physical activity.

**2** Each modified game should be played for long enough for behaviour to implicitly emerge.

**3** Students who are not playing in a given game should document the team's performance using digital capture.

### Data recording

**1** After each modified game is played, observe the recording of your own and your team's performance.

**2** Choose any four of the modified games to use to complete the data table.

| Task constraint | Key information presented by constraint | Observed emergent behaviour |
|---|---|---|
| Rule change | | |
| Scoring procedure (points) | | |
| Team size (number of players) | | |
| Field dimensions | | |
| Opposition strategy | | |

### Tasks

**1** Evaluate how effectively the task constraints presented you with tactical problems to solve and whether they narrowed your search towards selected solutions or movement strategies. Give specific examples.

**2** Evaluate the effectiveness of the constraints-led approach in developing specific movement strategies for the physical activity selected for this topic.

**3** Justify your response using specific examples from this activity or any other activity covered in this topic.

# Chapter review

## Key questions and responses

**[3.1] What personal tactical strategies can you devise to develop your technique and tactical awareness?**

Poor technique can be a rate limiter that restricts your tactical performance in a game. To develop your tactical awareness, you may need to improve your technique. Task simplification and constraints-led practice environments are two effective personal tactical strategies that you could use to improve your technique and optimise your tactical performance.

**[3.2] How can you use task constraints to develop your tactical awareness?**

The constraints-led approach is an ideal teaching approach for physical education, to develop your tactical awareness. This is because constraints-led learning environments are carefully manipulated using task constraints, so that they present you with tactical problems to solve and narrow your search towards selected solutions or movement strategies. These environments are like the performance environment, since they are representative and variable. They are designed to facilitate implicit learning, and allow you to have optimal transfer of skills from practice to the performance environment.

# Exam-style questions

## Section A: Multiple-choice questions

KEY OBJECTIVES
1

**1** The act of kicking accurately with your left foot is an example of your:
- **a** perception.
- **b** technical ability.
- **c** tactical awareness.
- **d** decision-making ability.

**2** A gap wide enough for you to run between opponents is an example of:
- **a** a rate limiter.
- **b** an affordance.
- **c** a tactical problem.
- **d** a movement strategy.

**3** Hitting the tennis ball deep to prevent your opponent from attacking the net is an example of:
- **a** a rate limiter.
- **b** an affordance.
- **c** a tactical problem.
- **d** a movement strategy.

**4** The inability to lift your upper body out of the water to effectively shoot in water polo is an example of:
- **a** a rate limiter.
- **b** an affordance.
- **c** a tactical problem.
- **d** a movement strategy.

**5** Lowering the height of the goal ring to improve your netball shooting technique is an example of:
- **a** part practice.
- **b** a rate limiter.
- **c** task simplification.
- **d** an individual constraint.

**6** To optimise the successful transfer of your technique from practice to the performance environment, it is important to:
- **a** use isolated drills.
- **b** identify and overcome individual rate limiters.
- **c** minimise variations of technique within practice.
- **d** learn in the environment in which techniques are performed.

**7** An ideal learning environment for improving your technique for transfer to the performance environment would be:
- **a** an isolated drill.
- **b** a representative game.
- **c** a simplified environment.
- **d** a game that matches your technical ability level.

8 Which of these is an affordance for the movement strategy of passing backwards in a game of soccer?
   - **a** a lack of dribbling skills
   - **b** a lack of perceptual awareness
   - **c** marked players forward of the ball
   - **d** unmarked players forward of the ball

9 In a game of touch football, the key information of a player rushing up out of the defensive line when you are rucking the ball is an example of:
   - **a** an affordance and a rate limiter.
   - **b** a rate limiter and a tactical problem.
   - **c** an affordance and a tactical problem.
   - **d** an affordance, a rate limiter and a tactical problem.

10 Which of these task constraints would emphasise the affordance that presents an opportunity for you to learn to execute a drop shot in badminton?
   - **a** a lower net
   - **b** a long narrow court
   - **c** a short and wide court
   - **d** using a half court tennis racquet

## Section B: Short-response questions (150–250 words)

KEY OBJECTIVES
1, 4, 7

1 Identify a personal technique from the game selected for this topic that you need to improve. Discuss how your poor technique restricts your opportunity to learn tactics or movement strategies associated with the physical activity.

2 Propose a personal tactical strategy to improve the technique you chose in question 1. Make sure that it allows skill transfer to the game, and the opportunity to develop your tactical awareness. The personal tactical strategy can take the form of a task simplification, or you could design a constraints-led practice environment. Ensure your practice environment is variable and representative, and that it facilitates implicit learning. Justify the design of your personal tactical strategy using secondary data.

## Section C: Extended response (400 words)

KEY OBJECTIVES
4, 5, 6, 7

1 Identify any movement strategy that you need to develop for the physical activity selected for this topic.

2 Devise a personal tactical strategy for developing the movement strategy you identified in question 1 in the form of a game that has been modified using task constraints. Your personal tactical strategy could simply be the design of a modified practice environment that incorporates task constraints to emphasise the affordance associated with your movement strategy.

3 Justify the design of your personal tactical strategy, specifically explaining how the constraints present the key information necessary to learn the movement strategy.

# WORKED EXAMPLE

## Unit 3 project–folio

**Your assessment for Unit 3, Topic 1, 'Tactical awareness', is in the form of a project–folio. In the project–folio, you are required to devise, implement and evaluate a personal tactical strategy and justify your conclusions. The aim of the personal tactical strategy is to optimise your tactical performance in the physical activity selected for this topic.**

This task involves gathering and analysing data about your personal performance and applying your knowledge of motor learning concepts to devise a tactical strategy. You are required to generate a 9–11-minute presentation to summarise your findings.

To help you to understand the requirements of the project–folio, this sample response models the process of devising, implementing and evaluating a tactical strategy. The response addresses all seven assessment objectives; however, it does *not* incorporate the evaluation of personal performance beyond one movement strategy from one principle of play. It is presented in a written format, rather than the prescribed multimodal format, and is longer than the prescribed length in order to demonstrate the possible integration of all motor learning concepts.

The structure of the response follows the stages of inquiry framework:

The task is purposely integrated with cricket, a physical activity that is outside the prescribed Invasion and Net and Court categories.

# Planning your project–folio

## Introduction

In this assessment task response, I document the implementation and evaluation of a personal tactical strategy. The strategy was devised to optimise my tactical performance when scoring runs as an opening or a middle order batter in cricket.

## Engage and understand

Engage and understand

### 1 Explain tactical awareness and how it can influence performance

One of the principles of play for batting in cricket is to score runs. This can be achieved by a batter not only possessing an effective technique, but also possessing tactical awareness. Tactical awareness is defined as the ability to read a game, identify opportunities and decide on appropriate tactics to exploit that opportunity (Amezdroz *et al.* 2019). A batter who is tactically aware uses various movement strategies, such as hitting the ball into gaps, to make scoring runs easier.

### 2 Gather primary data about performance

To identify a movement strategy that I need to develop to optimise my batting performance, I gathered primary data about my batting in a traditional cricket game played at the start of the unit. The data was gathered by an observer using the game performance assessment instrument shown in Table F1.

**Table F1** Game performance assessment instrument for assessing cricket batting in a traditional game

| **Game performance assessment instrument<br>Cricket batting skill execution** | | | | | | |
|---|---|---|---|---|---|---|
| **Player name: _____ Evaluator name: _____** | | | | | | |
| Directions:<br>• Observe the player for two innings and record the number of runs scored from each ball faced by placing a mark in the corresponding column<br>• When innings is complete, tally the number of balls in each run category | | | | | | |
| **Runs scored from each ball faced** | | | | | | |
| Innings | 0s | 1s | 2's | 3s | 4s | 6s |
| 1st | 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 \|\|\| | \|\|\|\| | \|\| | \|\| | \|\|\|\| | |
| No of balls | 33 | 4 | 2 | 2 | 4 | 0 |
| 2nd | 𝍸 𝍸 𝍸 \|\|\|\| | \|\|\| | \| | | \|\| | |
| No of balls | 19 | 3 | 1 | 0 | 2 | 0 |

| | Details of balls not scored from | | | |
|---|---|---|---|---|
| Innings | Not played at | Played and missed | Played defensively | Hit to a fielder |
| 1st | 𝍸 \| | 𝍸 | 𝍸 𝍸 𝍸 \|\| | 𝍸 \|\| |
| Total | 6 | 3 | 17 | 7 |
| 2nd | 𝍸 | \|\| | 𝍸 𝍸 | \|\|\|\| |
| Total | 3 | 2 | 10 | 4 |

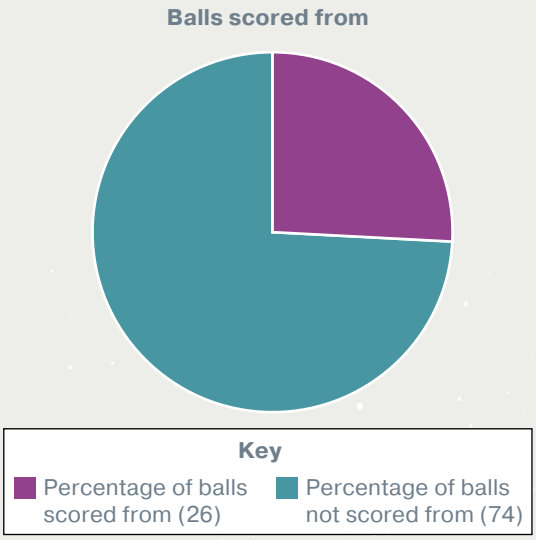
## Apply and analyse

Apply and analyse

**3 Analyse primary and secondary data to identify a tactical limitation on performance**

The data shows a tactical limitation with my batting. Over both innings, I scored from 26% of the balls that I faced, which is approximately 1 in every 4. This means that I did not score from 74% of the balls that I faced, which is approximately 3 in every 4 balls (see Table F2).

**Figure F1** Proportion of total balls scored from and not scored from in a traditional cricket game.




Most of the balls that I did not score from were either played defensively (52%) or hit to a fielder (21%) (see Table F3). This indicates that I can hit the ball but tend to play in a defensive manner.

**Table F2** Analysis of each ball faced over two innings in a traditional cricket game

| | Total balls faced | Balls scored from | Balls not scored from |
|---|---|---|---|
| 1st innings | 45 | 12 | 33 |
| 2nd innings | 25 | 6 | 19 |
| Total | 70 | 18 | 52 |
| Percentage | 100 | 26 | 74 |

**Table F3** Analysis of balls not scored from over two innings in a traditional cricket game

| Innings | Total balls not scored from | Not played at | Played and missed | Played defensively | Hit to a fielder |
|---|---|---|---|---|---|
| 1st innings | 33 | 6 | 3 | 17 | 7 |
| 2nd innings | 19 | 3 | 2 | 10 | 4 |
| Total | 52 | 9 | 5 | 27 | 11 |
| Percentage | 100 | 17 | 10 | 52 | 21 |

**Figure F2** When opening the batting, I need to learn to play the ball into space and give myself the opportunity to run a single.

Playing so defensively has a negative impact on my batting performance, as I waste a lot of scoring opportunities. My defensive mindset allows the bowler to dominate and creates mounting pressure on me to score runs, resulting in errors of judgement like being run out. I need to improve this area of my batting.

To improve my batting, I need to score more. Rather than constantly playing the ball defensively straight in front of me or hitting it to the fielders, I need to play the ball into space and give myself the opportunity to run a single.

This movement strategy is called *rotating the strike*. It forces the bowler to continually readjust, as they must deal with the continuous rotation of the batter, rather than bowling to the same batter for the entire over. This can disrupt the bowler's line and length, resulting in many 'loose' deliveries and more scoring opportunities for the batter (Australian Cricket Board, 2000).

### 4 Devise a personal tactical strategy to optimise performance

My personal tactical strategy to optimise my batting performance was to design and implement a modified game, which I called 'Singles Zone', aimed at developing my ability to play a delivery into space to allow me the opportunity to run a single.

## Personal tactical strategy

### Modified game: Singles Zone
### Learning outcomes

- To develop the movement strategy of playing deliveries into space, to allow the opportunity to run a single and rotate the strike.
- To develop specialised movement sequences related to the movement strategy, e.g. front-foot and back-foot attack; on-side, off-side and square of the wicket shots; calling and running between wickets.

### Constraints-led approach learning design
### Rules/task constraints

- **Field:** 40 m across × 50 m long with stumps placed so that the 'batting' stumps are 10 m from the rear boundary and the 'bowling' stumps are 20 m away
- **Players:** 4 pairs (2 batters, 1 bowler/1 wicketkeeper, 2 on-side fielders, 2 off-side fielders)
- **Batters:** each batting pair attempts to score as many runs as possible from 6 × 6-ball overs
- **Bowlers:** bowl from the same end using a run-up limited to four steps
- **Fielders:** two fielders on the on-side fielders and two fielders on the off-side at all times
- **Out:** batters lose 2 runs instead of going out if they are bowled, caught, or run out or if they hit the ball over or into the boundary

**5 Justify the development of the strategy**

The design of the modified game incorporated the four learning design principles of the constraints-led approach. These learning design principles were chosen as they are based on the motor learning theory of ecological dynamics. There is extensive research evidence to support the effectiveness of these learning design principles in skill development (Amezdroz *et al.* 2019).

I followed this sequence of steps in designing the modified game.

**a Use task constraints to manipulate the environment**

*i Identify and overcome rate limiters using task constraints*

Before I designed a learning environment, it was important that I identified and considered the most relevant rate limiters that were restricting me from playing the ball into space. Rate limiters are factors that restrict an individual's performance (Amezdroz *et al.* 2018). Once I identified the rate limiters responsible for this behaviour, I was able to manipulate the learning environment to overcome their impact and allow the opportunity for the learning of the movement strategy (Moy, 2018).

**Figure F3** Batting in the nets is a rate limiter that restricted my learning to rotate the strike.

The most relevant rate limiters:

- my lack of technical ability: I am not capable of using the angle of the bat and the position of my body to manoeuvre the ball in the desired direction to run a single (individual learner constraint)
- a fear of being run out (individual learner constraint)
- the rules of cricket: there is no limit to the number of balls a batter can face in an innings, reducing the pressure to score quickly (task constraint)
- traditional coaching methods: practice often means batting in the nets without fielders, a batting partner, or the aim of scoring runs (environmental constraint).

Playing a defensive shot straight in front of me or straight to the fielders is a personal response emerging from the interaction of these constraints or rate limiters. To overcome these rate limiters, my modified game incorporated learning design principles and specifically chosen task constraints (see Table F4).

**Table F4** Learning design modifications to overcome the impact of rate limiters

| Rate limiter | Learning design modifications |
|---|---|
| A lack of technical ability | My own unique technique is given the opportunity to implicitly emerge through the interactions between:<br>• my individual learner constraints<br>• the task constraint of having to score as many runs as possible from a limited number of deliveries<br>• the practice environment |
| Fear of being run out | Task constraint: batter loses 2 runs instead of being out |
| Unlimited number of balls in an innings | Task constraint: limit placed on balls faced in the innings, that is, each batting pair faces 6 × 6-ball overs (36 balls) |
| Traditional coaching methods | Representative practice environment that incorporates fielders, a batting partner and a game context |

*ii Present the tactical problem using task constraints*

To develop my ability to play a delivery into space so I can run a single, the learning environment must present me with the tactical problem – scoring runs quickly without batting aggressively – to which this movement strategy is the solution. This was done by manipulating the environment using the following task constraints:

- each batting pair faces a total of 36 deliveries
- batters are 'out' (lose 2 runs) if the ball is hit over or into the boundary
- the field size is decreased to 40 m wide × 50 m long.

*iii Identify and emphasise affordances using task constraints*

In order to learn a movement strategy, I must be able to detect the affordance or key information that presents an opportunity to execute that strategy (Fajan *et al.* 2009). Therefore, my modified game incorporated the key information that presented the opportunity of playing a shot and scoring a single, that is, space between fielders. According to Chow (2013), it is important to use constraints to limit the number of solutions available to the learner because games are so complex.

To narrow my search towards the selected solution, I emphasised the affordance of space by introducing the task constraint of fewer fielders (see Table F5).

**Table F5** Task constraints used to present the tactical problem and emphasise the affordance for the movement strategy

| Tactical problem | Task constraint used to present the tactical problem | Desired movement strategy (solution) | Affordance | Task constraint used to emphasise affordance |
|---|---|---|---|---|
| Score runs quickly without batting aggressively | Each batting pair faces a total of 36 deliveries<br>Batters are 'out' (lose 2 runs) if the ball is hit over or into the boundary | Play a delivery into the space between fielders so I can run a single | Space between fielders | Fewer fielders |

**b Design representative and variable practice environments**

To enable the transfer of skills from practice to the performance environment, practice should resemble the performance environment (Moy, 2018). To achieve this, the modified game that I designed incorporated the key information that I would see when batting and respond to in a game of cricket, such as a bowler, fielders and a batting partner.

The modified game incorporates variability. For example, each batting pair faces six different bowlers. Variable practice is essential, as the game of cricket is variable, allowing me to more easily adapt to changing conditions in the game (Amezdroz *et al.* 2018).

**Figure F4** The affordance of space was emphasised in my learning design.

**c Match task complexity to the ability level of the learner**

The modified game design incorporates the principle of task simplification, as batting is made easier but the task still incorporates the key perceptual information from the performance environment (Amezdroz *et al.* 2018). The task constraint of fewer fielders was introduced to make the detection of space easier for me. A second rule limiting bowlers' run-ups to four steps was also introduced to simplify the environment by limiting bowling speed.

**d Facilitate implicit learning**

To facilitate implicit learning of my batting technique, I was allowed the freedom and time to explore the modified game. This will result in continuous and dynamic interactions between my individual learner constraints, the task being performed and the environment. These interactions will create instability, resulting in my system self-organising and my unique batting technique implicitly emerging (Davids, Button and Bennett, 2008).

This exploration is supplemented by external focus instructions that relate to the result of a movement. For example, I am told what to do (e.g. 'Hit the ball into space'), but I am not told how to do it (e.g. 'Rotate your wrist joint towards the ball').

**6 Implement personal tactical strategy and gather primary data about its impact on performance**

My personal tactical strategy of a modified game of cricket was implemented and primary data was gathered in relation to the number of runs that I scored from each ball faced over two innings. The data was gathered by an observer using the same GPAI used for gathering the initial data about performance, shown in Table F6.

**Table F6** GPAI for assessing cricket batting in the modified game

| Game performance assessment instrument<br>Cricket batting skill execution | | | | |
|---|---|---|---|---|
| Player name: _____ Evaluator name: _____ | | | | |
| Directions:<br>• Observe the player for two innings and record the number of runs scored from each ball faced by placing a mark in the corresponding column<br>• When innings is complete, tally the number of balls in each run category | | | | |
| **Cricket batting skill execution** | | | | |
| Innings | 0s | 1s | 2's | 3s |
| 1st | 𝍸 \| | 𝍸 \|\|\|\| | | |
| No of balls | 6 | 9 | 0 | 0 |
| 2nd | 𝍸 \| | 𝍸 𝍸 𝍸 | | |
| No of balls | 6 | 15 | 0 | 0 |

**7 Analyse and synthesise data to determine the effectiveness of the personal tactical strategy**

Having gathered data from the modified game, I was able to compare it to the data from the traditional cricket game and analyse the impact my personal tactical strategy had upon my scoring performance.

**Table F7** Analysis of each ball faced over two innings in the modified cricket game (Singles Zone)

| | Total balls faced | Balls scored from | Balls not scored from |
|---|---|---|---|
| 1st innings | 15 | 9 | 6 |
| 2nd innings | 21 | 15 | 6 |
| Total | 36 | 24 | 12 |
| Percentage | 100 | 67 | 33 |

**Figure F5** Proportion of total balls scored from and not scored from in the modified cricket game 'Singles Zone'

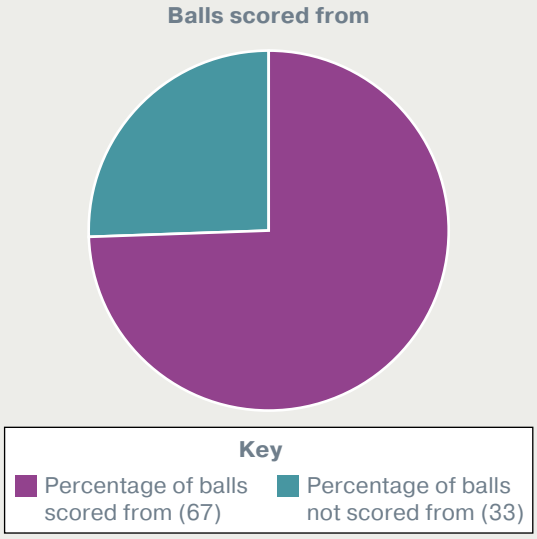



**Table F8** Comparison of scoring rate between the traditional cricket game and the modified cricket game

| | Percentage of balls scored from | Percentage of balls not scored from |
|---|---|---|
| Traditional cricket game | 26 | 74 |
| Modified cricket game | 67 | 33 |

## Evaluate and justify

Evaluate and justify

**8 Evaluate the effectiveness of the personal tactical strategy on performance**

My personal tactical strategy, in the form of a cricket game modified using constraints, was successful in improving my batting performance. Participation in the modified game enabled me to develop my ability to adjust my batting technique to play balls into space, call and run a single, and rotate the strike. I used a variety of specialised movement sequences to achieve this, including making shots on-side, off-side and square of the wicket, calling, and running between wickets.

**9 Justify evaluation using primary data**

The improvement in my batting is evident in the data collected while playing the modified game. Specifically, on average over two innings, I scored from 67% of the balls that I faced, which is approximately 2 in every 3 (see Tables F7 and F8, and Figure F5).

Previously, I got 'bogged' down against accurate bowling and scored from approximately 1 in every 4 balls faced. Participation in the modified game had a positive impact on my batting performance, as I took advantage of opportunities to score 24 singles from 36 balls faced. As suggested in the literature (Australian Cricket Board, 2000), the movement strategy of running a single to rotate the strike disrupted the bowler's line and length, resulting in many 'loose' deliveries and more scoring opportunities.

**10 Justify evaluation using secondary data**

The constraints-led approach to learning design, based on the motor learning theory of ecological dynamics, was significantly responsible for my batting development. This evidence-based learning design optimised my learning of skills and their transfer from practice to the performance environment (Amezdroz *et al.* 2018). This supports claims made by Renshaw and Moy (2018), that modified or 'backyard' type games are effective learning environments as they meet the skill acquisition needs of learners.

The manipulation of the environment using task constraints was successful in overcoming rate limiters, presenting the tactical problem and narrowing my search towards the movement strategy or solution of scoring runs by hitting the ball into space. My batting technique was allowed to implicitly emerge through the interaction between individual learner, task and environmental constraints.

**a Use task constraints to manipulate the environment**

*i Identify and overcome rate limiters using task constraints*

According to Amezdroz and colleagues (2018), overcoming the impact of rate limiters is an important first step to facilitate learning. My modified game successfully manipulated task constraints to overcome the impact of the most relevant rate limiters that restricted my performance. This allowed me the opportunity to learn the movement strategy.

For example, previously the individual learner constraint of my fear of losing my wicket through a run out prevented me from even thinking about running a single when I hit the ball near a fielder. However, having the rule that I was only penalised 2 runs if I got run out made me less worried about trying. This task constraint, combined with the task constraint of facing a limited number of deliveries within a representative practice environment, shaped my behaviour and encouraged me to attempt to play the ball into space to run a single.

*ii Present the tactical problem using task constraints*

The combined task constraints were successful in creating an environment that presented me with the tactical problem of having to score runs quickly without batting aggressively. The task constraint of limiting the number of deliveries I could face encouraged me to score quickly. The task constraint of penalising me 2 runs for hitting a 4 or 6 discouraged me from playing aggressively. Also, I was not given much opportunity to score a 2 or a 3 due to the modified playing dimensions.

*iii Identify and emphasise affordances using task constraints*

According to Tan, Chow, and Davids (2012), without the exaggeration of affordances through constraints, learners become less aware of opportunities and 'blindly' search for solutions. The task constraint of having fewer fielders in the modified

game narrowed my search and made me more aware of the affordance of space. This allowed me the opportunity to solve the tactical problem by playing deliveries into the space between fielders and running a single.

**b Design representative and variable practice environments**

The modified game was an example of representative practice, because it incorporated the key elements that a batter would see and respond to in a game of cricket, such as a bowler, fielders, a batting partner and a game context. These elements must be present to facilitate the learning of skills and so that they can be successfully transferred from practice to competition (Renshaw *et al.* 2010). For example, practising against a bowler allowed me to learn to coordinate my batting action in response to information I perceived from the bowler's action. This relationship is known as perception–action coupling (Gibson, 1979). The presence of fielders allowed me to learn to detect the affordance of space required to successfully score a single (Fajan *et al.* 2009). The ability to coordinate actions with perceptions and detect affordances does not develop automatically (Amezdroz *et al.* 2019). Therefore, the more I practise in representative environments with key information present, the better I will become in these areas.

The presence of key information in the modified game allowed me the opportunity to develop the principles of decision making (Hopper, 2003). Batting against a bowler allowed me to practice reading the cues of the bowler and the ball's flight to anticipate the delivery (read), and to move into position early to play a shot (respond). The positioning of fielders allowed me to explore the most appropriate shot to use to play the ball into space (react). Finally, after executing a shot, I moved into position to run a single with my batting partner (recover).

In the modified game, I faced a variety of bowlers. This meant that I had to adapt my batting technique to many different bowling speeds and delivery angles. Even though I found this difficult, in the long term it will allow me to more easily adapt to a variety of bowlers in the actual game. Research has conclusively shown that varied practice results in better skill transfer to the game than constant practice (Amezdroz *et al.* 2018).

**c Match task complexity to the ability level of the learner**

The task constraint of having fewer fielders increased the amount of space on the field. This made it simpler for me to place the ball away from fielders to allow me to run a single. The shorter bowling run-ups resulted in slower bowling. This is an example of task simplification, as the slower bowling allowed me more time to choose and execute the appropriate shot to place the ball into space. Practising my whole batting technique in this simplified practice environment, rather than breaking it down into parts, allowed me to learn to time and coordinate my batting with the bowler's action (Amezdroz *et al.* 2018).

**d Facilitate implicit learning**

My most effective batting technique to manoeuvre the ball into space was allowed to implicitly emerge through interactions between:

- my ability to coordinate my body movements with the flight of the ball (individual learner constraint)

- the task of scoring as many runs as possible from a limited number of deliveries (task constraint), and
- the slowness of the wicket (environmental constraint).

Focusing on the result of the movement minimised the conscious control of my body segments (Amezdroz *et al.* 2018). This enabled my body to work out the appropriate wrist, elbow and shoulder movements, along with the bat angle and body position to manoeuvre the ball into space. Research has shown that instruction that minimises conscious control of movement leads to superior skill performance and learning (Masters and Poolton, 2013).

**11 Evaluation of personal performance**

I have selected the body and movement concepts of quality of movement and relationships as criteria to assess my personal performance as an opening batter. The quality of my movement has developed, to allow me to effectively demonstrate the movement strategy in an authentic performance environment. I can effectively move my body into the best position possible to play a front-foot or back-foot shot accurately into space to allow me time to run a single.

**Figure F6** This image demonstrates my ability to effectively play a square drive.

As shown in video footage, when I face a full-pitched delivery aimed at my pads, I step forward and across the crease to play an on drive. In sequence, my trunk, shoulders, elbows and wrists move to accurately control the bat, so that when I hit the ball it travels in the desired direction between the on-side fielders. The efficiency, timing and sequencing of these movements allows me to give enough force to the ball with minimal effort.

My ability to effectively place the ball between fielders is somewhat inconsistent over an entire innings. However, throughout an innings I am capable of effectively demonstrating a variety of specialised movement sequences, such as back-foot drives and front-foot drives to execute the desired movement strategy.

To play a shot that accurately places the ball between fielders, I must be able to effectively apply the body and movement concept of relationships to my batting performance. The video shows that I interact with bowlers to read their cues, and I interact with the ball to read its flight path, allowing me to anticipate the line and length of a delivery. This relationship is important, as it enables me to get into position early, giving me time to decide what shot to play and then to carry out my decision effectively, in this case, to play a square drive (Figure F9).

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# 4 EXPLORING ETHICS AND INTEGRITY

**Figure 4.1**
Ethics and integrity are essential in fair play.

Every sport has rules, but why do we follow them? One reason is just to be practical; we follow the rules to play 'properly'. Another reason is ethical; we follow the rules because it's the right thing to do. Ethics is an important factor in sport and physical activity. It includes principles such as integrity, values and the importance of fair play. Having a sense of ethics also helps us deal with ethical dilemmas in sport and physical activity.

In this chapter, you will recognise and explain concepts relating to ethics and integrity. You will examine the concepts of integrity and values, and consider how these affect fair play in sport. And you will investigate external influences on sport, and consider how these can lead to ethical dilemmas.

## KEY QUESTIONS

**4.1** How do we recognise ethical dilemmas in sport and physical activity?

**4.2** How do ethical actions shape fair play?

**4.3** Why is integrity fundamental to sport?

**4.4** What external factors create or influence ethical dilemmas in sport?

## YOUR CHAPTER PLAN


4.1 Ethics and ethical dilemmas

4.2 Fairness and fair play

4.3 Integrity

4.4 External influences on games and sports

Chapter review

# 4.1 Ethics and ethical dilemmas

## Ethics and morals

The terms **ethics** and **morals** are often used interchangeably. The two concepts are not identical, but they have strong connections to each other.

Ethics are a set of principles, rules and **norms**. These might be personal or professional – you often hear of 'business ethics' or 'political ethics'. Ethical principles usually come from an external source, such as a code of conduct. Morals refer to a person's own beliefs and the actions they take based on those beliefs. Morals are personal, although they might be heavily influenced by external sources, such as someone's religion.

Together, ethics and morals help us to determine acceptable behaviour and ideas of what is right and wrong. We learn what is considered right and wrong, in life and in physical activity, by observing the behaviour of others, such as our peers, family, coaches, school and the community.

Morals and ethics have a lot of overlap – we often see ethical behaviour and moral behaviour as the same thing. In some cases, though, there can be a clash between the ethics of two possible courses of action, and you need to work out the right thing to do. These situations can be called ethical dilemmas.

**ethics**
a system of principles and rules of conduct

**morals**
personal actions and beliefs with respect to conduct

**norms**
society's accepted standards of behaviour

## Values

Your **values** are your central beliefs about what is most desirable in life, and these also affect your ethics and morals. Values help guide your decisions, behaviour and actions, because you prioritise the things you consider most important. Some values that you may see people demonstrate, especially in a sporting context, are such things as honesty, discipline, patience or compassion.

You develop your values from your own interaction and learning in particular social and cultural contexts. Your values are what give you your sense of right and wrong. These values act as a foundation for ethical behaviour.

There are two key characteristics which are particularly relevant to understanding conflict and ethical dilemmas, which can frequently arise in physical activity.

- How you act or behave is influenced by your **value system**. A value system, for example, might determine whether you decide to cheat or not. A value system reflects what priority you give to different values.
- You also need to understand your **value structure**, which is how compatible your values are with each other. Your value structure also means whether you have particular values that can reduce conflict.

As individuals, we each form our value systems from social interaction and experiences. Peers, family, coaches, school and community all play key roles.

The ethical values of individual athletes and teams are also affected by coaches, the policies of sporting clubs or bodies, and individual and team behaviour. All of these factors teach a system of ethical values to athletes.

**values**
beliefs about what is important or desirable

**value system**
the relative priorities that you give to different values

**value structure**
how compatible your values are with each other

**Figure 4.2** Effective relationships between athletes and coaches play a key role in the development of ethical values.

## Ethical dilemmas

**dilemma**
a difficult or complex situation in which the way forward is not clear

Every day, you make small ethical decisions. However, you can unexpectedly face a **dilemma** that is ethically challenging. In these situations, you may not immediately know what is the correct or most appropriate action to take.

Play by the Rules is a sports education and governance program run by Sports Australia and the sports and recreation departments of every state in Australia. It says this about ethical dilemmas:

> *In sport, where performance, ethics, values, principles and morals collide on a regular basis, making the right decision is not always straightforward. Ethical dilemmas and choices often exist in 'grey areas' – where right and wrong are not so clear.*

Play by the Rules
http://mea.digital/qpe34_2

For example, there can be an ethical dilemma around the sponsorship of sports teams. Teams need sponsorship funds for equipment, uniforms and transport to games, but should they accept money from problematic sponsors, such as venues that have poker machines? There isn't an obvious right or wrong answer to that question, and people will have different opinions.

When faced with an ethical dilemma, you need to make decisions about how the dilemma can be resolved. The basis of ethical decision-making is choice and balance, involving three areas of consideration.

- Personal gain: are you benefiting at the expense of another?
- Everyone, everywhere: what would the world be like if everyone behaved like this?
- Self versus others: is this behaviour aligned to the group or team values?

Throughout this chapter and the next, you will learn to recognise and investigate some of the factors that contribute to ethical dilemmas, as well as the principles that we want to uphold when addressing these dilemmas.

# Ethics in sport and physical activity

Ethics and ethical dilemmas are relevant in all parts of our lives, including the sports we watch and play. Ethical values form part of the character and integrity of players, and influence how they engage in physical activity. They also shape the attitudes of spectators and supporters, and their communities.

In the last decade there have been some major examples of ethical dilemmas in sport in Australia. These dilemmas involve players and spectators, various sporting bodies, and other **stakeholders**, such as officials, administrators and sponsors.

**stakeholder**
someone who is affected by an issue

Some of the general areas of ethical concern in sport include:

- doping for improved performance
- on-field violence
- 'sledging', racism, sexism and homophobia
- on-field behaviour towards officials
- off-field behaviour in relation to gender, sexuality and sexual assault, substance abuse and recreational drug use, and violence
- institutional fraud
- cheating
- gambling, betting and match-fixing
- coaching and management practices.

**Figure 4.3**
On-field violence between players can be an ethical concern in sport.

Unethical behaviour doesn't happen just because an individual makes a bad decision. In sport, there are pressures both from and towards different groups – participants, spectators, supporters, administrators and officials – that make it harder to maintain ethical behaviour. Some of the pressures become clear when you consider questions such as:

- Is there too much emphasis on competition and winning in games and sports?
- How can we make sure that competition is fair?
- Should there be any differences in how male and female players are treated in games and sports?
- Should performance-enhancing substances or technologies be permitted in games and sports?
- Should we favour participation over performance?
- How does commercialisation affect games, sport and physical activity?

## Check your understanding 4.1

1. Explain what is meant by the term 'ethics'.
2. Describe the tensions that may create an ethical dilemma.
3. Explain how your values support you in recognising and analysing ethical dilemmas.

**Figure 4.4** Pressure from spectators and supporters can contribute to unethical behaviour.

## Apply and analyse
distinguishing values

LEARNING EXPERIENCE

KEY OBJECTIVES
1, 3, 4

Questionnaires such as this are useful tools for gathering primary data for your investigation–report assessment.

1. Rank each of the values listed in the table based on how important they are to you personally. Rank them from 1 (not at all important) to 5 (extremely important). Be honest in your rankings.
2. As a class, collect everyone's responses. Add the rankings together for each value, then divide them by the number of students to find the average response.
3. Discuss the results as a class. What might it mean if individuals have responses that are significantly different to the average response?
4. Identify what actions players might take in a performance environment that would display each of these values.

| Value | Description | Importance | | | | |
|---|---|---|---|---|---|---|
| Being fair | I am fair and don't cheat | 1 | 2 | 3 | 4 | 5 |
| Companionship | I am there with my friends | 1 | 2 | 3 | 4 | 5 |
| Compassion | I am concerned about the people around me in my sport | 1 | 2 | 3 | 4 | 5 |
| Conformity | I try to fit in with the group | 1 | 2 | 3 | 4 | 5 |
| Conscientious | I am reliable and give 100% when playing or competing | 1 | 2 | 3 | 4 | 5 |
| Contract maintenance | I don't spoil the game or competition | 1 | 2 | 3 | 4 | 5 |
| Enjoyment | I enjoy myself and have fun | 1 | 2 | 3 | 4 | 5 |
| Health and fitness | I get fit and healthy through sport | 1 | 2 | 3 | 4 | 5 |
| Obedience | I do what I am told | 1 | 2 | 3 | 4 | 5 |
| Personal achievement | I put in the best performance I can | 1 | 2 | 3 | 4 | 5 |
| Public image | I like to look good to others | 1 | 2 | 3 | 4 | 5 |
| Self-actualisation | I get a buzz or feel really good when playing | 1 | 2 | 3 | 4 | 5 |
| Showing skill | I do the skills or techniques well | 1 | 2 | 3 | 4 | 5 |
| Sportsmanship | I am well mannered, play with honour, and think it's important to play by the rules | 1 | 2 | 3 | 4 | 5 |
| Team cohesion | I lift the team when things are difficult | 1 | 2 | 3 | 4 | 5 |
| Tolerance | I try to get on with other people in my sport, even if I don't like them | 1 | 2 | 3 | 4 | 5 |
| Winning | I like to win or beat other people | 1 | 2 | 3 | 4 | 5 |

Source: Adapted from Whitehead, J, Telfer, H and Lambert, J, 2015, ***Values in Youth Sport and Physical Education***, Oxfordshire: Routledge

# 4.2 Fairness and fair play

Sport Australia has identified four characteristics that it considers vital to the future of Australian sport, going as far as to name them 'the essence of Australian sport'. These are:

- fairness
- respect
- responsibility
- safety.

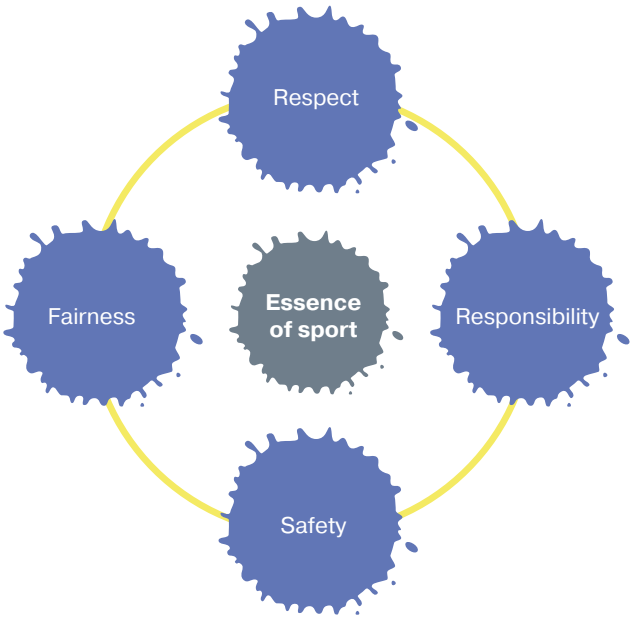



**Figure 4.5** Four characteristics make up the essence of Australian sport.

These characteristics also describe how to judge ethical actions in sport.

- *Fairness* means that we should function within the spirit of the rules of games, never taking an unfair advantage and always making informed, honourable decisions.
- *Respect* means that we should recognise the contribution that people make to sport, treating them with dignity and consideration, as well as caring for the property and equipment they use. We should also respect the rules of the game, its participants and the game itself.
- *Responsibility* means that we should take responsibility for our own actions. We should always be positive role models for others.
- *Safety* means that we should encourage healthy and safe procedures, preventing and reporting dangerous behaviour, while demonstrating concern for others.

While all of these characteristics are important, fairness is particularly significant, because it feeds into the concept of fair play.

## What is fair play?

All sports have rules about such things as how the game is played, the number of players allowed and the equipment to be used. The aim of rules is to produce a fair and even contest. But the concept of **fair play** means more than just following rules; it aims to make sure the game is a worthwhile activity for everyone involved.

**fair play**
fairness, justice and respect in sports and games

The International Fair Play Committee recognises and promotes eight key aspects of fair play:

- respect: showing respect for the sport, the players, the 'spirit' of the game and yourself
- team spirit: seeking victory for the entire group, not just one player
- equality: competing on equal terms
- integrity: playing within a sound ethical framework
- solidarity: supporting teammates
- tolerance: both accepting others and accepting decisions
- excellence: striving to be the best you can be
- enjoyment: playing sport because you enjoy it.

## Formal and informal fair play

In some activities and situations, fair play is formalised and made part of the rules; in other cases, it is informal.

- **Formal fair play** involves conforming to the rules of the game or competition. All sports have processes to enforce formal fair play, such as penalties for breaking the rules, excluding repeat offenders, and suspensions, fines and bans for serious cases.
- **Informal fair play** involves more than just playing by the rules. It considers a player's attitudes towards the game, teammates, opposition, referees and spectators. Informal fair play includes things like shaking hands with the opponent or officials, owning fouls, and giving the ball back when a change of possession occurs.

**formal fair play**
conforming to the rules of a game or physical activity

**informal fair play**
displaying positive attitudes towards a game and those involved

Because aspects of informal fair play are usually not specifically controlled by rules, they are harder to enforce. Therefore, it is easier to take advantage of opponents by ignoring informal fair play.

## Gamesmanship

**Gamesmanship** is when players do not break the rules, but they push the boundaries of what is acceptable to gain an advantage over their opposition. It includes actions such as:

**gamesmanship**
gaining an advantage using questionable means, but without breaking any formal rules

- faking an injury
- distracting a referee
- delaying tactics
- 'psyching out' an opponent.

Actions such as these violate the spirit of informal fair play, even if they are not against the written rules.

**Figure 4.6** When you carry out informal fair play, you show that you respect the game and those involved.

Gamesmanship often results from a 'win-at-all-costs' attitude, where players will bend the rules to gain a competitive edge. Individuals who indulge in gamesmanship value winning more than they value how the game is played. This can lead to an ethical dilemma for players, coaches and even audiences – is it acceptable to violate the spirit of fair play if it helps you or your team to win?

The point at which behaviour in a game of sport moves from acceptable to unacceptable can change with the circumstances. The type of sport, and the level and the location of the game can all influence what is considered acceptable. For example, players are likely to behave differently in a mixed social basketball game compared to an NBA playoff game.

## Check your understanding 4.2

1. Clarify how fair play is linked to ethical behaviour.
2. Describe the concepts of formal and informal fair play.
3. Explain how gamesmanship can cause or complicate an ethical dilemma.

# 4.3 Integrity

According to the International Centre for Sporting Security (ICSS), **integrity** is the single most fundamental value in sport. The ICSS suggests that without integrity, competition is meaningless.

Integrity means fair and honest performances and outcomes, free from external interests, without players seeking to gain a competitive edge through illegitimate means. When players act with integrity, the reputation of the players and the team, the sport's institutions and the sport itself are enhanced.

**integrity**
honesty and soundness of moral principle and character

## Personal and sporting integrity

Before discussing integrity in sport, we should start by considering integrity on a personal level. What does it mean for a person to 'act with integrity'?

A person with integrity does what they say they will do, in accordance with their values, beliefs and principles. You show integrity when you show respect for yourself and others, and accept moral responsibility and accountability for your actions.

**Figure 4.7**
Integrity is made up of three factors.

You can consider sporting integrity as also having three sources. These are the ethics of:

- the participants in the sport
- the sporting institutions who control the sport
- the sport itself.

The interplay of these three ethical sources shapes our concept of sporting integrity.

University of Queensland's Centre for Sport and Society
http://mea.digital/qpe34_3

## Integrity and community confidence

When all the stakeholders in a sport (including athletes, administrators, officials, supporters and institutions) show integrity, they promote community confidence in that physical activity. Stakeholders demonstrate integrity when they encourage fair and honest performances and outcomes, and when they work to ensure that results are not affected by prohibited substances such as performance-enhancing drugs, or by outside influences such as match-fixers.

Community confidence, in turn, promotes positive engagement by participants, administrators and officials, as well as supporters and other stakeholders, such as sponsors. We are more likely to be positively engaged with sports that show integrity.

Research indicates that ethical behaviour in five main areas promotes positive engagement in competitive sports:

- sports managers, officials and coaches: these people have to serve sports while keeping in mind the best interests of the athletes and institutions they represent
- athletes: this group must show discipline and ethical actions that contribute to personal development, which reinforces performance excellence
- the sports environment: the ceremonies and competition of sports should encourage more participants and increase people's loyalty to the sport
- the age group or sporting level: sports need to offer both social and competitive opportunities to young players, so they can broaden positive engagement, support and interest
- sporting institutions: organisations who run sports should provide reviews, checks and balances to reduce unethical behaviour.

**Figure 4.8** Junior leagues build engagement with sports by supporting and teaching young players.

However, despite the importance of integrity in sport, human nature often drives players or teams to gain a competitive or financial advantage. When this behaviour crosses the line of what is considered fair and honest, the reputation of those involved is often diminished, and community confidence and interest in the sport are diminished.

The integrity of a sport comes into question when, for example:

- rules are broken
- athletes don't play in the spirit of the game
- the sport becomes driven by commercial interests
- cheating occurs.

In 2010, a survey titled '*Ethical and Integrity Issues in Australian Sport*' looked at a range of different sporting environments and found that engagement in sport was reduced by such factors as:

- athletes going beyond the spirit of the game
- verbal abuse
- athletes being pushed too hard by coaches or parents
- negative behaviours or practices by coaches, administrators or officials.

Sports and physical activities need to be fair, reputable and enjoyable if people are to engage with them positively, as participants, spectators or passionate supporters.

## CASE STUDY

**SECONDARY DATA**

This case study provides an example of how actions that damage the integrity of a sport can reduce public trust and engagement.

### Turf: Putting integrity ahead of popularity

Racing has been galloped on from within. Skin and flesh has been ripped back to the bloodied bone. Self-inflicted hurt and humiliation. Racing, it seems, breeds traitors as regularly as mares drop foals.

From the cobalt scandal in 2017 that ripped some careers to bits as utterly as a losing punter tears up a worthless ticket. To Group I trainer Robert Smerdon and his sophisticated race-day treatment scheming and now the arrest of Darren Weir, the country's most successful trainer.

Police released Weir and two other licensed men yesterday afternoon pending further inquiries after assistant commissioner Neil Paterson said the searches found four jiggers (taser-like instruments), an unlicensed firearm and cocaine. Included in the investigations are possibly animal cruelty breaches and conduct that would corrupt a betting outcome.

Racing has brought on temptations to cheat like never before. Racing in NSW has introduced The Everest sprint, which is planned to be worth $15 million in 2020. Victoria has replied with the innovative All-Star Mile, with prizemoney of $6m making it one of the richest 1600m races on the planet.

Racing romances the public with the likes of Black Caviar and the world's best mare Winx. Their invincibility enhanced by the setbacks they have overcome. Their resilience makes the heart beat faster, but so much fonder too.

Yet racing is a much diminished sport that no amount of prizemoney can restore. It has slipped from interest as the public has access to so many other sports and scandals as rich as those highlighted yesterday cheapen the gallops.

If those involved in racing don't respect the sport and its business, why should others bother? Well, in truth they don't.

It is why Racing Victoria is both brave and correct as it so willingly exposes the imperfections, the gross dishonesty that can thrive in the murk of early morning trackwork and locked stable doors.

Racing Victoria's chief executive Giles Thompson operates quietly and without fuss. A former Betfair boffin, Thompson has defiantly put the sport's integrity ahead of its popularity and a tarnished name.

The Weir goings-on of yesterday, whether guilty or innocent, hurt racing. The scarring is ugly. The cobalt and Smerdon scandals were inside jobs. Racing got at by its own.

Thompson and his integrity team, headed previously by Terry Bailey and now by Jamie Stier, have proved relentless and effective investigators in a sport too keen to look after their own, it seems, at any cost.

Trainer Darren Weir has been banned from the sport until 2023.

Thompson figures that the sport's integrity is enhanced when it is protected, even if the ramifications are ugly front-page headlines.

He was not with Racing Victoria when the ruling body made such a tepid attempt to punish jockey Damien Oliver for the serious breach of betting on a race in which he rode in 2012. But he watched and learnt.

It is not a short-term fix. Revelations such as yesterday's arrest of Weir, the trainer of Prince of Penzance who won the 2015 Melbourne Cup ridden by Michelle Payne, the first woman to win the most famous race in the nation, stain racing no matter Weir's guilt or innocence. It only reinforces the image of racing: the sport of rorts.

Thompson is backing in that the sport's overall strength and exposure of the traitors will reassure the public that racing doesn't need Winx to take you for the ride of your life.

To continue to do that racing needs to support integrity departments with more money and resources and forget the egotistical chase to stage the richest races in the world. First prize: integrity. And you can't put a price on that.

Source: Patrick Smith, 31 January 2019, ***The Australian***

## QUESTIONS

KEY OBJECTIVES
1, 4, 5

1. Explain what is meant by the sentence 'Thompson has defiantly put the sport's integrity ahead of its popularity and a tarnished name'.
2. Determine how the three different elements of integrity – the ethics of individuals in sport, the ethics of the sporting institution and the ethics of the sport itself – have been compromised in this example.
3. Evaluate the reasons for racing being a 'much diminished sport'. Does this incident affect whether it is seen as 'fair, reputable and enjoyable'?
4. Was the penalty for this incident appropriate and sufficient? Reflect on your response and justify it, if possible using secondary data.

## Check your understanding 4.3

1. Explain how integrity increases community confidence in sport.
2. Summarise why positive engagement in a physical activity by stakeholders enhances the reputation and standing of that activity.
3. Suggest two steps a governing body might take to improve the integrity of its sport.

## Apply and analyse
integrity and FIFA

LEARNING EXPERIENCE

KEY OBJECTIVES
1, 4, 5

Football (soccer) is referred to as 'the world game': it's perhaps the most played sport in the world. However, in recent years, especially at higher levels, the integrity of football and its governing bodies has been called into question.

In 2016, FIFA, the international governing body for football, published a 'Roadmap for the future of football'. This was a statement of FIFA's vision to promote the game of football, protect its integrity and bring the game to everyone. The guiding principles of this vision were transparency, accountability, cooperation and inclusivity.

With this in mind, consider the information presented in Table 4.1, Figure 4.9 and 4.10 (page 100).

**Table 4.1** FIFA income and expenditures 2011–14.

| Income and expenditure | Amount (US$) |
|---|---|
| *Total FIFA income 2011–14* | 5718 million |
| *Key FIFA expenditures 2011–14* | |
| World Cup | 2312 million |
| Funding for member associations and confederations (e.g. FA cup, Premier Leagues, Football Australia) | 598 million |
| Other events | 505 million |
| Football development programs | 454 million |
| Other expenses | 649 million |

Source: FIFA

**Figure 4.9** Many newspaper articles followed the stories of corruption in the 2022 FIFA World Cup bid.

## Qatar 2022 World Cup bid victory was 'completely illegitimate', says new corruption watchdog as FIFA comes under new pressure to investigate claims of payments and dodgy deals

- **Foundation for Sports Integrity makes the claim in report on Qatar 2022 bid**
- **They allege millions of pounds were paid to FIFA executive committee members**
- **Argentine chief Julio Grondona allegedly received a £3.6m mystery payment**
- **The Foundation described Qatar's 2022 win as 'completely illegitimate'**

By ADAM SHERGOLD FOR MAILONLINE
**PUBLISHED:** 20:40 AEDT, 29 May 2018 **UPDATED:** 20:40 AEDT, 29 May 2018

Source: Adam Shergold, 29 May 2018, *Daily Mail*

**Figure 4.10** A news report suggests that the recently revised FIFA code of ethics could be considered unethical in its own right.

## Keep bribes quiet for 10 years, FIFA won't punish you

Posted 14 Aug 2018

**FIFA has officially eradicated corruption.
All it took was pressing the delete key.**

Soccer officials and players who bother checking out the new code of ethics governing their conduct will find the word 'corruption' missing. They also will discover how to avoid being banned for paying and receiving bribes.

Corruption was scrubbed as an official misdemeanor during secret meetings where executives executed the first overhaul of the code since a wave of scandals left soccer's governing body "clinically dead" by 2015

Source: Rob Harris, AP News, 14 August 2018
© 2018 AP via AAP

### QUESTIONS

1. Analyse how the reputation of professional football has been affected by recently uncovered lack of integrity from players and officials.
2. Consider your own attitudes towards football. Decide how this information influences your attitudes towards the game. Comment whether you are more or less likely to engage with football after reading this information.
3. Suggest why FIFA published their 'Roadmap for the future of football'. Explain your reasoning.
4. Predict whether the 'Roadmap for the future of football' will be effective in improving the integrity and reputation of professional football.

# 4.4 External influences on games and sports

As you saw earlier, community confidence in sport and physical activity promotes positive engagement with those sports. However, the 'community' engaged with a sport may be much more than just local players. Fans, players from other competitions, sponsors, media companies, governance bodies and other stakeholders also have an interest; someone on the other side of the world may care deeply about a sporting event happening in Brisbane or Sydney.

Because so many individuals and organisations may be stakeholders, there can be significant outside influences acting on a sport and those playing or watching it. Whether positive or negative, these influences can affect or cause ethical dilemmas around a sport – but they can also help to address those dilemmas.

## Governing bodies

Governing bodies are organisations set up to manage particular sports, and they each have **governance** systems. Sporting governance systems include defined values, codes of behaviour, by-laws, rules and policies. These systems support individuals, teams and organisations in keeping sport safe, fair and ethical. They work to maintain ethical values and foster fair play and ethical behaviour in sport, at a class, school and club level. Sport Australia is an example of a sporting governance peak body, as they provide guidelines and principles for sporting organisations to follow in upholding the integrity of Australian sport.

**governance**
management and oversight of an organisation or system

When they discover unethical behaviour in sport, governing bodies need to act with consistency, transparency and accountability. Unethical behaviours include such things as bribery, match-fixing and illegal use of performance-enhancing drugs, which taint the integrity of individuals, teams and even whole sports. When a governing body acts to stop unethical behaviour, it cultivates community confidence in the ethical values of the sport.

The International Association for Athletics Federations (IAAF) is the first governing body to hand over complete control of its integrity programs to an independent governing body, which has its own board members for all decision-making. This governing body, known as the Athletics Integrity Unit, is responsible for fighting all forms of corruption and ethical misconduct within athletics. The Athletics Integrity Unit aims to drive cheats out of the sport and do everything in its power to support honest athletes around the world.

### Codes of conduct

Rules and self-regulation are important factors to support ethical behaviour and fair play, and to combat threats to integrity in sports. Many sporting organisations have their own specific rules and codes of conduct, and they must communicate them clearly if they want to encourage ethical behaviours and fair play.

To be effective, a sporting organisation has to set up clear consequences for breaches to their code of conduct, and apply them consistently and transparently. To maintain the integrity of their sport, they must use resources to continually promote awareness of ethical behaviour to players, coaches and other stakeholders.

**Evaluate and justify**
investigating codes of conduct

1 Research any code(s) of conduct that are available at your school and a local sporting club.
2 Analyse the code(s) of conduct to explain the ethical values they show.
3 Evaluate how the code(s) of conduct would influence the behaviours of a player, coach or spectator.
4 Justify, using your personal experiences, why a code of conduct is not always followed.

**LEARNING EXPERIENCE**
KEY OBJECTIVES
4, 5, 6, 7

# CASE STUDY

**SECONDARY DATA**
This case study provides an example of how a governing body can impact sport integrity by it's own actions.

## Cricket Australia 'partly to blame' in ball-tampering scandal

A scathing review into Australian cricket has condemned a 'winning without counting the costs' culture that left players in a 'gilded bubble'.

The independent report was commissioned by Cricket Australia (CA) after a ball-tampering scandal rocked the Test team in South Africa in March.

The review found that CA was partly to blame, and viewed more widely as 'arrogant and controlling'.

The governing body said it would accept most of the report's recommendations.

The ball-tampering incident shocked Australia and led to 12-month suspensions for team leaders Steve Smith and David Warner, and a nine-month ban for batsman Cameron Bancroft.

It also hastened the departures of coach Darren Lehmann and CA chief executive James Sutherland.

'Responsibility for that larger picture lies with CA and not just the players held directly responsible for the appalling incidents at Newlands [in South Africa],' said the report released on Monday.

The report may fuel calls for the three players' suspensions to be reduced, Australian media reported.

## 'Play the mongrel'

The 145-page review was conducted by not-for-profit organisation The Ethics Centre. Its other findings included:

- that players were frequently pushed to 'play the mongrel', often against their nature,
- they operated in a bubble 'disconnected, for much of each year, from families, friends and the grounding influence of community',
- CA reverted 'to bully tactics or worse, ostracising' when situations went 'against them', according to one unnamed insider.

Among 42 recommendations, the review proposed setting up a new ethics committee and selecting players based on character in addition to ability.

CA said it would accept 34 recommendations and consider seven more. It had rejected one proposal that would excuse players from taking part in T20 cricket.

'We are very committed to moving the game forward and using this review as a platform to do that,' chairman David Peever said.

However, he also described it as 'at times difficult to read and in some instances, difficult to agree with'.

Tim Paine, who succeeded Smith as Test captain, said the players had adjusted their priorities.

'I think, potentially for a little bit, we got a little bit wrapped up in our own self-importance,' he said.

Source: BBC News, 29 October 2018

## QUESTIONS

KEY OBJECTIVES
1, 4, 5

1. Explain what you think was meant by Tim Paine's statement that players had 'adjusted their priorities'.
2. Distinguish reasons for this incident, according to the report commissioned by Cricket Australia.
3. Decide whether you think 'playing the mongrel' is an ethical action in sport. Discuss your response with the class.
4. How effective was Cricket Australia's response to the report? Justify your response, using secondary data as evidence.

## Globalisation and media coverage in sport

National and international sport has become big business, with huge dollars spent on improving the opportunities and chance of success for athletes, teams and nations. According to the National Sport Plan (Sport 2030), the global sports industry is worth over $400 billion a year. In Australia, more than $12 billion is spent on sport each year.

**globalisation** organisations operating or influencing others on an international scale

**Globalisation** of sport is often referred to as 'global sport'. Sport is part of the international economy because of how interconnected the world has become. International sport is continuing to increase, and along with this there is an increase in the number of international governing bodies, media, competitions and money that is made from it. Globalisation and targeted branding have both increased the profile of sport in our daily lives.

Consider, for example, the soccer jerseys of international teams, which are now widely available. A young fan may have never been to Barcelona, or any international soccer game, but they wear a FC Barcelona jersey on the weekend with 'Messi 10' on the back. The globalisation of soccer, including the marketing and branding of the athletes through such avenues as clothing, has made players like Lionel Messi into household names.

**Figure 4.11** The Messi soccer jersey, worn by many young soccer players in Australia, is an example of marketing and branding in global sport.

The globalisation of media is a key factor in global sport. Media is a powerful factor in community, national and international sport. Media coverage has a strong influence on the success of sport at all levels in society. The way in which particular sports, sporting events and athletes are displayed influences what people think about those sports and events.

Role models influence individual ethical values and behaviours at all levels of sport: local, national and international. In particular, the representation of ethical elite athletes in the media can help promote ethical values in sport. A player's contribution to international sport can be judged by how much attention and money they draw to the sport. Those 'global athletes' who draw increased media attention, and often scrutiny, also have a huge influence on local sport.

The media puts out images of sports and athletes that may have particular 'spin'. For example, media may present images that have a social, political or economic bias. The media representation of sport carries messages about the ethics of athletes, teams and particular sports. This messaging influences how individual athletes, sporting teams, countries and cultures are perceived by the public.

## Local community factors

Global influences on sport are strong, but local factors can also be significant. Some local factors are parallel to global factors; sponsorship is one example of this. A major league team attracts multinational sponsors, while a local cricket club attracts local sponsors. However, the local team may still face similar ethical dilemmas about accepting particular sponsors, or about what their sponsors demand in return for support.

Other local factors may be unique to individual communities, such as specific issues of access and equity. For example, imagine there is a community where there are plans to demolish the basketball court and build apartments in its place. This would reduce access to sport for local citizens. City planners and local politicians need to consider many factors when making decisions like this. Such situations can lead to ethical dilemmas – is the influx of money and jobs from the apartment development project more important to the community than young people having sporting and social opportunities from a basketball league?

One factor is so widespread in local communities, it has become almost a global issue. It is the behaviour of spectators at sporting events, and particularly parents at junior events. Many communities find they have parents who abuse spectators and referees, put pressure on children to perform at high levels, and generally reduce the enjoyment of everyone else involved. Some local sporting groups and bodies have developed 'spectator behaviour' programs to try to manage this behaviour.

### Check your understanding 4.4

1. Suggest what influences an athlete to follow the rules and regulations that govern sport.
2. Explain the terms 'globalisation' and 'global sport'. How has globalisation affected ethical values and integrity in sport?
3. Identify and describe a factor in your local community that influences engagement with sport and that might potentially cause ethical dilemmas.

# Chapter review

## Key questions and responses

**[4.1] How do we recognise ethical dilemmas in sport and physical activity?**

What is considered ethical action varies according to individual sports, the stakes of the competition and the values of the sport and players. Ethical dilemmas may arise when these different factors come into conflict. When evaluating the ethics of a decision or behaviour, we must have perspective and consider the context in which the decision was made.

**[4.2] How do ethical actions shape fair play?**

Fair play is a concept that requires players, teams and officials to follow the rules (formal fair play) and values (informal fair play) of sports and physical activities. Formal fair play is easily enforceable with penalties, suspensions and bans for players who break the rules. Informal fair play is harder to enforce and there are players who ignore informal fair play to unfairly gain an advantage. The extent to which players, teams and officials behave ethically and meet concepts of fair play influences the integrity and reputation of a sport.

**[4.3] Why is integrity fundamental to sport?**

Integrity in sport means that results are not affected by prohibited enhancements, such as doping, or outside influences, such as match-fixing. Integrity ensures that fairness of outcomes and performances, accountability and responsibility are evident in sport. When players, teams, officials and institutions act with integrity, the reputation of the players, the team and the sport itself are enhanced. This behaviour, in turn, promotes positive engagement by the community.

**[4.4] What external factors create or influence ethical dilemmas in sport?**

Several different external groups or factors can influence sport and physical activity. Governing bodies regulate organisations, teams and individual athletes to protect the integrity of sport, in part through codes of conduct. The globalisation of sport through the media affects how individuals and communities perceive the importance and integrity of sports and games. Local factors can also affect ethical issues in sport within local communities.

# Exam-style questions

## Section A: Multiple-choice questions

KEY OBJECTIVES
1

**1** Ethics are:
- **a** a guide to living a good life.
- **b** the social influences on our lives.
- **c** a decision-making process about specific issues.
- **d** the reasoning that guides attitudes, behaviours and actions.

**2** Ethical actions are best described as:
- **a** a life well lived.
- **b** determining right from wrong.
- **c** a set of moral, character and integrity qualities informing choice.
- **d** influences on our own individual qualities and choices in physical activity.

**3** An example of formal fair play is:
- **a** serving to the correct court in badminton.
- **b** staying quiet for the opposing player's serve in tennis.
- **c** stopping to check if an injured opposition player is alright.
- **d** not walking across a golf green between the hole and another player's ball.

**4** The practice of trying to gain an advantage through questionable means without breaking the rules is known as:
- **a** integrity.
- **b** sportsmanship.
- **c** gamesmanship.
- **d** informal fair play.

**5** Integrity in sport is best defined as players:
- **a** playing by the rules.
- **b** demonstrating ethics and values.
- **c** demonstrating good behaviour on and off the field.
- **d** demonstrating fair and honest performances, free from external interests or unfair advantages.

**6** When the integrity of a sport is questioned, sport administrators are often quick to react by disciplining those responsible. They do this:
- **a** to improve the integrity of the sport.
- **b** to discourage others from unethical behaviour.
- **c** because community confidence and interest is diminished.
- **d** because of community expectations.

**7** The International Association for Athletics Federations (IAAF) is:
- **a** a governing sporting body.
- **b** a specific rule applicable to athletics.
- **c** also known as the Athletics Integrity Unit.
- **d** responsible for monitoring the integrity of all athletes, in all sports.

8 In sport, purposely breaking a rule with the intention of gaining a competitive edge is:
   - **a** sportsmanship.
   - **b** not a moral offence.
   - **c** something only elite athletes do.
   - **d** a breach to the ethical code of sport.

9 The increase in world interconnectedness is known as:
   - **a** new media.
   - **b** technology.
   - **c** globalisation.
   - **d** sport integrity.

10 Which of the following correctly describes the relationship between globalisation and ethical behaviours?
   - **a** Globalisation has no impact on ethical behaviours in sport.
   - **b** Globalisation can support international efforts to increase integrity, leading to more ethical behaviour in sport.
   - **c** Globalisation only creates more unethical behaviours in sport, due to increased international media coverage.
   - **d** Globalisation influences ethical behaviours at international competition, but has no influence on ethical behaviours at local sporting competitions.

## Section B: Short response questions (150–250 words)

KEY OBJECTIVES
1, 4, 7

1 In 2018, three Australian cricket players were found guilty of ball tampering to gain an advantage in a test match. Cricket's international governing body, the ICC, enforced a one-match ban on one of the players and fined another. However, Cricket Australia imposed lengthy suspensions on all three players. Explain why Cricket Australia imposed such harsh bans on its players.

2 Identify an ethical dilemma that is currently affecting a sport or physical activity in your school or local community. Explain why this situation is causing such a dilemma, and describe the factors that are causing it. Consider and describe the impact this dilemma could have on the integrity of local sport if it is not addressed.

## Section C: Extended response (400 words)

KEY OBJECTIVES
4, 5, 6, 7

The National Integrity of Sport Unit (NISU) provides national oversight on monitoring and coordinating efforts to protect the integrity of Australian sport. Two of the key threats to integrity in sport that the NISU has identified are match-fixing and doping. Suggest another threat to the integrity of Australian sport that the NISU should also focus on, and justify your choice with evidence.

# WORKED EXAMPLE

## Unit 3 investigation–report

**Your assessment for Unit 3, Topic 2 – 'Ethics and integrity', is an investigation–report. In this task you are required to use the stages of inquiry to devise an ethics strategy in response to an ethical dilemma.**

This worked response should help you to devise a strategy in response to an ethical dilemma. Annotations throughout the example explain the subject matter and how to develop your own assessment response. Note that while it works through the process of responding, this is not an example of the final, assessable investigation–report for Summative internal assessment 2.

Your assessment must name the context of the physical activity for both the dilemma and the strategy – class (i.e. your own class), school or community (i.e. the local, national or international community). The sample given in this section is for a class context.

The structure of the response follows the stages of inquiry framework:

It also incorporates the ethical decision-making framework (page 112).

# Planning your investigation–report

## Introduction

The introduction frames the investigation by identifying the ethical dilemma and the physical activity context.

The ethical dilemma that I am investigating involves gender, physical activity and the two co-educational Physical Education (PE) classes at my school.

In our school, male and female students are required to play different sports. The PE faculty's policy is that boys play football (soccer) and girls play netball. These are two physical activities that students must study for their assessment in PE. However, three of the girls in our classes, myself included, play club football outside of school. We wish to play football for our assessment, which would mean playing in mixed teams at school. That change could potentially affect the integrity of the school's sports and assessment programs.

This presents a potential ethical dilemma. In this assessment task, I will design and develop an ethics strategy in response to that dilemma.

**Figure 1** Female students in my school want to play mixed football

## Engage and understand

Identifying and explaining the dilemma and relevant concepts contributes up to 4 marks to your total result.

### 1 Recognise the ethical dilemma

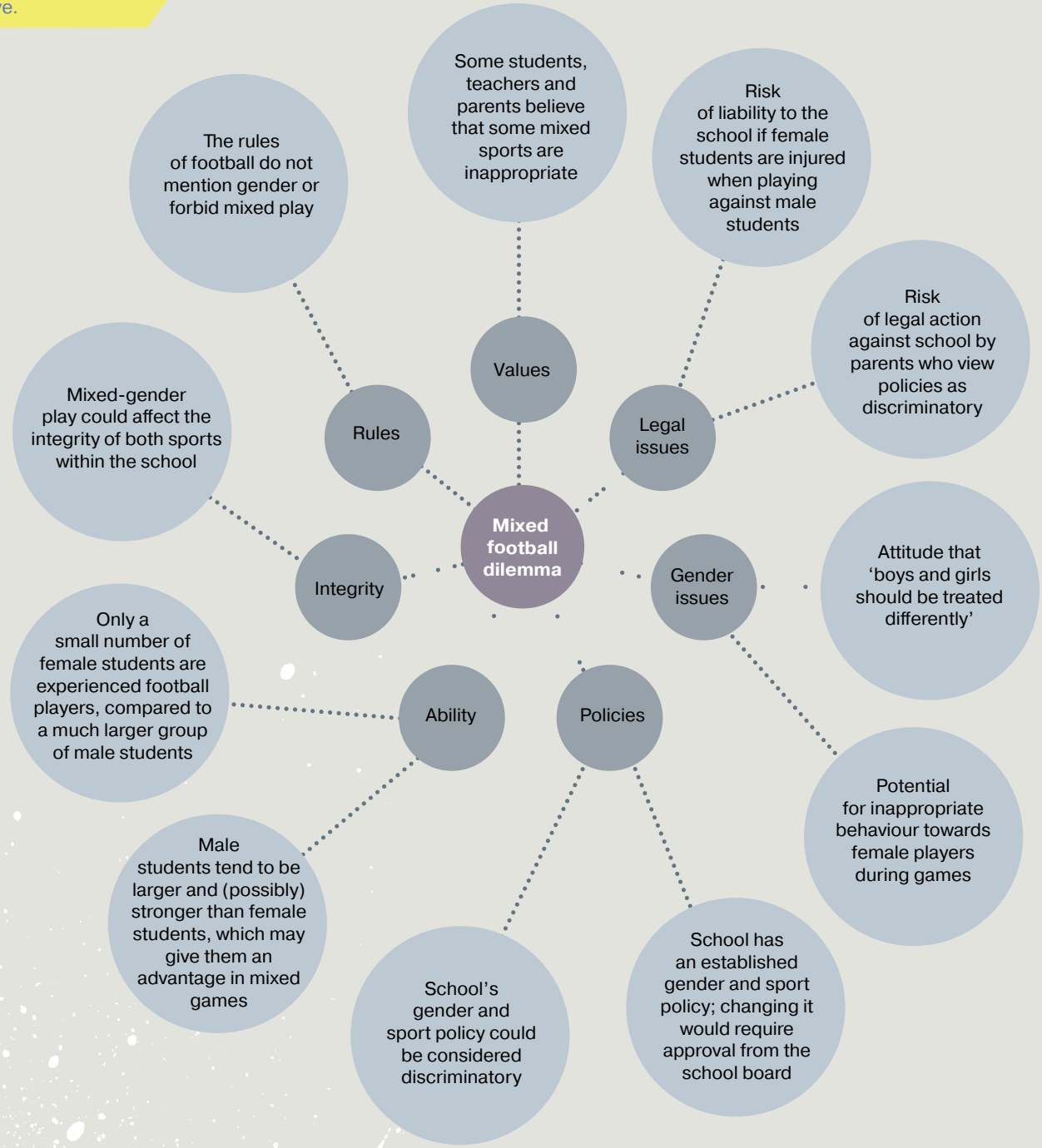
Allowing female students to play football with or against male players is not just an organisational challenge. The proposal has met resistance from multiple stakeholders in the school. This resistance suggests that an ethical dilemma is involved.

Ethical dilemmas: > p. 110

An appropriate ethical dilemma should involve multiple tensions and factors, both positive and negative.

To help recognise the ethical dilemma, I created a mind map and brainstormed tensions that may contribute to the issue.

**Figure 2** Developing a mind map assisted in clarifying the complexity of the ethical dilemma




Out of this brainstorming session, I hypothesised that the attitudes and values of stakeholders are the primary factor influencing the dilemma. Several teachers and students expressed concern with the idea of female players competing against male players, feeling that it is dangerous or 'unfair', and that it will encourage antisocial or sexist behaviour and increase vulnerabilities to injury for female players.

# Apply and analyse

### 2 Gather primary and secondary data

My next step was to gather primary and secondary data. The process I followed to develop my strategy design involved gathering primary and secondary data, then analysing the data and examining the component parts to develop meaning. This gave me new knowledge about the dilemma that I could develop through synthesis and it informed my strategy design about the ethical dilemma.

Sub-headings such as these could be used within the final report.

The primary and secondary data was used for two different purposes:

1. Supporting my hypothesis about the ethical dilemma and getting the facts about stakeholders' concerns. This also ties into the first stage of the ethical decision-making framework.
2. Devising an ethics strategy to address the ethical dilemma and shape a course of action.

Use appropriate terminology for a technical audience, such as hypothesis, synthesis and stakeholders.

For primary data, I interviewed stakeholders about the dilemma and their concerns. I developed a short, anonymous questionnaire (following the guidelines in the Assessment essentials section of my textbook) that asked about attitudes and values towards gender and sport. The questionnaire (shown in Table 1) asked stakeholders to respond to several statements, using a scale of 1 (strong disagreement) to 5 (strong agreement). There were three statements about male and female sport that were framed positively, and three statements about mixed sport that were framed negatively.

**Table 1** Questionnaire on attitudes towards gender and sport

| Statement | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|
| 1 Girls should have the opportunity to compete equally against boys. | 1 | 2 | 3 | 4 | 5 |
| 2 Boys and girls should be able to play different sports. | 1 | 2 | 3 | 4 | 5 |
| 3 Mixed sport is potentially dangerous for female players. | 1 | 2 | 3 | 4 | 5 |
| 4 Boys would act inappropriately towards female players in mixed sports. | 1 | 2 | 3 | 4 | 5 |
| 5 Mixed sport can be equally rewarding for both male and female players. | 1 | 2 | 3 | 4 | 5 |
| 6 Mixed sport is likely to disadvantage female players. | 1 | 2 | 3 | 4 | 5 |

I distributed the questionnaire to all the students in both PE classes, also asking them to give it to their parents to consider to complete; I also gave it to both teachers in the school's PE faculty.

All sources of secondary data need to be included in your references.

My school's PE policy is another source of primary data, as it outlines the school's reasoning for separating the genders for sport, and for labelling soccer and netball 'boys' and 'girls' sports respectively.

I investigated several sources of secondary data, including a number of readings from Google Scholar, online media outlets and reference texts in our school library.

Two of the most useful secondary data sources were articles from the 'Play by the Rules' website: 'Girls Playing in Boys Teams' and 'Support girls to "play up" against boys'. Both these articles examined the issues around mixed-gender teams, and how coaches can support girls who wish to play against or alongside boys.

'Play by the Rules' articles
http://mea.digital/qpe34_IR1

http://mea.digital/qpe34_IR2

Another useful source was Football Queensland's website, and their 'Pathways for Girls' programs. This includes their National Training Centre, where male and female teams compete against each other. This reading strongly supported the course of action I was proposing.

Football Queensland's 'Pathways for Girls'
http://mea.digital/qpe34_IR3

Analysis and synthesis of data contributes up to 6 marks to your total result.

### 3 Analyse primary and secondary data

I received 46 responses to the questionnaire. The results are shown in Table 2, while Figures 3 and 4 present the results as column graphs.

**Table 2** Responses to questionnaire

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|
| 1 Girls should have the opportunity to compete equally against boys. | 5 | 7 | 12 | 15 | 9 |
| 2 Boys and girls should be able to play different sports. | 4 | 6 | 8 | 12 | 16 |
| 3 Mixed sport is potentially dangerous for female players. | 4 | 7 | 10 | 16 | 9 |
| 4 Boys would act inappropriately towards female players in mixed sports. | 3 | 6 | 8 | 13 | 16 |
| 5 Mixed sport can be equally rewarding for both male and female players. | 6 | 7 | 10 | 10 | 13 |
| 6 Mixed sport is likely to disadvantage female players. | 5 | 6 | 11 | 9 | 15 |

**Figure 3** Responses to the positive statements in the attitudes questionnaire

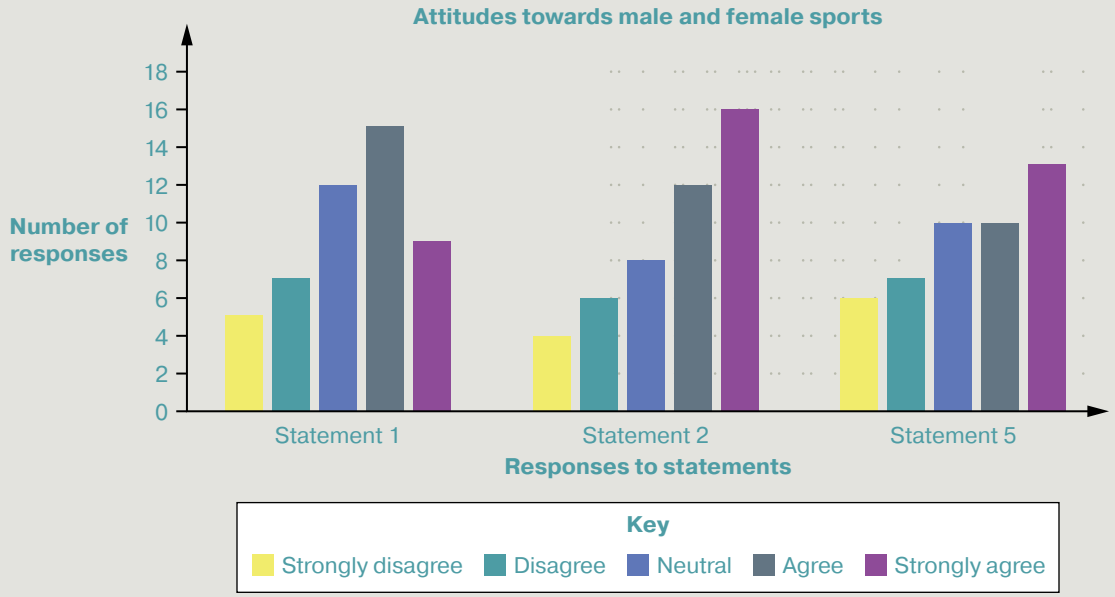
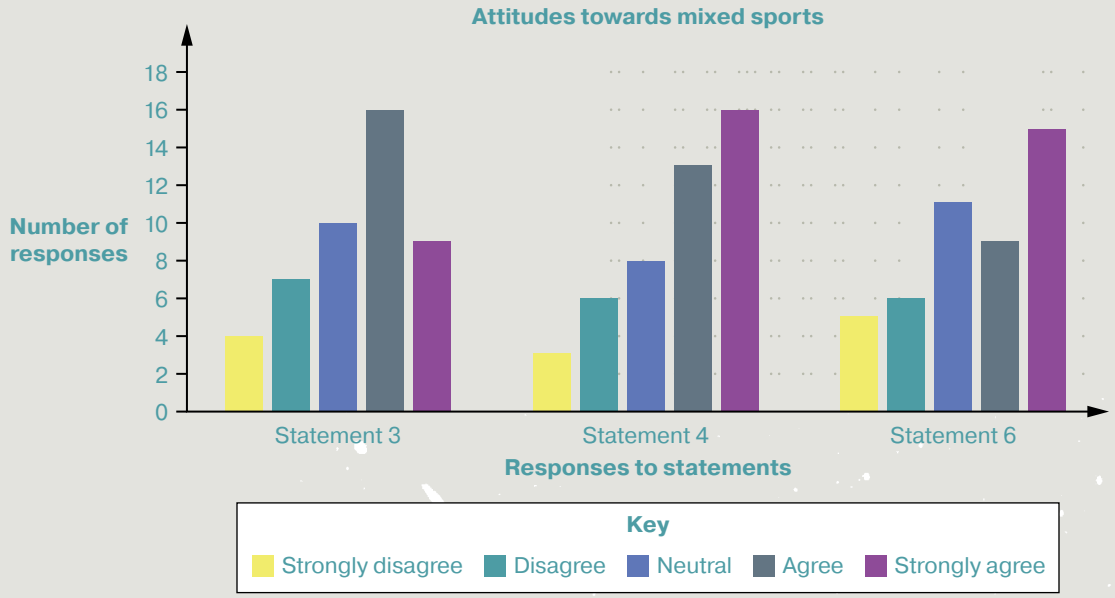



**Figure 4** Responses to the negative statements in the attitudes questionnaire




The data suggests that most stakeholders (teachers and parents) are positive or neutral towards the idea of male and female players playing the same sports, given their responses to statements 1, 2 and 5. However, the majority were negative towards the concept of mixed sport; they mostly agreed with statements 3, 4 and 6, which outlined potential problems with mixed play.

My analysis of the results is that most stakeholders want female players to have opportunities to play the sports they enjoy. However, many of them also believe certain stereotypes and perceptions about both male and female players, such as:

- female players lack the skill to compete against male players
- female players are more likely to be hurt if playing against males
- male players are likely to dominate and not involve girls in the game.

This analysis is supported by the 'Play by the Rules' articles on mixed play. These articles show that stereotypes of female players do affect the beliefs and actions of a significant number of parents and coaches.

Another aspect of my analysis was reviewing the school's PE policy. My conclusion from the analysis is that this policy is not universal, and other schools do not assign gender rules to soccer and netball in the same way. The school's vision of integrity for these sports reflects the stereotypes I have outlined, but these stereotypes are not replicated in inter-school or societal competitions and rules. This means that while changing the policy could be interpreted as challenging the integrity of these sports within my school, it would not challenge their integrity at a larger or more objective level.

Your report must address both fair play and integrity in order to get the highest mark, not just one or the other.

After synthesising the primary and secondary data, and developing new knowledge about the dilemma, I decided that my ethics strategy should focus on addressing stereotypes and perceptions about male and female players, and working to convince stakeholders that mixed sports can be safe, rewarding and positive activities.

However, I also needed to examine my own attitudes at this point, in line with the second stage of the ethical decision-making framework. Are my own biases affecting my decision making? Is my desire to play football at school blinding me to potential problems? To address this possibility, I decided to give stakeholders the opportunity to voice concerns and to question my ethics strategy.

Make sure to refer back to the ethical decision-making framework where appropriate.

### 4 Develop the ethics strategy

I called my ethics strategy 'Combatting gender stereotypes in sport'. The course of action involves four stages, based on my synthesis of primary and secondary data:

1. *Establish an implementation team*. This team involves all of the female students who wish to play against male students, an equal number of male students who are interested in mixed football, and both PE teachers. It's important that this group include Mr Bennett, my PE teacher, who has expressed opinions such as 'football is too technical for girls' and 'boys are more highly skilled', as someone who can voice concerns.
2. *Hold a weekend workshop*. The implementation team will develop a plan and script for a workshop that presents, questions and ultimately negates gender stereotypes in sport. The workshop needs to address both male and female stereotypes. The parents of all PE students will be invited, and given the opportunity to discuss their attitudes about gender and sport.
3. *Play a demonstration mixed game*. Immediately after the workshop, the implementation team will hold a friendly 7-a-side mixed football game, similar to those held by Football Queensland's National Training Centre. The participants in the workshop will watch the game and be given opportunities to act as coaches or referees. The game is intended to be an opportunity to demonstrate to the stakeholders that mixed soccer can be a positive, competitive experience, and to show that the stereotypes that were discussed are not actually reflected in game play.

4 *Hold a follow-up discussion*. Immediately after the friendly game, the stakeholders will be given the opportunity to discuss the match, their expectations of what would occur, the integrity of the sport and how they feel about the gender stereotypes that were examined during the workshop. This discussion should give stakeholders the opportunity to share their attitudes with other stakeholders, not just with the implementation team.

If the strategy is successful, the stakeholders should be more willing to question gender stereotypes in sport and it could reduce their concerns about mixed games. The strategy would then be followed up by a submission to the school board to discuss altering the school's gender and sport policy.

I believe this strategy is ethical, and have examined it against the five criteria of ethical decision-making:

1 It does the most good or least harm, as it does not disadvantage any participants, or put anyone at risk.

2 It respects the rights of all stakeholders, as it gives them the opportunity to express concerns, ask questions and (if they wish) withdraw from the process.

3 It treats stakeholders equally and respectfully, listening to their concerns and giving them the choice of whether to support mixed sport at school in PE classes.

4 It best serves the community and the sport, allowing the students who want to promote mixed football the chance to play the game and to break down harmful stereotypes and perceptions.

5 It leads players to act with integrity, making assessment opportunities equitable, allowing all students to demonstrate and display their abilities to teachers and fellow students during PE classes. It potentially challenges the integrity of sport within the school, but not in a wider context.

These criteria could also be used as part of the evaluation of the strategy.

**Figure 5** This ethics strategy gives students the opportunity to address harmful stereotypes about both male and female players

## Evaluate and justify

Evaluating and justifying your strategy contributes up to 7 marks to your total result.

While I do not need to implement my ethics strategy as part of the assessment report, I do need to provide information on how I would evaluate it if I did implement it.

I would use a logic model to evaluate the impact and effects of the ethics strategy, and to inform my decisions regarding the course of action. My evaluation would help me to refine my strategy, as well as to check the progress of my research and identify potential outcomes, implications and limitations of the ethics strategy.

The intent of the strategy is to advocate for a change to the school's policy on gender and sport, with the aim to enhance positive engagement in PE classes and optimise integrity through the review of discriminatory policy, restricting choice of physical activities based on gender.

### 5 Use a logic model

The logic model applies five steps to the evaluation process.

The first step is to identify the problem. The ethical dilemma being investigated involves the concept of fair play and integrity in relation to mixed involvement in football in the PE classes at my school.

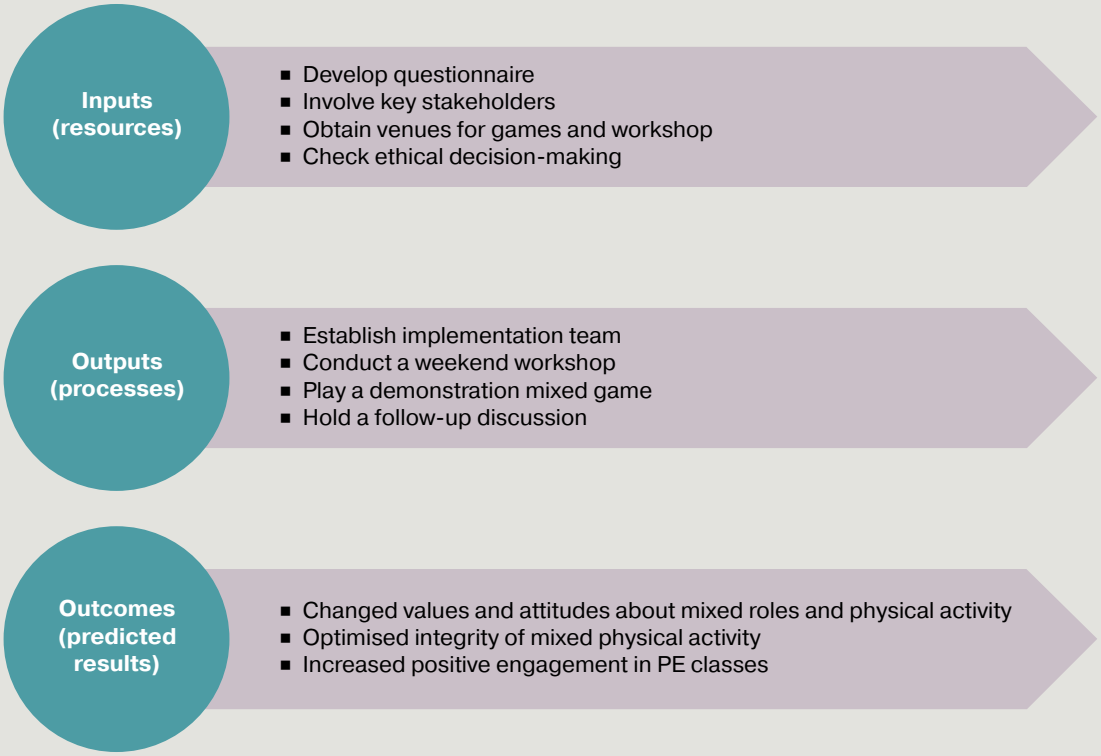
The second step requires me to review the evidence that informs my strategy. This will assist me to justify why I am choosing this course of action. I created a table to help with this stage.

**Table 3** Evidence justifying my strategy

| Strategy – what am I doing? | Evidence – why am I doing this? |
|---|---|
| **Establish an implementation team** | Involve key stakeholders<br>Conduct pre-test questionnaire<br>Gather additional primary data |
| **Hold a weekend workshop** | Investigate values and attitudes about mixed physical activity<br>Gather additional primary data |
| **Play a demonstration mixed game** | Involve key stakeholders<br>Gather additional primary data |
| **Hold a follow-up discussion** | Involve key stakeholders<br>Investigate values and attitudes about mixed physical activity<br>Gather additional post-test primary data using original questionnaire |

The third stage of evaluation involves the development of the logic model. This requires the development of a list of resources, a list of the processes being used and a list of the intended outcomes of the strategy. I arranged these in a graphic organiser to inform my evaluation.

**Figure 6** The resources, processes and predicted results of my ethics strategy




The fourth stage of the evaluation process is to monitor the logic model. This will be done by continually gathering primary data during each phase of the strategy. I intend to gather additional feedback from the implementation team, my peers and teachers, as well as making my own observations.

The final stage of the evaluation involves a review of the entire ethics strategy:

- reviewing the data and what it indicates
- reflecting on observations
- considering ways to enhance or adapt the ethics strategy to suit the class context.

Your evaluation needs to align with your analysis, not your desired outcome. If the data suggests your strategy would not work, respond to the data and adjust your strategy.

## Conclusion

In my conclusion, I will support my course of action in response to the ethical dilemma, using evidence from primary data and secondary data. I will also use this data to evaluate the effectiveness of the ethics strategy, appraising the potential outcomes, implications and limitations of the course of action.

The last part of my report will be a reference list that acknowledges all the data sources I drew on in my investigation.

The final report must include a title page and a table of contents.

The reference list does not count towards the 1500–2000 word limit for the report.

# 5 DEVISING ETHICS STRATEGIES

**Figure 5.1**
Groups such as Play by the Rules create ethics strategies to promote fair play and integrity in sport.

Chapter 4 identified the factors that shape ethical dilemmas. The next step is for you to devise ethics strategies to optimise positive engagement in sport and physical activity. To do this, you need to be able to make ethical decisions, and be prepared to adjust your ethics strategies once you have evaluated them.

In this chapter, you will identify and investigate several significant ethical dilemmas in sport. You will learn how to assess the potential outcomes, implications and limitations of an effective ethics strategy. You will also learn how to generate primary data and examine secondary data to support evaluation of an ethics strategy.

## KEY QUESTIONS

**5.1** How can we make effective decisions to address ethical dilemmas?

**5.2** How do ethics strategies reflect and influence fair play and integrity?

**5.3** What ethical dilemmas occur in relation to gender and sport?

**5.4** What ethical dilemmas occur in relation to ability and sport?

**5.5** What ethical dilemmas occur in relation to technology and sport?

**5.6** What ethical dilemmas occur in relation to corruption and sport?

## YOUR CHAPTER PLAN


5.1 Ethical decision-making
5.2 Ethics strategies
5.3 Gender and sport
5.4 Ability and sport
5.5 Technology and sport
5.6 Corruption and sport
Chapter review

# 5.1 Ethical decision-making

When you are faced with ethical dilemmas, you have to make decisions about how to deal with them. Ethical decision-making means you have to think carefully about a situation, acknowledge your biases and assumptions, and use your ethics and morals to decide on a course of action. You must make a judgment and then act on your decision.

You will need to make ethical decisions as part of your Unit 3 investigation–report assessment. This task requires you to examine an ethical dilemma in a class, school or community context, and to make ethical decisions about how to address that dilemma. As part of your investigation, you need to generate primary and secondary data through observation and research for further analysis and synthesis. You then use this evidence to devise a course of action in response to the ethical dilemma.

This chapter shows the process you will need to follow to successfully complete this assessment. A model of the process is provided after the end of the chapter (p. 140).

## Identifying a dilemma

Ethical dilemmas can happen when you have to choose between actions you believe might both have good points, or even between two actions that you don't like at all, because there is no better option available. For example, an ethical dilemma might involve you having to choose between:

- honesty and loyalty
- the welfare of individuals and that of the community
- short-term benefits versus long-term outcomes.

When you identify a dilemma in sport, you need to ask yourself:

- what is my reason for playing sport?
- what **principles** are most important to me in this dilemma?
- what values do I have in relation to this dilemma?
- what morals, rules, laws and culture are relevant to this dilemma?

**principle**
fundamental truths that determine right and wrong

For example, for many people the key purpose of sport is to win, but how they go about achieving this is also very important.

The choices we all make are a direct result of our own motivations for playing sport, our principles, and our ethics and values, as well as the sport's own rules and culture. Tensions arise when these factors come into conflict.

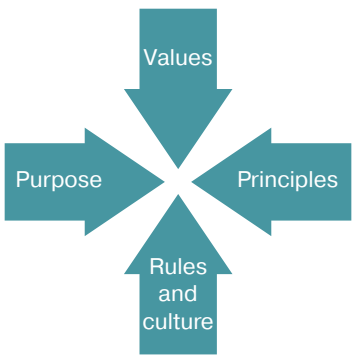



**Figure 5.2** Dilemmas become complex when determining factors interconnect.

The principles of what's fair in sport, playing by the rules and good sportsmanship are very subjective and their meaning constantly changes. This is where the tensions occur.

- Purpose: We all play sport to achieve different purposes. Some play to win and are fiercely competitive, with a 'win-at-all-costs' attitude. Others compete to enjoy the experience, meet with friends and be part of a team.
- Principles: We also have different principles that guide our behaviour. For example, different athletes might put more or less emphasis on such things as playing fair, doing our best, playing by the rules and not causing harm.
- Rules and culture: Each sport has its own set of formal rules that dictate appropriate behaviour. Sports also have their own culture, which is informal but still influences what is seen as appropriate.
- Values: Our values, ethics and morals, which are shaped by complex individual factors, guide our behaviour as well.

Consider a simple example of how a dilemma might occur. During a volleyball game, you launch to block a spike from the opposition. As you block, the ball just tips your left hand then goes out of play. Neither referee sees that you touched the ball. The referee calls the ball out and your team is awarded the point. In that instant, you're faced with a dilemma, and you might ask:

- What is your purpose in playing volleyball?
- What principles are most important to you when you are playing?
- What rules and culture of the game do you respect when playing volleyball?
- What essential values do you exhibit when you play volleyball?

Your values might oppose each other – you have loyalty to your team, but you consider yourself an honest individual. Should you tell the referee you touched the ball?

Some dilemmas can really challenge your ethics and values and make you consider what is the best choice to make. To make an ethical decision, you can use a framework to guide you step-by-step through the decision-making process.

**Figure 5.3** Dilemmas are evident for both players and referees.

# The Ethical decision-making framework

*'We all have choices, we all have decisions to make and whichever choice you make will have ramifications – positive or negative. If you're prepared to make decisions that are incorrect or bad, then you need to be prepared to take the repercussions that come from that'.*

**World champion cyclist Anna Meares**

When you are challenged with making an ethical decision, you are influenced by a range of guiding principles. There are three common concerns that can be used to guide ethical decision-making in all dilemmas in sport and physical activity.

- Consequences: decisions are made based on the consequences for others' positive engagement. Ask 'How will this affect other people?'.
- Principles: decisions should be a matter of principle, not influenced by consequences, and should follow rules. Ask 'What is the right course of action?'.
- Personal values: decisions are made in accordance with one's personal values and morals. Ask 'What do I think is the right thing to do?'.

It is important to remember that an ethical decision does not always make everyone happy.

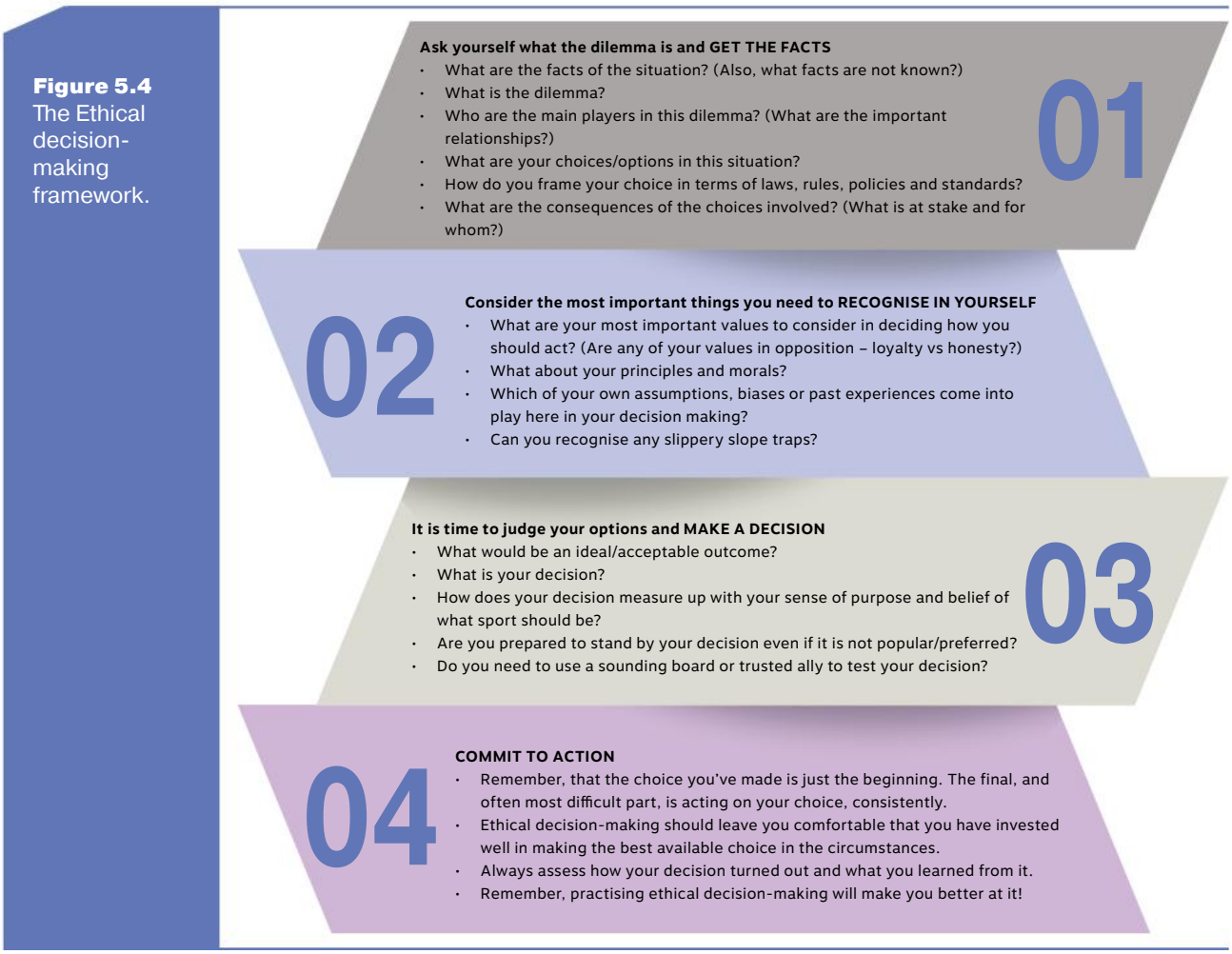



**Figure 5.4** The Ethical decision-making framework.

The Ethical decision-making framework, a tool created by the Play by the Rules organisation, presents four sections that guide our responses to an ethical dilemma and inform a decision. The framework uses an inquiry approach to investigate the dilemma, which can be connected to the similar approach you have followed in your Physical Education studies.

## 1 Get the facts

The first step is to identify the problem by getting all the facts about the dilemma, as well as finding out information that you don't already know. You also need to identify the values of the people involved, as well as the tensions that the dilemma is causing. This may require some research to identify the stakeholders and how they relate to the dilemma.

You should think of this information as primary data, as it's directly related to the dilemma. While this data may not be as concrete and defined as statistics from a GPAI, it's just as meaningful. In addition, you may need to consult secondary data, such as policies, laws, rules and standards.

Some guiding questions to help you collect your data are:

- What's the dilemma?
- What do I already know?
- What information do I still need to find out?
- Who are the stakeholders ?
- What do the rules, laws and policies say? How can they inform my choices?
- What strategies have been used previously in similar situations?
- What are the choices for a course of action?
- What are the consequences for each course of action?

Synthesising this information creates new knowledge about the dilemma. You then need to consider the options there might be before you predict the consequences.

## 2 Recognise in yourself

The second step requires you to consider your values, morals and guiding principles. What values must you prioritise to act ethically? You also need to consider any tensions that might arise from conflicting values, such as loyalty to the team versus personal honesty.

During this process, you need to identify any personal biases or assumptions that you might have made about the dilemma. You might consider how your prior experiences relate to this situation. You can also research other strategies that have been used in response to similar problems in other contexts. This will further help you in developing a response.

Some guiding questions to help you collect your data are:

- Which of my values does this dilemma affect?
- Are there any tensions between my values?
- What principles are involved in this dilemma?
- What biases and assumptions could affect my decisions?
- What past experiences inform my decision?

## 3 Make a decision

The third step requires you to make a decision. At this stage you need to evaluate each of the options to devise an ethics strategy – a plan of action that aims to solve the dilemma.

Your decision must align with your values and what you believe the purpose of sport to be. Remember that you will need to stand by your decision, so you need evidence from your primary and secondary data to support the development of your strategy.

Some guiding questions to help you collect your data are:

- Which course of action will do the most good or the least harm?
- Which strategy will respect the rights of all stakeholders?
- Which course of action will treat stakeholders equally and respectfully?
- Which strategy will serve the community and the sport best?
- Which course of action will lead players to act with integrity?

## 4 Commit to action

The final stage is often the most challenging and difficult step – carrying out your ethics strategy and overcoming any obstacles you encounter. You probably won't make everyone happy by your course of action. However, you can be confident that your choice has been carefully considered and supported by evidence.

Part of committing to action is evaluating the consequences of your ethical action. You should be able to make this evaluation, and justify your course of action, using evidence from your research, including your primary and secondary data.

In summary, in order to synthesise your data effectively, ask yourself:

- What's the problem?
- What are the options?
- What are the possible outcomes?
- What action do I choose to take?
- How did it go?

This synthesis of information will help you create new knowledge about the dilemma, which can then inform your ethics strategy and enable you to take appropriate action.

**Check your understanding 5.1**

1. Explain why there are usually tensions in making decisions about an ethical dilemma.
2. Propose characteristics that would describe an acceptable outcome from an ethical course of action.
3. Comment on reasons why committing to an ethical course of action is often the most difficult step to take.

## 5.2 Ethics strategies

An ethics strategy is a course of action designed to enhance integrity and support positive engagement in sport and physical activity. Ethics strategies can be used to target ethical dilemmas in a physical activity in a class, a school or the wider community. Ethics strategies can influence an individual's and team's integrity, as well as the integrity of the physical activity itself.

Consider the issue of sideline behaviour from spectators, including parents. Poor sideline behaviour can range from putting undue pressure on young people to win, all the way through to physical violence. Contemporary research shows that such behaviour has a significant impact on participation. We also know that parents or guardians have a profound impact on young people's enjoyment and involvement. Often, parents' behaviour on the side lines of the field determines whether their child has a good time playing sport.

By helping parents to be better role models and supporters, we can build nurturing environments for young people to play sport. Ethics strategies such as making parents volunteer as managers, fundraisers or club administrators, act as part of the team or club on game days, or arrange social events, are some courses of action adopted by community clubs.

**Figure 5.5** Community clubs can create and implement strategies to improve the behaviour of spectators and parents.

Another example of an ethics strategy might be having a substitution policy for participants in interschool sport. This substitution policy might say that each player on the team is to receive equal playing time throughout the season. This policy could lead to improvements in a coach's personal responsibility and integrity. Using a policy like this would enhance players' positive engagement, as all players on the team would get equal time in play. This policy therefore supports positive engagement in physical activity.

**Figure 5.6** A substitution policy can enhance positive engagement for players.

A code of conduct is a third example of an ethics strategy. Codes of conduct written separately for players, parents, officials and administrators ensure that everyone understands their particular responsibilities regarding fair play and appropriate conduct.

Consider the following code of conduct for students. How might this code operate within your class context? What changes might you make to this example? How might breaches of this code be treated?

## Student code of conduct

- Play by the rules.
- Never argue with an official.
- Control your temper. Verbal abuse of officials and sledging other players, deliberately distracting or provoking an opponent are not acceptable or permitted behaviours in any physical activity.
- Work equally hard for yourself and your team. Your team and class performance will benefit, so will you.
- Be a good sport. Applaud all good plays by classmates whether they are made by your team or the opposition.
- Treat all participants in your physical activity as you like to be treated. Do not bully or take unfair advantage of another student.
- Cooperate with your teacher, classmates, teammates and opponents. Without them there would be no competition.
- Participate for your own enjoyment and benefit, not just to please parents and coaches.
- Respect the rights, dignity and worth of all participants regardless of their gender, ability, cultural background or religion.

**Source: Adapted from Sport Australia, 2019**

This code of conduct could be implemented in your class. If you recorded compliance and breaches, it would provide an opportunity for collecting primary data.

As part of your investigation–report assessment task, you need to devise an ethics strategy to address the ethical dilemma you have identified. Your aim when devising the ethics strategy is to optimise integrity and positive engagement. You are also required to evaluate and justify the development of the strategy and its effectiveness. You must appraise the potential outcomes, implications and limitations, using evidence from your own primary and secondary data.

## Devising and implementing an ethics strategy

There are three phases in developing an ethics strategy. You can use the inquiry process to guide you through the development.

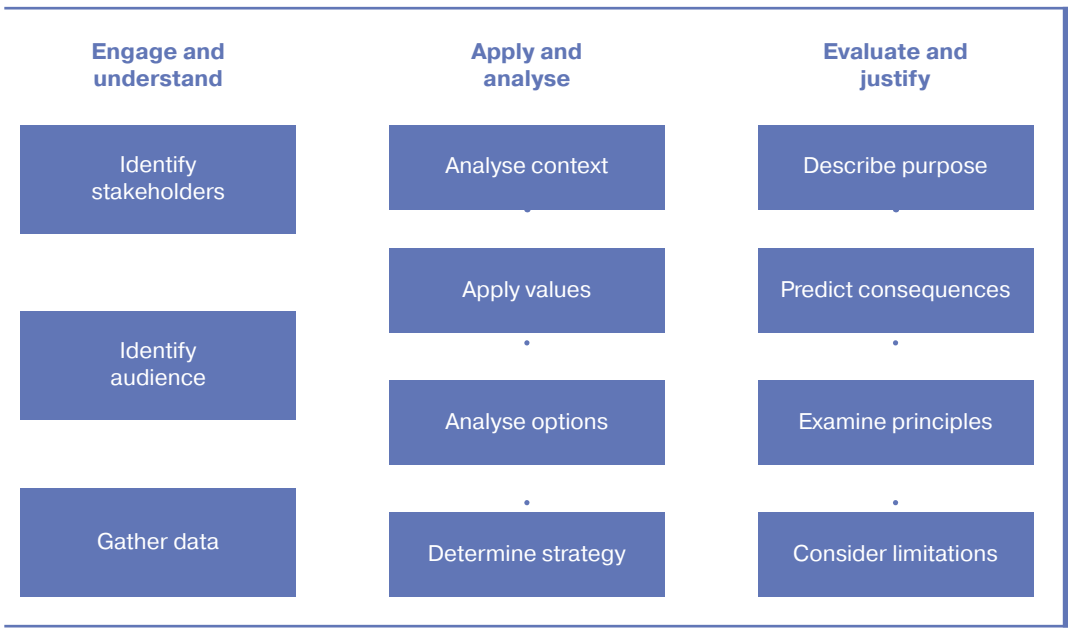



**Figure 5.7** You can use an inquiry process to devise and implement an ethics strategy.

### Phase 1: Engage and understand

In this phase, you need to:

- **a** identify the stakeholders involved in this dilemma, such as the participants and controlling organisations
- **b** identify the audience for the strategy – those people who are likely to see the outcome of the ethics strategy
- **c** gather primary data about the situation.

### Phase 2: Apply and analyse

In this phase, you need to:

- **a** analyse the context of the dilemma, including important relationships that exist
- **b** apply your own values in how you should act, and consider past experiences that might come into play
- **c** analyse all options to predict the most acceptable outcome
- **d** determine an ethics strategy.

It's also useful during this stage to explain your reasoning to a trusted peer. This will help you to further test your decision before implementing your ethics strategy.

### Phase 3: Evaluate and justify

In this phase, you need to:

**a** describe the purpose of the strategy
**b** predict the potential consequences of the strategy and how these may affect other people
**c** examine the principles involved, and how well your strategy aligns with the rules of the game
**d** consider any other implications and limitations of the strategy.

Remember that the purpose of an ethics strategy is to provide a well-considered course of action to enhance integrity and support positive engagement in physical activity.

## Evaluating ethics strategies

While you are developing an ethics strategy, it's vital that you evaluate each alternative strategy and determine whether each is succeeding in its purpose. You need to evaluate each strategy to make decisions about which will:

- produce the most good and do the least harm
- best respect the rights of all involved
- treat people equally or proportionately
- best serve the community as a whole
- lead players to act with integrity.

Data Essentials
UNITS 1+2, p.viii

There are several methods to evaluate an ethics strategy; the one examined here is the logic model described in the Data Essentials section of your Year 11 textbook (p. viii). It has five distinct steps in the evaluation process:

- Step 1: Identify the problem
- Step 2: Review the evidence
- Step 3: Draw a logic model
- Step 4: Monitor the logic model
- Step 5: Evaluate the logic model

The evaluation of a strategy doesn't just happen at the end, but occurs throughout the investigation of the dilemma. This model is most effective when steps 1–3 are implemented at the beginning of the research, while steps 4 and 5 should continue throughout the investigation.

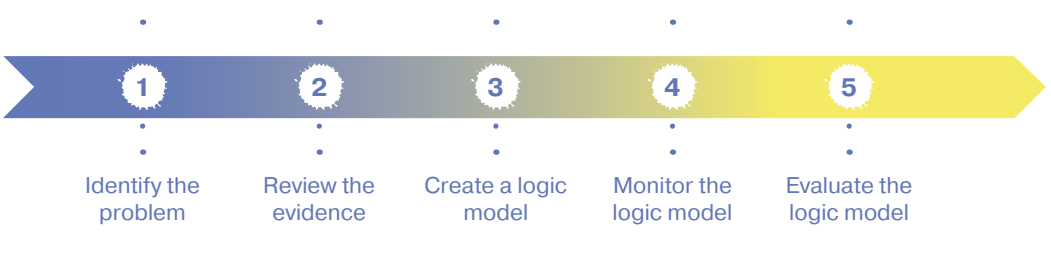



**Figure 5.8** Evaluation of an ethics strategy is a five-step process.

Particularly in step 4 and 5, there are several guiding questions that will help you develop your primary data. Ask yourself:

- What does the data tell me?
- Why am I observing these results?
- How can I enhance the outcomes for all stakeholders?
- Does anything in the strategy need to be changed?

Remember that quality primary data needs to be valid, reliable and unbiased. You may also need some secondary data as supporting evidence, which should come from reports of ethics strategies that have been used previously in response to similar dilemmas.

**Check your understanding 5.2**

1. Explain why you need to consider all stakeholders when devising an ethics strategy.
2. Propose an ethics strategy in response to the ethical dilemma of poor sideline behaviour by parents.
3. Comment on why an ethics strategy needs to serve the whole community and lead players to act with integrity.

## Designing ethical games

**INTEGRATING MOVEMENT**

KEY OBJECTIVES
1, 4, 5, 6, 7

Sample response: pp. 305–307

**Category:** Invasion, Net and court
**Physical activity:** Any

### Purpose

1. To design and implement an ethics strategy for a class, based on the ethical principles of fairness, respect, responsibility and safety.
2. The data collected in this activity could be used to support your research for the investigation-report assessment.

### Preparation

**Time:** three lessons; one to plan the task, one for implementation and data capture, one for data analysis and discussion

**Location:** as required

**Equipment:** digital capture devices, journal, GPAI, other equipment as required

### Setup

1. In this activity you will develop an ethics strategy using various small-sided games.
2. Class numbers will determine the size of the games as well as the number of games developed.

3. Devise rules for these games that specifically support fairness, respect, responsibility and safety.
4. Some points to consider:
   - How will you ensure that the game is fair and doesn't allow participants to take unfair advantage of any of the rules?
   - What values have you considered in developing the game?
   - How will you ensure that players participate within the spirit of the game?
   - How will you ensure that participants are treated with dignity and consideration throughout the process of planning, devising and implementing the game?
   - How will you ensure that participants will take responsibility for their own actions?
   - How will you encourage healthy and safe procedures, preventing and reporting dangerous behaviour, while demonstrating concern for others?

**Performance**

1. Implement your game(s) with participants.
2. Gather video evidence of the game(s) to view and reflect on afterwards, using the tasks below.

**Data recording**

1. Appoint an observer for each game being developed. The observer may wish to capture the development discussions on video, or you could develop a data gathering tool to record the discussion, issues raised and the outcome of the game development process.
2. Individual group members should each use a journal to record their own and others' attitudes, behaviours and choices, as observed in the development of the game.
3. Video each of the games so you can later analyse player attitudes, behaviours and choices.

**Tasks**

Complete these tasks after planning is completed.

1. Explore the process of game development in your small group. How did participants reach consensus about how the game might be performed?
2. Predict the likely outcomes for participants.
3. Comment on any challenges that came up during the game development. Assess how these challenges were overcome.

Complete these tasks after the game has been played.

4. View the video of the game. Discuss how the action of each participant affects:
   - teammates
   - opposition players
   - spectators/observers not playing the game.
5. Assess the success of the small-sided game in having participants to follow the principles of fairness, respect, responsibility and safety.
6. Justify your responses, using data from your journal and the video evidence of your group's participation in the game.

# 5.3 Gender and sport

The remaining four sections of this chapter examine a variety of case studies, providing examples of dilemmas and ethics strategies in school and community contexts. These case studies focus on specific areas that may present ethical dilemmas, the first of which is gender.

Sport often embodies ethical values such as inclusion, respect and fairness. However, the sporting world can promote unethical values and behaviours if it reinforces gender stereotypes. Many ethical dilemmas can emerge from this; the following are just a few examples.

Negative attitudes to women and discrimination against athletes or teams based on gender can threaten the integrity of sport. In 2010, the Australian Sports Commission surveyed more than 3700 respondents (across players, coaches, officials and administrators) about ethics and integrity issues in sport. They judged that 'negative attitudes towards women' was the second most frequent antisocial behaviour that negatively impacts sport.

| Issue | Frequency (%) |
|---|---|
| Overuse or misuse of alcohol | 5.50 |
| Negative attitudes towards women | 5.00 |
| Negative attitudes towards homosexuality | 3.00 |
| Road safety issues | 2.50 |
| Negative attitudes towards men | 1.50 |
| Risky/potentially harmful sexual activity | 1.00 |
| Non-performance-enhancing/illicit drugs | 0.25 |

**Table 5.1** Antisocial behaviours negatively influencing Australian sport.

**Source: Ethical and Integrity Issues in Australian Sport, 2010, Australian Sports Commission**

**Figure 5.9** The offensive responses to this image of AFLW player Tayla Harris showed how common antisocial attitudes can be within sport.

Negative attitudes towards women do not just show up as antisocial behaviour; they can also take the form of not valuing women's contributions to sport. Professional female athletes are often paid less than their male counterparts, or receive less support (financial or otherwise) from sporting bodies. For example, despite significant recent growth in female participation in Australian rules football, AFLW players are paid much less than AFL players, while the 2019 AFLW league competition received less media coverage than the new variation of men's Australian rules football, AFLX.

Governance bodies organise sport using gender groupings to make competitions fair. However, this gendered division can sometimes become an ethical dilemma:

- Should female athletes have the opportunity to compete in male competitions?
- What rules and ethics should govern where transgender athletes play in competitive sport?
- Is it OK to verify a player's gender, and if so, how should it be done?

## Identifying the dilemmas

Negative attitudes to women and women's sport influence fairness, respect, responsibility and safety. Unfortunately, these negative attitudes happen frequently in all parts of society. We need to reflect on how athletes, sporting institutions and spectators should respond to these attitudes in schools and communities.

As you begin devising an ethics strategy, don't forget to consider the following questions:

- What are the consequences? How will this affect other people?
- What principles are involved? What is the appropriate course of action?
- How are your personal values reflected in your behaviour? What do you think is the right thing to do?

The following case study shows how an ethical strategy can be developed and applied in a community context.

**Figure 5.10** Despite a significant growth in AFLW player numbers, womens' sport still struggles for recognition in the media.

# CASE STUDY

## NRL's 'blokey culture' targeted in Club Respect trial at 27 Victorian youth clubs

For the NRL it's been a disastrous off season, with allegations of violence against women reaching crisis levels.

North Queensland's Ben Barba received a lifetime ban after a video emerged of him allegedly assaulting his partner at a Townsville casino during the Australia Day weekend.

St George Illawarra's Jack de Belin has been charged with aggravated sexual assault, and Manly's Dylan Walker faces charges of assaulting his partner.

On Thursday the Australian Rugby League Commission moved to limit the damage, announcing it would stand down players facing serious indictable offences while they were before the courts.

The commission said the new policy would help rebuild the rugby league's tarnished reputation.

Amid this backdrop, a new program is trying to stamp out violent and sexist behaviour before it begins by changing the 'blokey culture' of youth sports clubs.

And it is women who have brought it into play.

Club Respect is being trialled at 27 NRL youth clubs in Victoria.

Using online tools and outreach, it aims to develop a culture of tolerance and respect at the grassroots level and tackle problematic attitudes towards violence against women and girls.

'When there's deep respect, there is no violence,' said Mary Crooks from the Victorian Women's Trust, which developed Club Respect together with violence prevention organisation Nirodah. 'Violent abuse and behaviours take root when there's not enough respect going around.'

At the Eastern Raptors NRL club in Boronia in Melbourne's east, Club Respect has been in place for three years and there is a belief it has had a profound impact.

Coaches and volunteers at the club use the Club Respect tools to address a range of issues, from creating a tolerant and accepting club culture to specific advice for coaches, volunteers and supporters.

Outreach from Nirodah workers has been a key part of the Club Respect program, with in-person instruction helping to change the culture.

'It's given us the tools we need to help interact with the kids,' said club president Trent Ousley.

In training sessions, the adults at the club are taught how to deal with situations ranging from violence, to unruly supporters, to sexism.

The club believes setting an example for young players is crucial, so they observe what is and is not acceptable behaviour.

'We want to create a movement,' said Paul Zappa from Nirodah.

'Imagine clubs where we squeeze out any opportunity for violence.'

## Focus on respecting women and girls

The Raptors have seen a big jump in the number of girls and women playing and in participating as volunteers and coaches since the introduction of the program.

'Respect is very important in this club, like from every age,' said Camille Chamodon, a 25-year-old player for the Melbourne Rebels Women's team.

Ms Chamodon regularly trains with the men at the Eastern Raptors and said the atmosphere was very different from her experience at other clubs.

'If boys and girls are together, play together, train together... that will show that we can live together and build something, that there is no big gap between boys and girls in sport and in life,' she said.

Mr Ousley said a 'cultural shift' had happened, and the message was getting through to the first generation of Club Respect players.

'If we can really teach the kids now core values for life, so respecting women, respecting each other, so maybe we can stamp out the next generation of domestic violence.'

Player Cooper Allan, 10, has been at the club for 18 months.

'You are meeting girls and treating them like you treat your friends,' he said.

His friend Mia Johnson agreed: 'It's really good that boys can accept women for who they are.'

## 'Treat people however you wanted': former player

Those attitudes are a world away from the experience Kevin O'Neill had when he was a top grade player in the UK in the 1980s.

He is now a coach with the Eastern Raptors.

'It was a very blokey attitude back when I was playing,' Mr O'Neill said.

'Do whatever you want. Treat people however you wanted.'

He said the culture at his club was a much-needed game changer.

'It's not taking the toughness out of the game. It's making that person a better person,' he said.

Elise Suhle's son plays at the club, and she has volunteered there for three years.

'The kids in this club, when they see their coaches, and their parents, and the trainers, everyone behaving like they should really — towards anybody, not just women — it rubs off,' she said.

Jasmine Dalen is an assistant coach for the under 7s.

She said inclusion has improved dramatically since Club Respect was introduced, but that's not necessarily the case at other clubs.

'Some of the mums at school even talk about the clubs they're involved at and they feel like they're not welcome... I often hear them say they don't feel included on the sidelines,' she said.

## Hopes to rollout program nationally

The goal is for Club Respect to transcend all sporting codes and be rolled out nationally.

Source: Norman Hermant, 1 March 2019, ABC News

### QUESTIONS

1. In the Club Respect trial, explain why you think that 'when there is deep respect, there is no violence'.
2. Identify and put in order the features of the ethics strategy that have encouraged a change in club culture. Use data to support your response.
3. Justify why this trial is achieving results at the grass-roots level, using secondary data.
4. Discuss the potential outcomes and limitations of the ethics strategy.

## Apply and analyse
making decisions about gender and sport

LEARNING EXPERIENCE
KEY OBJECTIVES
1, 4, 7

1 Investigate a dilemma that is related to gender and sport or physical activity, in a class, school or community context.
2 Devise an ethics strategy related to your chosen issue to enhance integrity and positive engagement. Use the following stages from the Ethical decision-making framework:
   - **a** Get the facts: investigate the issue and describe the dilemma.
   - **b** Recognise what's important: consider values, ethics and assumptions.
   - **c** Make a decision: decide what is the desirable outcome.
   - **d** Commit to action: design a course of action to reach that outcome.

## Evaluate and justify
evaluating the effectiveness of a strategy about gender and sport

LEARNING EXPERIENCE
KEY OBJECTIVES
5, 6, 7

1 Using your response from the previous learning experience, evaluate how well your ethics strategy might work to enhance integrity and optimise engagement for all stakeholders in the class, school or community context.
2 Predict possible outcomes of the strategy.
3 Use the logic model and the following prompts to refine the ethics strategy. Will the strategy:
   - produce the most good and do the least harm?
   - respect the rights of all who have a stake?
   - treat people equally or proportionately?
   - serve the community as a whole?

**Figure 5.11** The disparity in prize money in sport between women and men is an ongoing ethical dilemma.

# 5.4 Ability and sport

When junior players are put into groups based on their ability, it makes it possible for them to enjoy fun, safe and inclusive experiences and for everyone to participate. Research shows that well-graded competitions allow for better skill development and also cater to those children and teenagers who seek competitiveness. However, sometimes the criteria used for grading, such as age or weight, do not reflect ability or participants' needs.

When you consider the role of ability in sport, particularly junior sport, issues can be raised, such as:

- fair and inclusive competition
- team selection
- ability groupings
- the use of weight and age categories.

These issues are ethical dilemmas that can threaten the integrity of sport.

The following case study shows the development of an ethical strategy to deal with some of these issues in both a school and community context.

## CASE STUDY

### ACT junior rugby union introduces mercy rule

It's officially no longer whether you win or lose in ACT Junior Rugby Union, but how you play the game.

ACT Junior Rugby Union says it wants more importance on the 'spirit of the game' rather than the result, introducing a mercy rule that forces dominant teams to take players from the field in lop-sided contests from under-13s to under-18s.

Grand finals in younger age groups could be in the firing line next.

The trial mercy rule was ratified by a council of representatives from clubs and schools last Tuesday. Under the trial rule, which will run until the end of the season, teams will progressively have to take players from the field as they get further in front, beginning when they hit a lead of 30 points.

Teams can lose a maximum of three players, but players can only return to the field of play if the advantage drops to 20 points. The rule will not apply to First XV school rugby or finals. Coaches can also make an agreement before matches not to enforce the rule.

It may be viewed by some as overprotecting kids from the reality of sport and the school of hard knocks, but ACTJRU secretary Michael Pini said the proposal was tabled a month ago and approved by a large majority last Tuesday.

'The feedback's been pretty positive. The only negative feedback was some clubs and schools hadn't communicated correctly across all age groups... that was probably disappointing,' Pini said.

'If the clubs and schools didn't want to do it, we wouldn't have trialled it.'

Pini said the purpose was to improve the retention of junior players and ensure less-competitive clubs do not become disillusioned. There are about 3000 junior players in the ACT.

'We spend too much time on the end result instead of playing,' Pini said.

'We're trying to think outside the box, so we don't go through the same thing week after week and year after year. Nothing changes and people end up leaving the sport because they're being flogged.

'I looked at a model where a team gets in front by 50 points and they stop the game, but that doesn't help anybody. Let's keep them playing.

'There's good and bad, but we're trying to see benefits from both sides of things. It's to make the weaker teams stronger by giving them some confidence and skill set, and making the strong teams better by seeing them play under more pressure.'

The mercy rule does not apply to age groups younger than under-13s, but they could also face changes.

'There's grand finals from under nines to 12s, but I'd like to think seriously about getting rid of grand finals up until an older age group to allow them to play for the sake of playing,' Pini said.

'There's too much emphasis on four points for a win and winning grand finals. I'm just trying to keep kids on the paddock... I just don't think we've got the kids out there playing as much as we used to. Is that because we're too competitive in terms of the kill for the win?'

Marist College's master of rugby Paul Mead said the school was so supportive of the mercy rule it had implemented it prior to last weekend's official commencement.

'I think it'll encourage the development and retention of players,' Mead said. 'We're all about the process of playing rugby at Marist, not just the result.'

Manager of ACT Brumbies junior development, Dan Hooper, said there had been a drop in participants in the early teenage years, so the trial was worthy.

'I'd say 80 to 90 per cent of delegates in the meeting were supportive of the rule and the reasons behind it; no one was really dissenting against it. But there were some who suggested where does it end?' Hooper said.

'I know it could be perceived as tough on the team that's winning, that they have to drop a boy and somebody has to go off the field through no fault of their own.'

## How it works

* 30 point lead – lose one player
* 40 point lead – lose a second player
* 50 point lead – lose a third player
* Players can return to the field once a lead is cut to 20 points.
* Maximum of three players off.
* Only applies to ages under-13s to under-18s.
* Under-12s and below must maintain even numbers on the field.

Source: Chris Wilson, 13 May 2014, *Sydney Morning Herald*

### QUESTIONS

1. Determine a case for and against the 'mercy rule' in junior sport.
2. Explain the purpose of the trial.
3. Evaluate how the rule change could affect the 'spirit of the game' in this junior sport.
4. Discuss the potential outcomes and limitations of this ethics strategy.

**Figure 5.12** Programs such as Get into Rugby provide opportunities for junior competitors to experience the game in a range of different formats.

## Apply and analyse
making a decision about ability and sport

1. Investigate a dilemma that is related to ability and sport in physical activity, in a class, school or community context.
2. Use the Ethical decision-making framework to devise an ethics strategy related to your chosen issue to enhance integrity and positive engagement.

**LEARNING EXPERIENCE**
KEY OBJECTIVES
1, 4, 7

## Evaluate and justify
evaluating the effectiveness of a strategy about ability and sport

1. Using your response from the previous learning experience, evaluate how well your ethics strategy might work to enhance integrity and optimise engagement for all stakeholders in the class, school or community context.
2. Predict possible outcomes of the strategy.
3. Use the logic model to evaluate and refine the ethics strategy.

**LEARNING EXPERIENCE**
KEY OBJECTIVES
5, 6, 7

# 5.5 Technology and sport

The use of technology in sport raises many potential ethical dilemmas. One concern is that technology can give some participants advantages over others. Innovative equipment such as swimmers' body suits, designed to reduce friction through the water, or more streamlined and efficient bicycle designs, can supplement traditional athletic skills. Technology used outside of competitions, such as training machines, hypoxic tents and chambers, and biochemical treatments, are used with the aim of enhancing performance.

**Figure 5.13** Technology has had a significant impact on people with disabilities competing in sport.

At the same time, technology can potentially increase fairness and create opportunities for athletes. This is particularly the case for athletes with physical disabilities, who are able to begin or continue competing thanks to prosthetics, specialised wheelchairs or other devices. Medical technology may also allow athletes to overcome illness or injuries that would prevent them from performing. So while technology may produce dilemmas, the ethics strategy to address such dilemmas cannot be as simple as 'ban all technology from sport'.

The following case study shows how some of the ethical dilemmas to do with technology in sport can be identified and discussed in a community context.

# CASE STUDY

## Why technology in sport poses a threat to keeping the game fair, safe and affordable

The history of technology in sport is a long and sordid love affair. It has thrilled, broken hearts, and either built success or elicited cries of fraud.

The humble golf ball is a good example. Fundamental to the game of golf is striking it from point 'a' to 'b' to end up in a hole in as few shots as possible. But apply a dimpled pattern to its surface and it can go further for less effort. Then optimise the pattern of the dimples and the ball will hook or slice less when struck. Suddenly the skill required to play the game is made easier.

Allowing any of these evolutionary steps is bound to trigger a debate about the importance and limits of technological progression.

## Keeping it controversial

History is littered with the controversial use of sports technology.

The Polara golf ball is a case of an innovation making a sport too easy, effectively deskilling it. The innovation benefited lower-skilled players who had a greater tendency to make mistakes but not higher-skilled golfers who were already adept at making an accurate drive. It essentially deskilled the game – and was banned.

Full-body swimsuits captured the public's imagination at the 2000 Sydney Olympic Games. The introduction of the suit was shown to improve a swimmers' performance dramatically as the designs evolved. After 43 records were broken in 40 events at the 2009 World Swimming Championships and 130 world records were broken in less than a year, the global swimming governing body voted to ban the full-length suits.

The tragedy was not that the suits were banned but that the world records remained in place. This meant that future athletes did not have the same advantage as those that had set them. This decision was arguably unfair.

Likewise the case of South African sprinter Oscar Pistorius. In 2008, he sought to compete in both the Olympic and Paralympic Games. The use of his prosthetic legs with carbon fibre blades resulted in a furious debate on what advantage they gave him.

After a protracted dispute involving studies and counter studies, Pistorius was allowed to run in both – mainly due to lack of agreement on the issue.

## Faster, higher, stronger

The motto of the Olympic Games is 'Citius, Altius, Fortius' (faster, higher, stronger). This suggests that we should embrace any progress and push all of our resources to achieve it.

Never is this more apparent than in cycling. Forty years ago riders were wearing woollen jerseys and using the same bike for all events. Now they wear advanced fabrics to maximise aerodynamics and optimise core body temperature while using different bikes based on terrain or effort. It could be argued that the technology makes the effort of athletes today incomparable to those of the past.

The cycling hour record involves riders cycling as far they can on a velodrome in 60 minutes. In the 1990s there was a flurry of innovations and bikes evolved away from the design that had remained virtually unchanged since the 19th century.

Worried that things were getting out of hand and that engineers might be dictating the results, the international cycling governing body outlawed these designs. It then rewrote the rules in such a way that a rider was expected to use a similar design to those made 50 years ago. It was a noble idea, but cyclists continued to try and find loopholes.

In late 2014, the governing body rewrote its rules again to allow contemporary time trial bike designs. The reality is that giving a sport some technological wiggle-room can keep sponsors coming, provide interest to fans and may prevent a sport from stagnating.

## Keeping it accessible

The equipment needed to perform a sport can determine its success and levels of participation. New and interesting technology may keep us engaged with a sport. But cost and access need to be monitored for it to remain accessible.

Part of the controversy around swimsuits was the fact that only athletes with the right sponsors could access them. Many others couldn't – effectively making it a case, metaphorically speaking, of bringing a knife to a gun fight.

Make sports equipment and technology too expensive and very few future athletes will participate. Keep the equipment too technically difficult to use and amateurs will have to move onto something else.

Stand-up paddleboarding, for example, has been described as the world's fastest growing watersport. But no robust governing body or equipment specification guides what length or width boards should be. Board width determines how stable the board is when paddled and therefore how skilled in balance a person needs to be. The narrower the board, the faster it will go but the more challenging it will be to use. Go wider and raw performance will suffer but more people will be able to engage with the sport.

## The safety conundrum

What about the impact of technological progress on safety? For example, the centre of gravity of javelins was changed in the late 1980s to ensure that they remained within existing throwing infields as athletes were throwing further and further. Likewise, headgear in amateur boxing was eventually adopted to provide extra protection to its athletes.

But unintended consequences also have to be taken into account. While headgear has reduced the general severity of head injuries, it can also give a boxer an increased sense of invulnerability. This might explain why there has not been a reduction in the number of recorded head injuries since headgear was introduced.

Ultimately, there is a philosophical difference between technologies that facilitate a sport and those that enhance it. Empirical science often needs to be accompanied by philosophical debate. In the case of runners with an amputation, it isn't just about how a prosthetic limb performs. It also challenges perceptions about disability and how closely humans should engage with technology.

Technology is there to facilitate a sport and to challenge the limits of our performance. But this has to be tempered with caution and vigilance to ensure a sport remains fair, safe and accessible.

THE CONVERSATION Source: Bryce Dyer, 21 July 2015, The Conversation, https://theconversation.com

**QUESTIONS**

1. The motto of the Olympic Games suggests that we should embrace all progress and put all our resources towards achieving it. Explain the reasons outlined in this case study for having caution in the use of technology.
2. Determine how technology can affect fair play, safety and integrity in physical activity.
3. Propose the consequences of removing any limits to technology in physical activity.
4. Discuss the potential outcomes and limitations of the ethics strategy.

## Apply and analyse
making a decision about technology and sport

1. Investigate a dilemma related to technology and sport or physical activity, in a class, school or community context.
2. Make decisions, using the Ethical decision-making framework, to devise an ethics strategy related to your chosen issue to enhance integrity and positive engagement.

**LEARNING EXPERIENCE**

KEY OBJECTIVES
1, 4, 7

## Evaluate and justify
evaluating the effectiveness of a strategy about technology and sport

1. Using your response from the previous learning experience, evaluate how well your ethics strategy might work to enhance integrity and optimise engagement for all stakeholders in the class, school or community context.
2. Predict possible outcomes of the strategy.
3. Use the logic model to evaluate and refine the ethics strategy.

**LEARNING EXPERIENCE**

KEY OBJECTIVES
5, 6, 7

# 5.6 Corruption and sport

Corruption in Australian sport has recently been highlighted through a series of high-profile cases, including match-fixing, the use of 'inside' information for betting and the use of performance-enhancing drugs.

Corruption has happened in many sporting codes, including football, tennis, cricket, horse and greyhound racing, basketball and baseball. It can involve a range of offenders, from players and coaches, referees and judges to administrators and organised crime groups. It can affect how sport is played, managed and promoted.

**Figure 5.14** The focus on gambling in physical activities may also lead to an increase in corruption.

Corruption, match-fixing and gambling on the results of sport influence fairness, respect, responsibility and safety.

The following article discusses a range of dilemmas related to corruption in sport, and describes efforts by an international group to develop an ethics strategy that could be applied in a community context.

# CASE STUDY

## Fans deserve fair play in major sports, not cheating and corruption

Why is global sport business booming and why does this come with the increasing frequency and growing size of integrity scandals of bribery, corruption and cheating?

I think that the digitisation of sport combined with big data analytics has dramatically increased the attractiveness of the product on sale. With that comes the desire to win or be associated with winners, a longing for social acceptance and narcissistic craving to shine.

Ultimately, there is no market without a product that is in demand. And sport is hot property.

One very important reason why sport has been in demand for decades is its primordial simplicity. Every human being understands 'you against me', 'them against us' and winners trumping losers.

But it is the digital production and distribution of sport competitions that now allows for global and instant access to a mass market for sport businesses. Big data analytics and near real-time digital responsiveness have enabled the slicing and dicing of sporting contests into endless sub-products.

## Odds on

Betting agencies are selling odds to *parts* of the sporting contest, such as who will score the first goal, who will commit the foul next or what will be the half-time score.

With these multiplying moments of monetisation of sport comes the opportunities for criminals to exploit the loopholes and gaps in integrity safeguarding.

Bribing an athlete to ensure that one tiny aspect of the sporting contest can be predicted is enough to make millions, such as the scandal in world tennis revealed in January this year.

Further fuelling the sport business gravy train are the rich, but not so famous (yet). They use high-profile sport to show off their economic power and bask in the reflected glory of their team – in the process creating a sense of personal achievement and social acceptance.

But are they the right reason to be involved in sport governance.

Could private sport ownership in Australia lead to similar excesses?

In order to access the benefits that global sport offers as a platform, winning at all cost is too often required on the sporting field, but also in the sport business corridors.

It may be achieved by taking performance-enhancing drugs that deliver superhuman performance, or using excessive financial resources to buy influence to stay in power.

So is sport business at the crossroads?

## Whom do you trust?

In sport governance, whom do we trust? Are the current crop of sport governors and sport managers capable, skilled and equipped well enough to combat the forces that seek to illegally exploit the exploding profit potential of sport?

How do we prepare, train and educate the future managers of sport? Can the primal spirit of sport be maintained and its integrity kept safe?

A global compact between the leading international sport federations on what should be the basic business principles that underpin and regulate the trade in sport is required.

A coalition of sport governing bodies, government, international authorities, business, academia and civil society was announced earlier last month in the Sport Integrity Global Alliance (SIGA).

The Alliance needs to agree on how far the commodification of sport can be allowed to progress before the integrity of its production and consumption is irrevocably tarnished.

Educators, researchers, administrators and politicians need to combine their brainpower and industry knowledge. An admirable and crucial initiative, but one is left wondering how key principles that more than 40 organisations signed onto are implemented and enforced.

How, for example, is such an Alliance going to establish an

> *[...] independent betting monitoring platform, capable of providing sport integrity intelligence alerts to sporting, law enforcement, betting operators and government stakeholders to assure early warning advice.*
>
> or
>
> *[...] establish independent monitoring, audit and oversight in relation to all sport-related development programs and financial transactions.*

And how can this happen when sports themselves are competing against each other for the best TV rights deal, host city arrangement, biggest sponsorship deal and slice of the gambling dollar, not to mention the best available athletic talent to take their sport to the next level?

Sports stars like Queenslander Ash Barty are targeted by sponsors and brands.

Those people who go to the stadium or the fans barracking from their living rooms need to be assured that sport is real.

They need to be confident that their cheers are part of a real contest, that the outcome remains unpredictable, the contest limited to those competing in it, and that there is always a chance that the underdog can win.

Only then can the superstars of world sport be role models for the millions of weekend warriors in communities around the world.

All of us, those who will only ever play sport for the fun of it, and who use sport to meet and congregate will decide if sport remains worthy of such prominence in society. If that primal spirit of sport is lost, so will be its profit potential, because nobody is prepared to pay a premium for a fake.

THE CONVERSATION Source: Hans Westerbeek, 9 May 2016, The Conversation, https://theconversation.com

### QUESTIONS

1. Determine the factors that have contributed to the rise of global sport but which can also impact integrity and fair play.
2. Explain the reasons for the establishment of agencies such as the Sport Integrity Global Alliance.
3. Predict a possible consequence for sporting contests of the increased role of betting agencies.
4. Discuss the potential outcomes and limitations of the ethics strategy.

## Apply and analyse
making a decision about corruption and sport

1. Investigate a dilemma related to corruption in sport or physical activity in a class, school or community context.
2. Use the Ethical decision-making framework to devise an ethics strategy related to your chosen issue to enhance integrity and positive engagement.

**LEARNING EXPERIENCE**

KEY OBJECTIVES
1, 4, 7

## Evaluate and justify
evaluating the effectiveness of a strategy about corruption and sport

1. Using your response from the previous learning experience, evaluate how well your ethics strategy might work to enhance integrity and optimise engagement for all stakeholders in the class, school or community context.
2. Predict possible outcomes of the strategy.
3. Use the logic model to evaluate and refine the ethics strategy.

**LEARNING EXPERIENCE**

KEY OBJECTIVES
5, 6, 7

# Chapter review

## Key questions and responses

**[5.1] How can we make effective decisions to address ethical dilemmas?**

Ethical dilemmas arise from the complex interaction of personal values, the reasons for participating in sport, the principles involved and personal morality.

**[5.2] How do ethics strategies reflect and influence fair play and integrity?**

Ethical strategies reflect and influence fair play and integrity by considering:

- **a** Consequences: decisions are made based on the consequences for others' positive engagement. (How will this affect other people?)
- **b** Principles: decisions should be a matter of principle, not consequences, and should follow rules. (What is the appropriate course of action?)
- **c** Personal values: decisions are made in accordance with one's personal values and morals. (What do I think is the right thing to do?)

**[5.3] What ethical dilemmas occur in relation to gender and sport?**

Negative attitudes towards women and discrimination against athletes or teams based on gender threaten the integrity of sport. Professional female athletes are often paid less than their male counterparts, and receive less support from sporting bodies.

**[5.4] What ethical dilemmas occur in relation to ability and sport?**

Graded competitions for junior athletes allow for better skill development and cater to those young players who seek competitiveness. However, the criteria used for grading, such as age or weight, may not accurately reflect ability or participants' needs.

**[5.5] What ethical dilemmas occur in relation to technology and sport?**

Enhancement technology, both within and outside of competitive performances, may give some participants advantages over others. At the same time, technology can potentially increase fairness and create opportunities for athletes, particularly those with physical disabilities.

**[5.6] What ethical dilemmas occur in relation to corruption and sport?**

Corruption in sport, such as match-fixing, gambling and the use of performance-enhancing drugs, has happened in many sporting codes. Corruption involves a range of offenders from players and coaches, referees and judges to administrators and organised crime groups.

# Exam-style questions

## Section A: Multiple-choice questions

KEY OBJECTIVES
1

**1** An ethics strategy is:
- **a** an influence on integrity and fair play.
- **b** mainly directed at an individual's behaviour.
- **c** a method or course of action designed to enhance positive engagement.
- **d** a major influence on the integrity of the individual, the team and the game itself.

**2** Principles associated with ethical decision-making include:
- **a** honesty, loyalty, trust and respect.
- **b** fundamental truths which determine right and wrong.
- **c** fair play, integrity and always performing at your best.
- **d** consideration of the most important factors related to the decision.

**3** Ethical dilemmas involve choosing between:
- **a** conflicting values and morals.
- **b** short-term and long-term outcomes.
- **c** different values which determine our behaviour.
- **d** producing the most good and doing the least harm.

**4** Ethical strategies provide:
- **a** solutions to dilemmas.
- **b** positive engagement in physical activity.
- **c** opportunities for fair play by participants.
- **d** a course of action to improve integrity of the player or organisation.

**5** Codes of behaviour offer guidelines for:
- **a** identifying and mandating behaviour.
- **b** directives to players, coaches and officials.
- **c** support of ethical behaviour and fair play in physical activity.
- **d** responsibilities regarding fair play and appropriate conduct for participants.

**6** Considering your most important values in deciding how you should act, using the Ethical decision-making framework, is mostly associated with:
- **a** Stage 1.
- **b** Stage 2.
- **c** Stage 3.
- **d** Stage 4.

**7** Tensions within dilemmas related to integrity and fair play include:
- **a** trying to keep all stakeholders informed.
- **b** engaging participants in the ethics strategy.
- **c** aligning policy with national sporting organisations.
- **d** dealing with the interaction of values, purposes, principles and morals.

**8** Consequences in a dilemma include:
- **a** deciding on values that conflict.
- **b** understanding the right course of action.
- **c** considering impacts on other participants.
- **d** trying to make everyone happy with decisions.

**9** Devising an ethics strategy must include:
- **a** integrity and fair play.
- **b** consistent implementation.
- **c** synthesis to determine right from wrong.
- **d** evidence-based decisions from a range of sources.

**10** Evaluating the outcomes of an ethics strategy to optimise integrity and positive engagement requires:
- **a** an ethical dilemma.
- **b** the interest of different stakeholders.
- **c** tensions that exist in relation to fair play and integrity.
- **d** a systematic process of review, using evidence from primary and secondary data.

## Section B: Short-response questions (150–250 words)

KEY OBJECTIVES
1, 4, 7

**1** Select an example from a case study in the chapter and use it to demonstrate how tensions arise in relation to fair play and integrity when there is an ethical dilemma.

**2** A range of policies are used for team selection in junior sport in schools and communities. Use primary and secondary data to describe how an ethical dilemma may be created from the implementation of a team selection policy.

## Section C: Extended response to stimulus (400 words)

KEY OBJECTIVES
4, 5, 6, 7

South African athlete Caster Semenya, the 800 metres world and Olympic champion, has a condition known as hyperandrogenism, a condition where high levels of natural testosterone occur in the body. New regulations will ban female athletes such as Semenya from competing in any race between 400 metres and 1500 metres unless they undergo medical treatment to reduce their testosterone levels down to an 'acceptable' range for women. The new regulation is an ethics strategy used by the International Association for Athletics Federations in an attempt to 'level' the playing field.
Predict the potential outcomes, implications and limitations of this ban, and how it may affect fair play and integrity, justifying your response using evidence from your research.

UNIT 4

# Energy, fitness and training and physical activity

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Unit 4 examines energy, fitness and training in the context of specific physical activities. In addition to demonstrating movement sequences and strategies, you will also observe, collect and analyse data to devise and evaluate fitness training strategies.

## Unit objectives

In Unit 4, you will:

1. recognise and explain energy, fitness and training concepts and principles about selected physical activities
2. demonstrate specialised movement sequences and movement strategies in the selected physical activity
3. apply concepts to specialised movement sequences and movement strategies in the selected physical activity
4. analyse and synthesise data to devise a training strategy
5. evaluate training and movement strategies
6. justify training and movement strategies
7. make decisions about and use language, conventions and mode-appropriate features for particular purposes and contexts.

## Physical activities

In Unit 4, the physical activities you explore must come from the following categories:

- Invasion
- Net and court
- Performance.

**Topic 1**

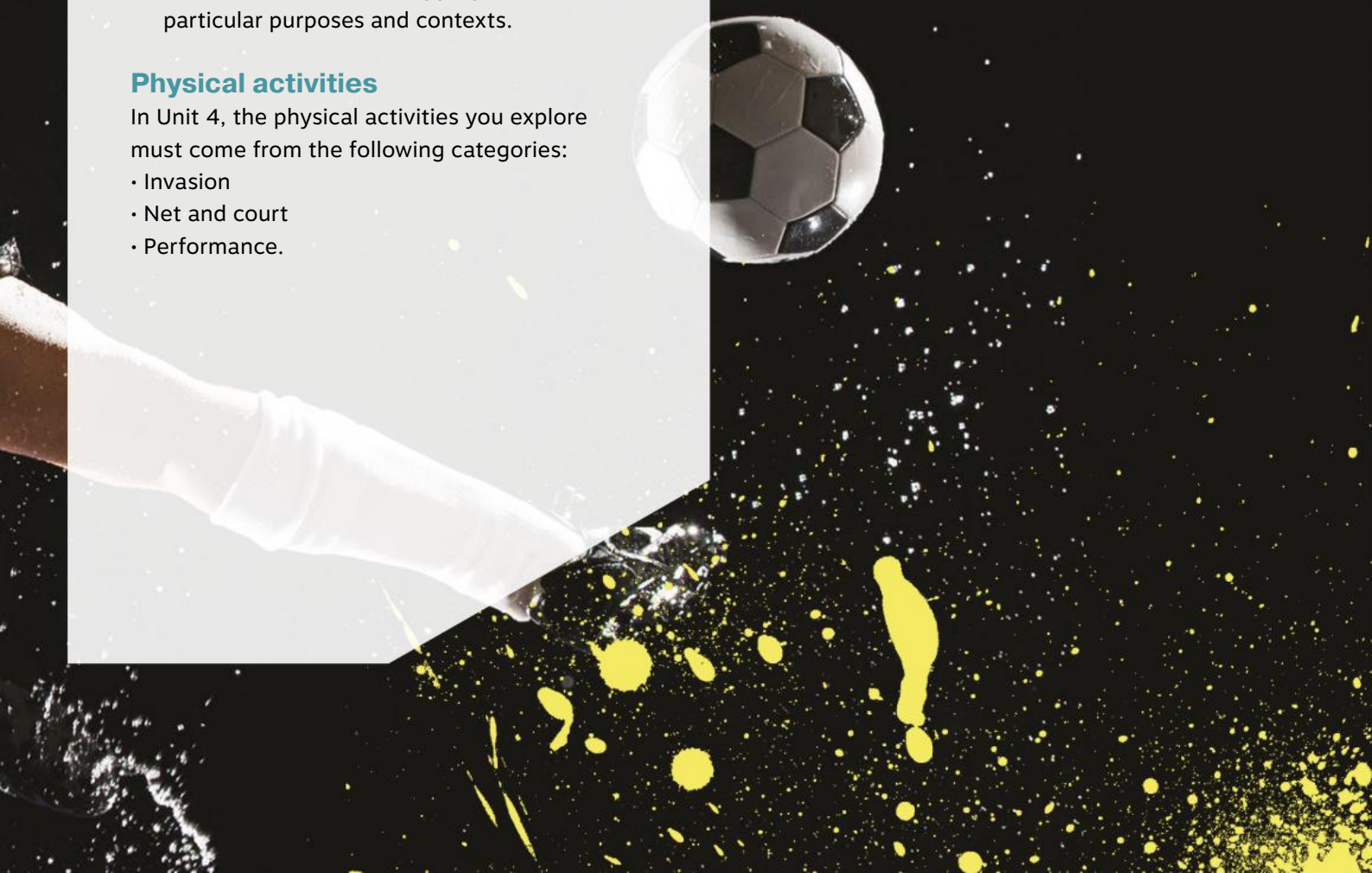
### Energy, fitness and training

6 Investigating energy systems

7 Assessing fitness requirements

8 Manipulating training principles

9 Designing training programs



# 6 INVESTIGATING ENERGY SYSTEMS

**Figure 6.1**
The human body needs energy to survive, grow and fuel movement.

Through your work with the Invasion, Net and court or Performance categories of physical activities, you will learn about energy production and energy systems. If you understand how the body responds to exercise and how it produces energy for you to perform, it will help you to optimise your physical performance.

In this chapter, you'll learn about how the body produces energy for physical activity, the interplay of the three energy systems and the impact of exercise intensity and duration on energy pathways.

## KEY QUESTIONS

**6.1** How does the body provide energy for physical activity?

**6.2** What are the fuel sources used to keep producing ATP for physical activity?

**6.3** How do the three energy pathways, known as energy systems, produce ATP?

**6.4** How does the intensity and duration of a physical activity impact which energy system is used in the production of ATP?

## YOUR CHAPTER PLAN


6.1 ATP and its role in physical activity

6.2 Fuel sources for resynthesising ATP

6.3 Energy systems and the production of ATP

6.4 The interplay of energy systems

Chapter review

# 6.1 ATP and its role in physical activity

Just like a machine, the human body needs energy to function – to live, to move and to perform physical activity. But where does that energy come from?

The human body produces an energy-rich compound called **adenosine triphosphate** (usually referred to as ATP). It is ATP that provides energy for bodily functions and physical activity. The energy used in physical activity relies on ongoing production of ATP using various fuel sources. Three different pathways or **energy systems** interact to provide energy for working muscles. How much each system is used depends on the intensity and duration of the activity.

**adenosine triphosphate (ATP)** is a complex chemical compound present in all living tissue, which provides energy to drive many processes in the body

**energy systems** the metabolic systems that facilitate energy to all cells

## The chemistry of ATP

ATP is an energy-rich organic compound found in all human cells. It is needed for just about every function in the human body, including cell respiration, nerve transmission, digestion, growth, repair and muscle action. ATP is sometimes called the 'energy currency of life'. In this context, energy is defined as the capacity to do work.

A compound of ATP is made up of several smaller molecules chemically bonded together. One of these smaller molecules is called adenosine, and it is linked to a chain of three phosphate groups (triphosphate) (Figure 6.2).

ATP contains a lot of potential energy due to its structure. This energy is stored in the high-energy bonds between the phosphate groups. Each of these phosphate bonds stores energy that the cell can use, but the bond between the second and third phosphate groups contains the most accessible energy.

> The chemistry of ATP is very complex, but you don't need to know any more than this for your Physical Education studies.

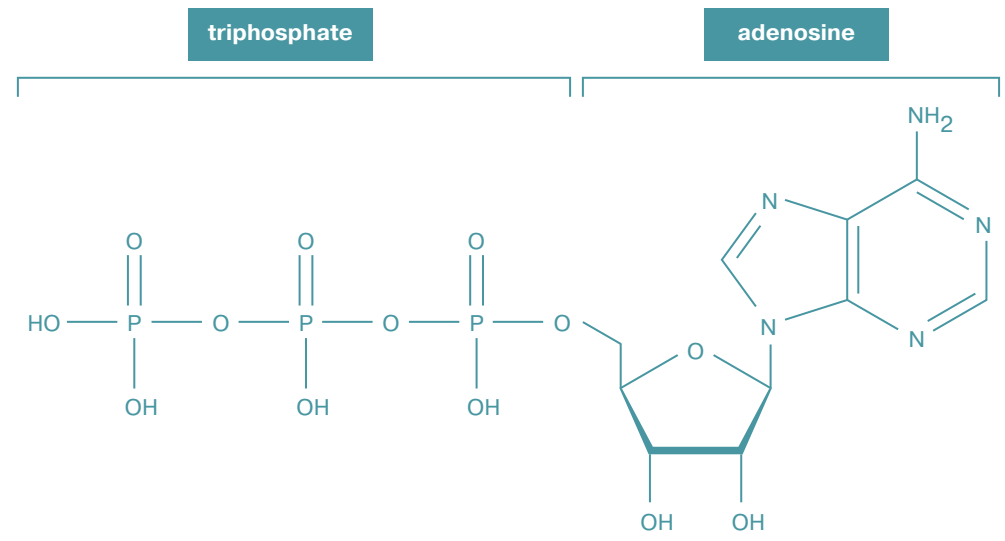



**Figure 6.2** The chemical structure of ATP.

## Breakdown and resynthesis

**adenosine diphosphate (ADP)** chemical by-product of the breakdown of ATP for energy production

**resynthesise** to synthesise again

**phosphorylation** biochemical process involving the addition of a phosphate group to an organic compound or molecule to form ATP

When your cells need energy for muscular work, a chemical reaction takes place. An enzyme helps the third phosphate molecule split from the ATP and the stored energy is released. This breakdown changes ATP into a different chemical, the energy-deficient **adenosine diphosphate (ADP)**, which only has two bonded phosphates attached, rather than three. The chemical energy released when ATP breaks down to ADP is converted into mechanical energy when the muscle contracts.

This process occurs in muscle cells and is anaerobic (it does not use oxygen), and it generates a rapid release of energy. However, your cells only contain a small supply of ATP, so your body has to continually produce ATP. Once the ATP molecule is split and energy is released, the ATP must be **resynthesised** (re-formed) using another source of energy if the muscular work is to continue.

The process of resynthesising ATP from ADP and phosphate is called **phosphorylation**. The energy to do this is provided by various fuel sources feeding into a combination of the three energy pathways or systems.

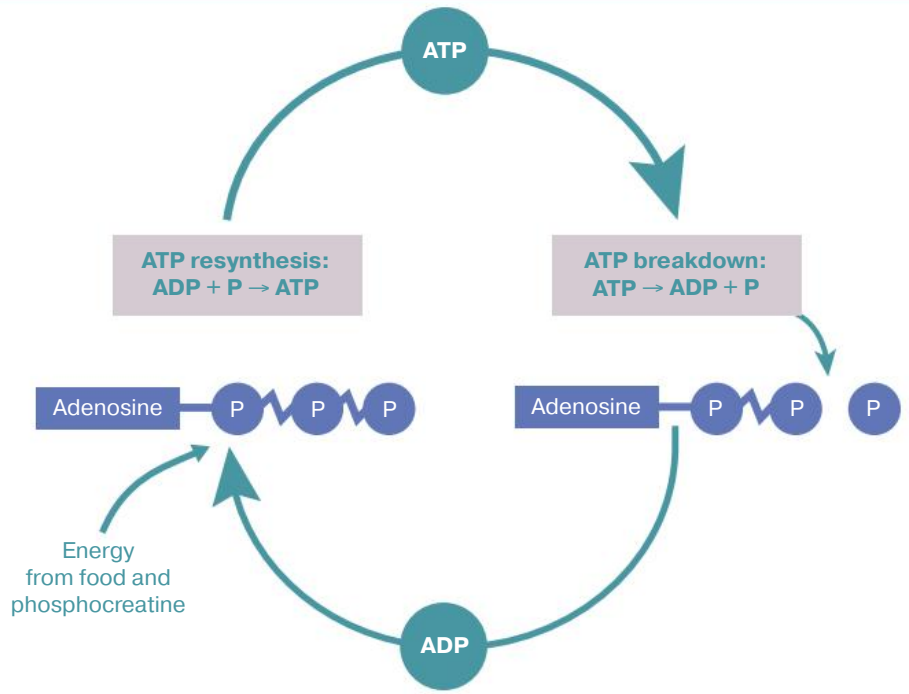



**Figure 6.3** The breakdown and resynthesis of ATP.

**Check your understanding 6.1**

1. Summarise the role of ATP in the human body.
2. Describe the process of the breakdown of ATP to release energy, shown in Figure 6.3.
3. Explain why the body needs to continually produce ATP.

# 6.2 Fuel sources for resynthesising ATP

ATP is vital for your body to function, but your cells can only store small amounts of the compound. To keep functioning, your body has to continually resynthesise ATP so that it has a store of energy.

To power the resynthesis of ATP, the human body uses three different series of chemical reactions. These are referred to as energy systems or pathways. Two of these systems depend on the food you eat (carbohydrates, fats or proteins), while the other depends on another high-energy compound found in cells, called phosphocreatine.

## Phosphocreatine

**Phosphocreatine** (PC) is a high-energy phosphate, stored in small amounts in the muscle cells, that releases large amounts of energy quickly when it breaks down.

PC breaks down into phosphate and creatine. The readily available energy released when PC breaks down makes it possible to rapidly resynthesise ATP from ADP, using a phosphate group from the PC.

**phosphocreatine** a compound that acts as a store of phosphate to facilitate energy for muscular contraction

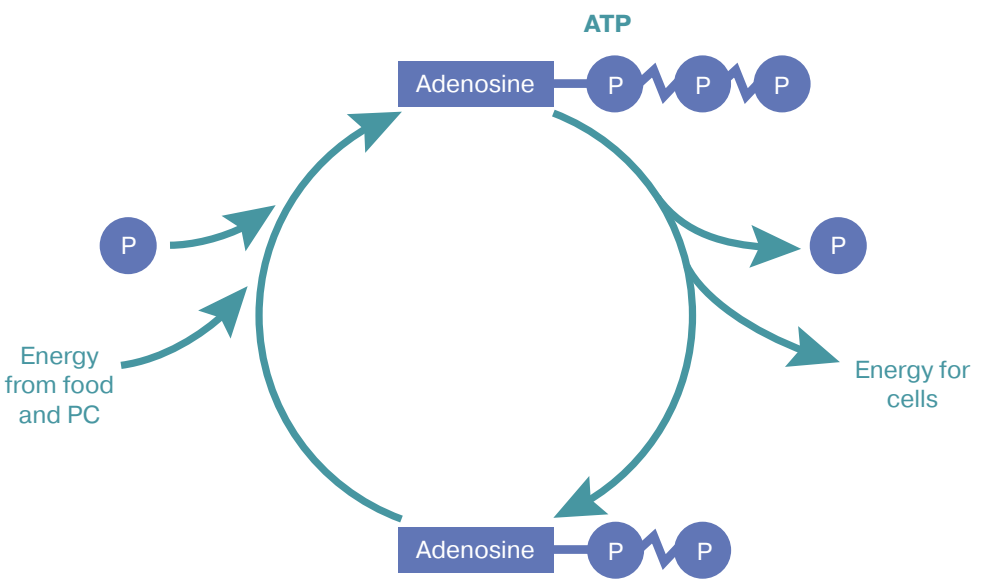



**Figure 6.4** The breakdown of PC releases energy and phosphate to resynthesise ATP from ADP.

This pathway of ATP resynthesis is rapid, making it suited to high-intensity, short-duration physical activity. However, it can only provide limited amounts of ATP, and the supply is used up very quickly (in approximately 10–12 seconds).

The average adult resynthesises approximately 60 kg of ATP per day but there is only an estimated 100 grams of ATP and 120 grams of PC stored in the body. Obviously, you also need other fuel sources and pathways to resynthesise ATP.

# Carbohydrates

**carbohydrates**
chemical compounds consisting of carbon, hydrogen and oxygen atoms in specific arrangements

**Carbohydrates**, chemical compounds made of carbon, oxygen and hydrogen, are the primary source of ATP production. There are two types:

- simple carbohydrates, which are sugars, found naturally in fruits, milk and milk products
- complex carbohydrates, which are in foods such as bread, grains, pasta, fruits and vegetables.

While both types can provide energy, complex carbohydrates are much more effective energy sources.

Carbohydrates are digested by the body and converted into the simple sugar **glucose**, which travels from the intestines through the bloodstream to the muscles. The body can also store a limited amount of the energy from digested carbohydrates in the form of **glycogen**, in the muscles or liver. Chemical reactions use glucose to produce the energy to resynthesise ATP, allowing muscular work and physical activity to continue.

**glucose**
a simple sugar that is an important energy source in living organisms

**glycogen**
the form in which energy from digested carbohydrates is stored in muscles and liver

Glucose stores quickly run low during intense exercise, so you need to eat carbohydrates daily through a balanced diet. Some research recommends that complex carbohydrates form a significant part of your **kilojoule (kJ)** intake each day. Nutrition Australia recommends that athletes who train heavily, particularly in endurance events, should increase their carbohydrate intake to approximately 70% of their total kilojoule intake.

**kilojoule (kJ)**
unit of energy used to refer to the energy content of food or drink

However, if you eat too many carbohydrates and do not balance energy input (kilojoules in) with energy output (kilojoules out), the excess glucose is converted to fat and stored as adipose tissue, causing weight gain.

**Figure 6.5** A cyclist refuels with a banana during a long-distance bike ride.

In contrast, glucose is used up more slowly by low-intensity exercise. Many endurance athletes use **carbohydrate loading** prior to exercise that will last more than an hour. This increases their muscle glycogen stores, which helps them delay the onset of fatigue. If endurance events last longer than about an hour, athletes may need to refuel by eating carbohydrates during the event. This is why you see many long-distance runners and cyclists eating gels, fruit or energy bars as they compete.

**carbohydrate loading**
a nutritional strategy to maximise muscle glycogen stores prior to endurance competition

## Fats

Fats are very energy-dense nutrients, containing approximately 37 kilojoules of energy per gram, and they can produce large amounts of ATP. Fats are in foods such as dairy products, nuts, fatty meats and oils.

Fats are broken down to **fatty acids**, which circulate in the blood, and triglycerides, which are found in the muscles or liver and are stored in **adipose tissue** throughout the body. These triglycerides contain huge amounts of energy; an 80 kg man has approximately 450,000 kilojoules of energy stored in the fat molecules of his adipose tissue, which would provide him enough energy to exercise for 120 hours!

Even though fats contain a lot of energy, the chemical process of converting them into more useable forms is too slow to provide energy during high-intensity activity. Instead, fats are your body's preferred energy source when you are at rest or doing low-intensity activities, such as walking.

If you have done aerobic training, your body is able to break down (oxidise) more fatty acids when you exercise at mild to moderate intensity. This reduces the demand on your glycogen stores, allowing the trained person to perform **submaximal exercise** at a higher level before experiencing the tiring effects of running low on glycogen. In other words, they can do more, for longer, before tiring.

Almost every research study for the last couple of decades has reported that many Australians have far too much **saturated fat**, sugar and salt in their diet. This has contributed to increasing rates of obesity, high blood pressure and chronic disease (such as type 2 diabetes and heart disease). Nutrition Australia recommends that men under 70 should have between 28–40 grams of healthy, **unsaturated fats** per day, while women under 70 should have only 14–20 grams per day. Unsaturated fats are found in foods such as oils, nuts, seeds, and some fish and vegetables.

**fatty acids**
chains of molecules that are the building blocks of fat

**adipose tissue**
connective tissues in the body containing deposits of fat

**submaximal exercise**
exercise at less than maximum intensity and/or duration

**saturated fat**
type of fat in which the fatty acid chains have single chemical bonds

**unsaturated fats**
type of fat in which the fatty acid chains have at least one double chemical bond

## Proteins

Proteins are nutrients that contain **amino acids**, which are the building blocks of our cells, tissues and muscles. Proteins come from foods such as meat, fish, eggs and dairy products.

Proteins don't play a major role in providing energy for the body, although in extreme cases, such as starvation or prolonged physical activities (e.g. ultra-marathons), amino acids can provide the energy to resynthesise ATP. Instead, they help you in building muscles, recovering from exertion or injury, and promoting overall fitness.

**amino acids**
organic compounds containing nitrogen, hydrogen and carbon

The recommended daily intake for proteins is 0.75 grams per kilogram of body weight for female adults, and 0.84 grams per kilogram of body weight for male adults. So a 60 kg woman should have approximately 45 grams of protein per day. For a person who does regular high-intensity training, this amount increases to 1.3–1.8 grams per kilogram of body weight.

Proper nutrition should be part of every athlete's training, as the wrong balance of carbohydrates, fats and proteins can severely affect strength, speed, power, endurance, recovery and general health. To help recovery after exercise, you need both carbohydrates and proteins to help promote muscle repair and growth. After key exercise, training sessions or games, an athletes' post-recovery nutrition for the day should include 0.3 grams per kilogram body weight of high-quality protein.

**Figure 6.6** Some athletes use protein shakes to increase protein intake after physical activity.

**Table 6.1** Forms of food fuel and storage sites in the body.

| Food fuel | Stored as | Site |
|---|---|---|
| Carbohydrate | Glucose | Blood |
| | Glycogen | Muscles and liver |
| | Excess as fat | Adipose tissue |
| Fat | Fatty acids | Blood |
| | Triglycerides | Muscles and liver |
| | Fat | Adipose tissue |
| Protein | Amino acids | Muscles |
| | Excess as fat | Adipose tissue |

## Check your understanding 6.2

1. Describe how phosphocreatine (PC) is used to produce ATP in muscle cells.
2. Explain why proteins are only used as an energy source for ATP resynthesis in extreme circumstances.
3. Identify why it is more efficient to use carbohydrates rather than fats as a fuel source for ATP resynthesis during high-intensity activity.
4. Explain why athletes who train regularly should increase their carbohydrate intake.

## Evaluate and justify
what should I be eating after exercise?

LEARNING EXPERIENCE

KEY OBJECTIVES
5, 6, 7

*Everyone is different in what they like to eat, what their appetite is like and what sits comfortably in their stomach in the hours after exercise but in general foods should:*

- *Be rich in quality carbohydrate to replenish muscle fuel stores*
- *Contain some lean protein to promote muscle repair*
- *Include a source of fluid and electrolytes to rehydrate effectively.*

*There's no one 'best' option for what to eat after exercise. Dairy foods such as flavoured milk, smoothies or fruit yoghurt can be a great option as they can provide carbohydrate, protein, fluid and electrolytes ticking all of your recovery goals in one handy option. Some other options that you may like to choose include:*

- *Lean chicken and salad roll*
- *Bowl of muesli with yoghurt and berries*
- *Fresh fruit salad topped with Greek yoghurt*
- *Spaghetti with lean beef bolognaise sauce*
- *Chicken burrito with salad and cheese*
- *Small tin of tuna on crackers plus a banana*

Source: *Recovery Nutrition Factsheet*, Sports Dietitians Australia, www.sportsdietitians.com.au

Using the suggestions from the excerpt above, and the information in this chapter on fuel sources to resynthesise ATP, come up with a post-exercise recovery meal. Consider:

- your body weight
- your food preferences
- the recommended amounts of protein and carbohydrates.

Justify your food and drink choices using secondary data.

# 6.3 Energy systems and the production of ATP

As you've seen, the two sources of energy used in the synthesis of ATP are:

- phosphocreatine (PC)
- food, namely carbohydrates, fats and (to a limited extent) protein.

But these sources do not all produce ATP in the same way. The methods of ATP production change, depending on whether the body is at rest or involved in physical activity.

The three pathways or energy systems that are used to produce ATP work at different levels depending on the duration and intensity of physical activity. The first two energy systems are **anaerobic** (taking place without oxygen) and the third one is **aerobic** (it uses oxygen).

**anaerobic**
taking place without oxygen

**aerobic**
needs oxygen to take place

## The three energy systems

Three energy systems power human bodies. These systems are chemical methods of producing ATP inside our muscles. They are:

- **the adenosine triphosphate–phosphocreatine (ATP–PC) system**, which uses the energy released by the breakdown of phosphocreatine
- **the lactic acid system**, which uses the energy released when glucose is converted to **lactate** in a process called glycolysis
- **the aerobic system**, which uses the energy released from the breakdown of carbohydrates or fats, using oxygen.

**lactate**
molecule that is the by-product of the anaerobic metabolism of glucose in muscle tissue

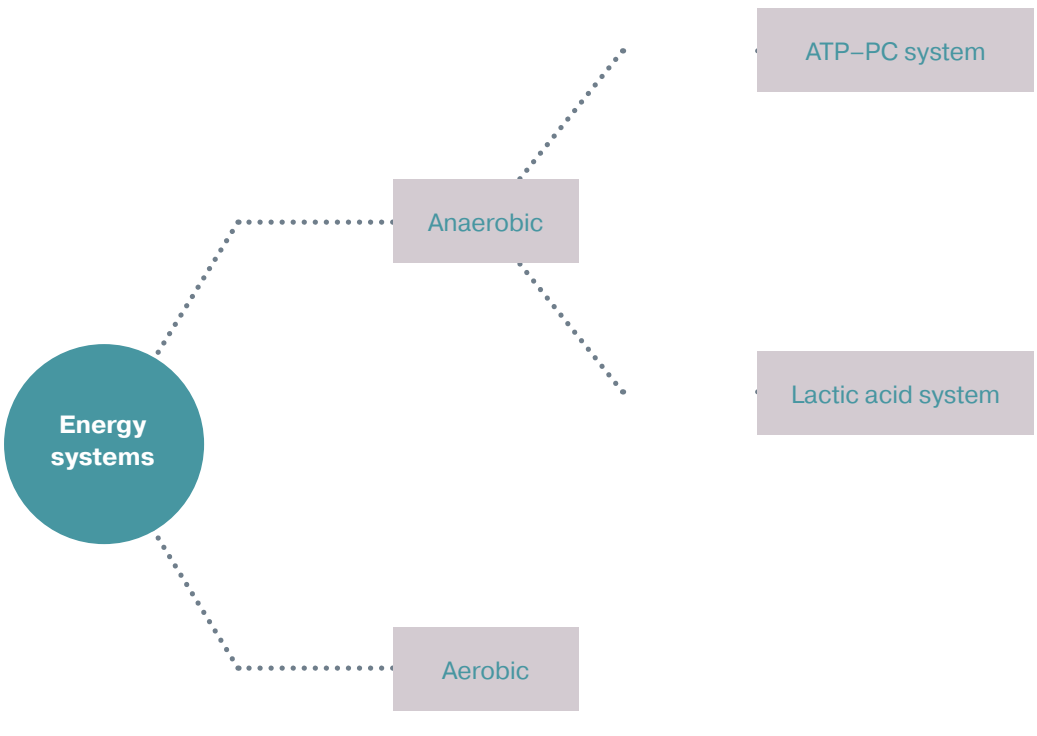



**Figure 6.7** The three energy systems in the human body.

All three energy systems can operate at the same time in a muscle cell. The main differences between the energy systems are:

- the speed at which they work
- the total amount of ATP they resynthesise.

The method the cell is using most at a particular moment depends on whether your muscles are resting or active, and on the intensity and duration of the activity. Energy demands during physical activity are constantly changing, especially during intermittent games and activities. There are activities which have periods of all-out effort, moderate-to-high-intensity moments and also periods of rest or low-intensity activity. The periods of rest or low intensity are opportunities for topping up ATP and PC stores in the muscles, as well as getting rid of waste products made by the chemical reactions that produce energy.

Before reading about each energy system in detail, read Table 6.2 for an overview and comparison of the three systems.

As you study these systems, remember that all three are involved in ATP production (to some extent) at all times.

| Energy system | ATP–PC system | Lactic acid system | Aerobic system |
|---|---|---|---|
| **Aerobic or anaerobic?** | Anaerobic | Anaerobic | Aerobic |
| **Speed of ATP production** | Very rapid | Rapid | Slow |
| **Fuel source** | Chemical fuel: phosphocreatine | Fuel from food: glucose | Fuel from food: glucose, fats (and protein in extreme circumstances) |
| **Quantity of ATP** | Very limited ATP production | Limited ATP production | Unlimited ATP production |
| **Limitations** | Limited PC stores in the muscle | Accumulation of hydrogen ($H^+$) ions | By-products are water and carbon dioxide; by-products do not cause fatigue<br>Glycogen stores become depleted |
| **What duration and intensity of exercise?** | Used in sprints or any high-intensity activity (95–100% of maximal effort) of short duration (up to 10–12 seconds) | Used in high-intensity activities (85–95% of maximal effort) lasting 1–2 minutes | Used in endurance or long-duration activities lasting over 5 minutes and of submaximal intensity (less than 85% of maximal effort) |

**Table 6.2** The characteristics of the three energy systems.

## Analysing energy systems

**Category:** Performance, Invasion or Net and court
**Physical activity:** The physical activity you are currently studying

**INTEGRATING MOVEMENT**
KEY OBJECTIVES 2, 3, 4

### Purpose

1. This activity is designed to gather primary data that illustrates the interplay of energy systems.
2. The primary data you collect could support your project–folio assessment task.

### Preparation

**Time:** one or two lessons

**Location:** school oval and classroom

**Equipment:** any required for the activity; heart-rate monitors; digital capture devices

### Setup

1. As a class, get into appropriate groups to perform the physical activity; for example, form teams for Invasion games.
2. All students who are performing or playing must put on a heart-rate monitor.
3. Students not currently performing or playing will observe and capture video.

### Performance

1. Perform the physical activity for the duration of the activity, or 10 minutes of game time.
2. Observers must record any behaviour that emerges during the performance period.
3. Once performances or games are complete, observers and performers swap roles.
4. Teachers are to ensure rules are enforced in games and that games are competitive.

### Data recording

1. Keep a record of all data from heart-rate monitors.
2. Observers use digital capture to gather primary data of game play.

### Tasks

1. Share and analyse the primary data using the five-step process: organise, interpret, classify, synthesise and communicate.
2. Identify the interplay of energy systems and the energy demands of the specialised movement sequences, movement strategies from the principles of play (for Net and court and Invasion activities), and body and movement concepts.
3. Determine your suitability to play a selected position, use the data you have collected to justify your evaluation.

# The anaerobic energy systems

There are two anaerobic methods used by the body for resynthesising ATP to supply energy. One uses phosphocreatine (PC) and the other uses glucose. (Remember, 'anaerobic' means that oxygen is not involved in the resynthesis process.)

## The ATP–PC system

The simplest energy system is the adenosine triphosphate–phosphocreatine (ATP–PC) system. This system provides energy through a chemical reaction to resynthesise ATP using phosphocreatine (PC).

A key element of the ATP–PC system is an enzyme called creatine kinase. This protein speeds up a chemical reaction that splits PC into phosphate and creatine, and releases energy. The energy is used in ADP phosphorylation, in which ADP and phosphate combine to make ATP. One molecule of PC yields or resynthesises one molecule of ATP.

The use of this system to provide energy for muscular work is limited by the small supply of PC in the muscle cells. This system mainly supplies ATP for muscular contraction during high-intensity, short-duration activities of up to 10–12 seconds, such as shot-put, long jump, weightlifting or running up a flight of stairs. Because this reaction happens very quickly, it occurs in the absence of oxygen (it is anaerobic).

Once the athlete has depleted the muscles' stores of PC, the body uses one of the other two energy systems as the main way to produce ATP, depending on the intensity of the physical activity. Often there is limited oxygen, so the lactic acid system is the next to contribute more to ATP supply.

**Figure 6.8** The ATP–PC system provides energy for short-duration, high-intensity activities, such as sprinting.

ATP and PC in muscle can be resynthesised aerobically during low-intensity exercise or at rest. The stores are quickly refilled, with ATP levels getting back to 70% in 30 seconds and reaching 100% 3–5 minutes after intense exercise stops. PC stores take slightly longer to recover, with approximately 80% after 2 minutes and full recovery within 8 minutes.

This is why athletes who are training for speed and power activities must have enough recovery time between each effort. Giving themselves the right recovery time means they can work at the correct intensity with each effort they make. It also means they are training using the correct energy system. Sprint and power athletes, and team sports athletes who need short intervals of high-intensity activity, rely heavily on their PC stores to provide energy.

**Engage and understand**
the ATP–PC energy system

1 Summarise how ATP is produced by the ATP–PC energy system.
2 Construct a diagram of the ATP–PC energy system.
3 Explain why the ATP–PC energy system is only able to supply energy for high-intensity, short-duration exercise.

LEARNING EXPERIENCE
KEY OBJECTIVES
1

## The lactic acid system

The second anaerobic energy system, the lactic acid system, starts to contribute more to ATP resynthesis when PC stores in the muscles have run low. The lactic acid system supplies the ATP your muscles need when you exercise at a high intensity and there is demand for rapid ATP production.

Remember, ATP resynthesis is the process of converting ADP and phosphate back to ATP. In the lactic acid system, the energy to do this comes from glycogen, the stored form of the carbohydrates you eat.

**glycolysis**
the reactions that convert glucose into lactate

**pyruvate**
a molecule produced by the breakdown of glucose

The lactic acid system is a more complex method of ATP production than the ATP–PC system. It uses carbohydrates (in the form of blood glucose) as the energy source and includes a series of 10 chemical reactions controlled by enzymes. This series of reactions is known as anaerobic **glycolysis**, where glycolysis is the breakdown of sugar. In this process, glucose is eventually converted into a simple acid called **pyruvate**. This happens very quickly, and for each glucose molecule that is broken down, the energy released resynthesises 2–3 ATP molecules.

**ion**
an atom or molecule with a net electric charge due to the loss or gain of electrons

This series of chemical reactions occurs in the muscle, resynthesising ATP rapidly for continued physical activity. If there is not enough oxygen to further break down pyruvate, another chemical reaction occurs; pyruvate is briefly converted to lactic acid, which almost immediately breaks apart into lactate and hydrogen **ions** ($H^+$).

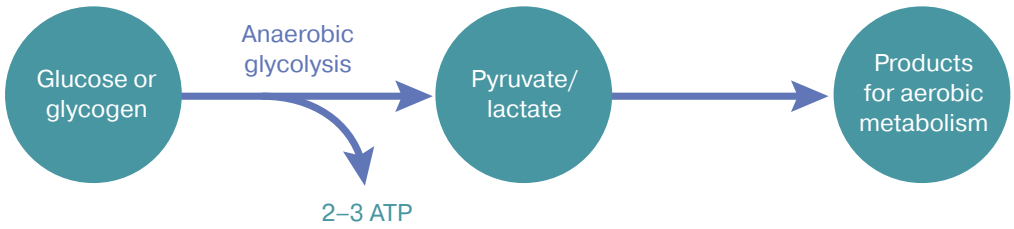



**Figure 6.9** The lactic acid system at work.

When physical activity is of high intensity and oxygen demands exceed the supply, the hydrogen ions in the muscles cells cannot be oxidised (react with oxygen) quickly enough and so they build up. The increase in hydrogen ions makes the pH levels lower in the muscles, which means these cells build up acidity. This is called **acidosis** and it affects the cellular processes in the muscle, interfering with energy production and muscle contraction.

**acidosis** lowering of the pH in any tissue, such as muscle cells or blood

The production of lactate is a normal part of anaerobic glycolysis. It isn't the presence of lactate in muscles cells, but the body's inability to remove lactate from them, that is the limiting factor in this system. When the clearance rate of lactate cannot keep pace with its rate of production, physical activity must stop or decrease in intensity so that the lactate can be cleared. Lactate is cleared aerobically (in the presence of oxygen). By training, you increase how efficiently you can clear lactate during exercise and in recovery.

Because of this limiting factor, the lactic acid system provides the energy for the resynthesis of ATP during high-intensity, moderate-duration activities lasting 30–120 seconds, such as a 100 m swim, a gymnastics routine or repetitive bursts of high-intensity activity during a soccer game. It also supplies ATP as a stopgap in the early minutes of longer submaximal activity until the oxygen supply increases and the aerobic system takes over.

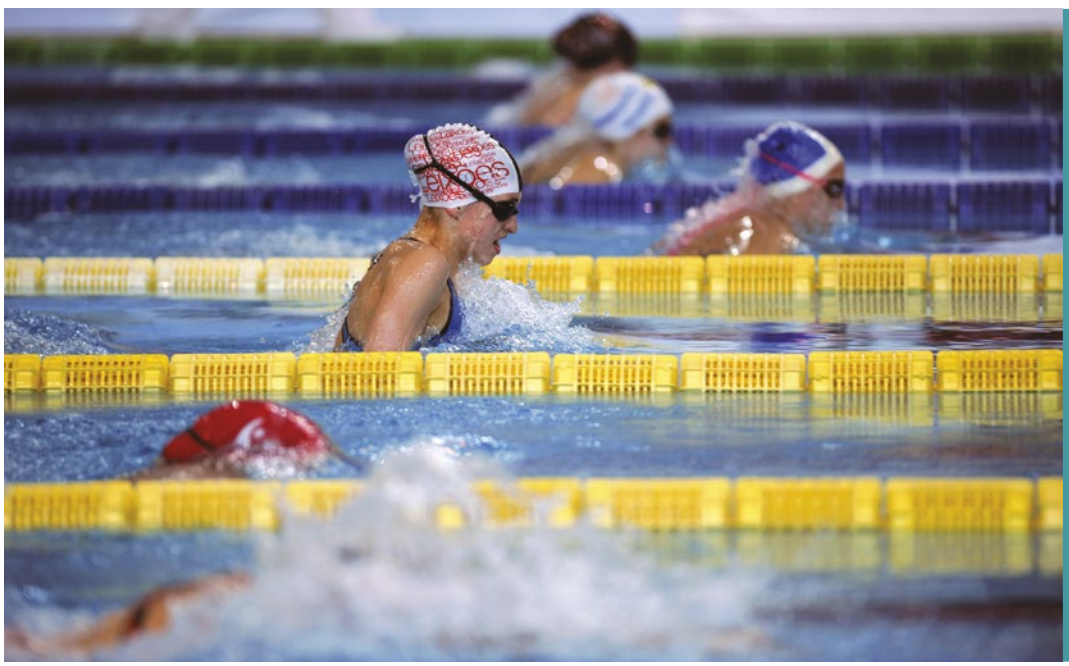


**Figure 6.10** The lactic acid system provides energy for moderate-duration, high-intensity activity, such as the 100 m swim.

## Engage and understand
the lactic acid system

LEARNING EXPERIENCE

KEY OBJECTIVES
1, 7

1 Create a graphic organiser to explain the lactic acid system. In your diagram, show:
   - the fuel it uses
   - whether it is aerobic or anaerobic
   - the yield of ATP
   - the rate ATP is produced
   - the by-products of the process.
2 Explain your graphic organiser to a classmate. If necessary, change it to make sure the information is accurate and that your classmate can use it to understand the lactic acid system.

## Sprint tests

INTEGRATING MOVEMENT

KEY OBJECTIVES
2, 3, 5, 6

**Category:** Performance
**Physical activity:** Track and field – track

### Purpose

1 This activity is designed to investigate the effect of high-intensity effort on heart rate.
2 If you are studying track and field, the primary data collected in this activity could support your project–folio assessment task.

Sample response: pp. 308–310

### Preparation

**Time:** one or two lessons

**Location:** running track marked out at 20 m and 50 m

**Equipment:** stop watches, heart-rate monitors, response tables

### Setup

1 This activity involves completing a series of high-intensity sprints.
2 Split the class into two groups:
   - Group 1 will perform 20 m sprints with 10 seconds of recovery between repetitions.
   - Group 2 will perform 50 m sprints with 30 seconds of recovery between repetitions.
3 Within each group, get into pairs. One member of the pair will conduct the sprints, while the other will act as their partner's timekeeper and data recorder.
4 Before performing the sprints, discuss the following questions as a class and record your answers.
   a How will the contribution of the different energy systems change from the first to the last sprint?

**b** How might the body respond differently if the athlete was a sprinter or an endurance athlete?

**c** How might the contribution of the energy systems differ with specific training and fitness?

**d** What might happen if you changed the recovery time (increased it or decreased it) or the distance sprinted (increased or decreased)?

**5** The runners in each group must put on heart-rate monitors.

### Performance

**1** Each runner in each group completes eight sprint repetitions, with their partners acting as timekeepers and data recorders.

**2** If the class has a second lesson available, runners and partners swap roles and repeat the sprint tests.

### Data recording

Each data recorder completes the table for their partner.

**1** Record the sprint time of each repetition.

**2** Records the heart rate immediately upon the completion of each repetition.

**3** Records the heart rate after 1 minute of recovery, and then after 3 minutes of recovery.

_____m sprint test with _____ recovery

| Repetition | Time | Heart rate (HR) | Recovery HR at 1 min | Recovery HR at 3 min |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |

### Tasks

Each runner and recorder should work as a pair.

**1** Graph the heart rate and time for each sprint.

**2** Describe the correlation between heart rate data and sprint times over the eight sprints.

**3** Discuss what is happening to heart rate at 1-minute recovery and 3-minute recovery. Using the primary heart rate data, explain your understanding of the energy systems in use and their role in recovery after exercise.

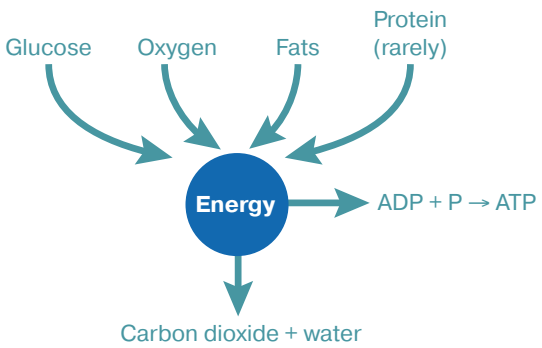
**4** Using the data gathered, comment on the relationships between heart rate responses, high-intensity exercise and recovery.

# The aerobic system

**mitochondria**
structures (organelles) within cells where oxygen and nutrients react and ATP is produced

The aerobic system is the most complex of the three energy systems that provide energy to resynthesise ATP. It has many more reactions in it than the other two systems. This system uses carbohydrates and fats as the primary fuels. The fuels are broken down in the **mitochondria** of the cell in the presence of oxygen to produce energy.

**Figure 6.11**
The aerobic energy system at work.




This energy system does not contribute to ATP resynthesis as soon as you begin to exercise especially if exercising at a high intensity. It takes time for the body to increase the supply of oxygen to the working muscles through increased breathing and heart rate. But once this system is in action, it produces an abundant supply of ATP and no by-products that cause fatigue, as long as the fuel and oxygen supplies remain adequate.

The limiting factors of this system are the stores of fuels (food) and the ability of the **cardiorespiratory** system to supply enough oxygen.

**cardiorespiratory**
relating to the heart, lungs, blood vessels and blood

## $VO_2$max and the lactate threshold

Two key factors affect the aerobic system:

- the supply of oxygen
- the presence of lactate.

The volume of oxygen a person can use in converting food to produce ATP is known as **$VO_2$max**. ($VO_2$max is sometimes called aerobic capacity, maximal oxygen uptake or maximal oxygen consumption.) $VO_2$max is a good measure of a person's capacity for ATP resynthesis and their ability to maintain intense activity without building up blood lactate.

**$VO_2$max**
volume of oxygen an individual can use to produce energy, measured in millilitres per kilogram per minute

**Blood lactate** is, as the name suggests, lactate in the blood. Lactate accumulates only when the amount being produced exceeds the body's ability to clear it through oxidation. Note that:

**blood lactate**
lactate that appears in the blood as a result of anaerobic metabolism

- lactate does not build up at all levels of physical activity
- the presence of blood lactate doesn't necessarily mean that the lactic acid system is the main system of ATP resynthesis at work
- blood lactate doesn't mean that the body cells are starting to experience anaerobic conditions.

The **lactate threshold** is the exercise intensity that an athlete can maintain for a period of time without their blood lactate concentration increasing much. It is generally measured in stages or levels.

**lactate threshold** the highest oxygen consumption or exercise intensity possible with a little increase in blood lactate concentration above resting levels

Lactate threshold 1 is the first point where there is a slight increase in blood lactate levels. For the untrained individual, this usually occurs at around 50–55% of their $VO_2$max, but for a trained endurance athlete it happens at around 80–90% of $VO_2$max. This means that the athlete can work at greater intensity, and for longer, before the body can no longer supply enough oxygen to the working muscles to clear the lactate being produced.

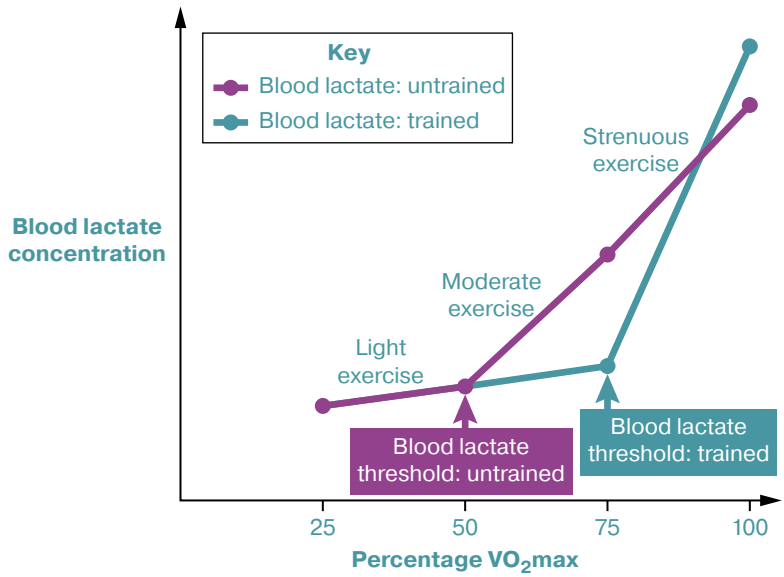



**Figure 6.12** Blood lactate thresholds of trained and untrained people at different intensities of exercise.

Lactate threshold 2, also known as the onset of blood lactate (OBLA), occurs when there is a further increase in blood lactate concentration. It happens as the intensity of exercise increases.

**Source: McArdle, Katch & Katch, 2015, *Exercise Physiology*, p. 162**

## The aerobic system in action

When you begin to exercise, your body does several things that increase your oxygen uptake. To rapidly boost the supply of oxygen to working muscles, all of these increase:

- respiratory rate (breathing rate)
- tidal volume (depth of each breath)
- heart rate
- stroke volume (amount of blood pumped by one beat of the heart)
- cardiac output.

Put simply, when you begin to exercise you breathe more often and more deeply. Your heart beats faster in order to provide more oxygen to the working muscles, and the muscles extract more oxygen from the blood in the arteries.

**excess post-exercise oxygen consumption (EPOC)**
increased rate of oxygen intake during recovery immediately following strenuous activity

The demand for oxygen remains high during your recovery after exercise, as you continue to need higher-than-resting levels of oxygen. This **excess post-exercise oxygen consumption (EPOC)**, as the name suggests, is your body taking in more oxygen to help recovery. It is also referred to as oxygen debt (see p. 173).

Three to five minutes after you begin exercising submaximally, your body can increase the oxygen supply enough to make it possible for most of the ATP to be produced aerobically. The aerobic system is therefore the major contributor of energy in longer-duration, continuous activities, such as marathons, fun runs, lap swimming, road cycling and walking.

**Figure 6.13**
The aerobic system provides energy for continuous activities, such as road cycle racing.

During exercise, the fuels for the aerobic system are:

- glucose, either from muscle tissue or from the liver, released into the bloodstream
- fats, either triglycerides from muscle or fatty acids from adipose tissue, released into the bloodstream.

The fuel used depends on the duration and intensity of the exercise. During rest and in low-intensity activities such as lawn bowls or slow walking, fats are the primary fuel. During exercise such as running, swimming and intense team sports, carbohydrates (glucose) are the primary fuel.

During prolonged endurance events, such as marathons or long-course triathlons, it is possible to use up all the body's carbohydrate (glucose) stores, especially if the athlete has misjudged their pre-event and event nutrition. When this happens, fats become the only fuel available. Using fats as the fuel requires far more oxygen than using carbohydrates to produce the same amount of ATP – so for the athlete to keep going at the same pace, the cardiorespiratory system has to work much harder. This puts a huge strain on the athlete and is often called 'hitting the wall'. At this point, many athletes are forced to reduce the intensity of their effort and also fight hard mentally to keep going.

## Check your understanding 6.3

1. Describe the difference between anaerobic energy systems and the aerobic energy system.
2. Select one of the energy systems and explain how it functions to provide energy to resynthesise ATP.
3. List two advantages and two disadvantages for each of the three energy systems: ATP–PC, lactic acid and aerobic.

## Evaluate and justify
blood lactate levels

LEARNING EXPERIENCE
KEY OBJECTIVES 5, 6

As high levels of lactate can impact on performance, it's vital that athletes train to:

- increase their tolerance to lactate
- increase the point at which it accumulates
- increase the rate at which their bodies can clear lactate during exercise and recovery.

Four elite swimmers are competing for spots on the Australian Olympic team. Figure 6.14 shows their personal blood lactate levels after high-intensity exercise.

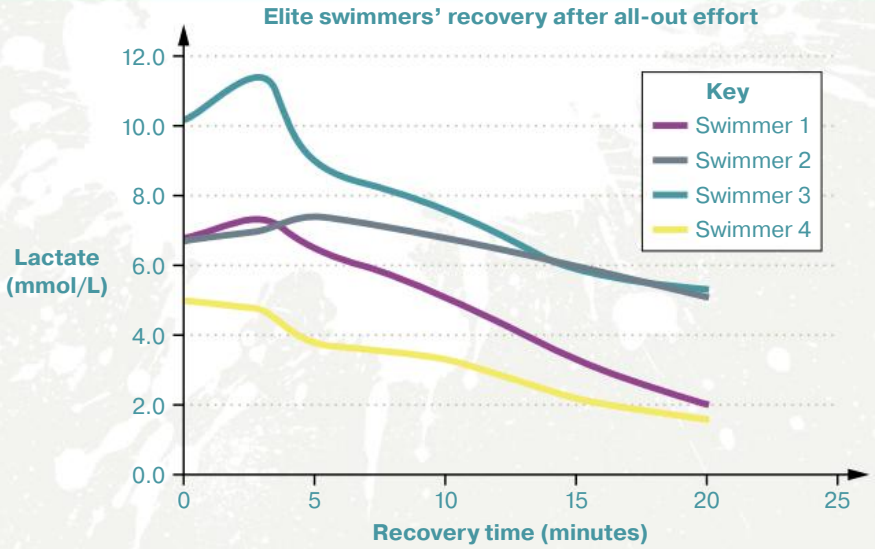



**Figure 6.14** Graph of lactate levels versus recovery time for four elite swimmers.

Apply your understanding of the lactic acid system, lactate clearance and the aerobic system during recovery to predict which two of the four swimmers were selected for the Olympics, and which two did not make it past the trials. Justify your response with reference to the secondary data in the graph.

# 6.4 The interplay of energy systems

As discussed, the human body has three energy systems and these produce energy at different times and in different amounts. Table 6.3 shows each system and its rate of ATP production and total amount of ATP produced (also referred to as yield or capacity).

**Table 6.3** Rate and yield of ATP from the three different energy systems.

| Energy system | Fuel used | Rate of ATP production | Number of ATP molecules produced by one molecule of fuel |
|---|---|---|---|
| ATP–PC | PC | Fastest | 0.7–1.0 |
| Lactic acid | Glucose | Fast | 2–3 |
| Aerobic | Glucose | Moderate | 36–39 |
| | Fatty acids | Slowest | 147 |

## ATP production during resting conditions

When your body is at rest, the demand for ATP is low and the ATP your cells need can be produced aerobically. The chemical reactions producing this ATP occur in the mitochondria of the cells in the muscle fibres. This process is also called cellular respiration.

At rest, the two fuels for aerobic energy production are fats (two-thirds) and carbohydrates (one-third). Fats and glucose (from the breakdown of carbohydrates) combine in chemical reactions with oxygen to release energy and produce:

- the waste product carbon dioxide, which we breathe out
- water, which is removed in sweat, urine and water vapour in the breath
- heat.

The energy released is used to combine ADP molecules with free phosphates to produce large quantities of ATP. Aerobic energy production is very efficient, producing 32 molecules of ATP for each glucose or fat molecule and 147 molecules of ATP for each fat molecule, without producing by-products that cause fatigue.

**Figure 6.15** The aerobic system provides energy when the body is at rest or performing low-intensity everyday activities,such as reading and talking.

## ATP production during exercise

During exercise, the energy system your body uses to produce ATP will depend on:

- how long the exercise continues (duration)
- how vigorous the exercise is (intensity)
- how aerobically fit you are.

Your body is always trying to produce the energy you need aerobically, because the aerobic system is the most efficient in terms of the amount of ATP produced and the type of wastes to be eliminated. To do this, your muscles need a constant, and sometimes large, supply of oxygen. When you begin to exercise, the demand for ATP increases quickly, particularly if the exercise is intense, and therefore the body goes into **oxygen deficit**.

Once you stop exercising, you have to recover and repay the deficit. This recovery includes ADP combining with phosphate to form ATP again. As a result, your breathing and heart rate remain high for some time after exercise stops. This is because your body works aerobically to deliver oxygen to the muscles to resynthesise ATP and remove any accumulated lactic acid and wastes. At this point you are said to be in **oxygen debt** and experiencing excess post-exercise oxygen consumption.

**oxygen deficit** period during exercise when oxygen consumption is below that necessary to aerobically supply the ATP

**oxygen debt** during recovery from exercise, oxygen uptake that is in excess of the normal oxygen uptake in a rest period

To produce all of the ATP required aerobically, you would need the oxygen supply to increase immediately. However, it takes time to get oxygen from the atmosphere into your lungs, absorbed into your blood and transported by the pumping of your heart to your muscles. If oxygen is in limited supply the muscles use the two stopgap methods of producing energy that do not rely on oxygen. The two anaerobic energy systems provide energy for ATP resynthesis during high-intensity, short-to-moderate duration activities, because there is not enough oxygen being delivered through the cardiorespiratory systems to produce all the ATP required aerobically.

## How energy systems work together

Each energy system contributes in varying amounts during physical activity, depending on the intensity and duration of the activity and the fitness level of the individual. They are not independent systems – they are linked together so that your body can work efficiently for as long as needed, and then return to its pre-exercise state as quickly as possible.

The energy systems are all making ATP at all times; but depending on the activity level, one energy system will be producing most of the ATP. Knowing which energy system is working to meet an athlete's ATP needs during a sporting event or activity is useful information for the coach and athlete, so they can design an effective training program, training session or training activity.

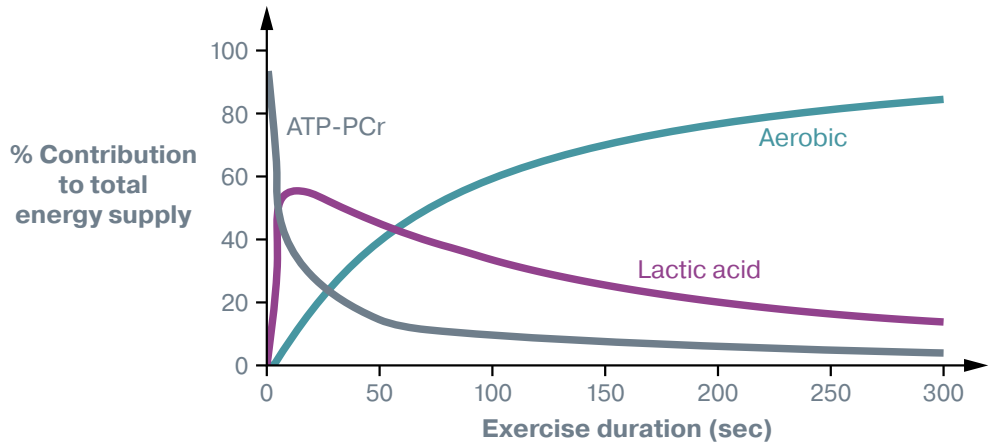



**Figure 6.16** A typical energy continuum, showing the relative energy system contribution to the total energy supply during maximal exercise.

### The energy continuum

You can think about how the energy systems interact by using an *energy continuum*. An energy continuum is a diagram, such as Figure 6.16, that shows the percentage of energy supplied by each system for different durations of physical activity.

At first, the ATP–PC system supplies the energy needed for muscular work, because there is an existing supply of ATP in the muscle cells. However, it is limited and can only be used to supply energy in the first few seconds of the activity.

As exercise continues beyond a few seconds, ATP resynthesis is sustained through a combination of the ATP–PC and lactic acid systems. This is because there is only a limited store of PC in the muscle cells. Notice that at the 10-second mark you can see the lactic acid system becomes more involved.

So high-intensity events that occur in a short time (e.g. the 100 m sprint) rely on the two anaerobic energy systems to meet the demand for ATP. Anaerobic mechanisms provide 70% of the body's energy demands during exercise bouts of around 1 minute.

Further into the period of physical activity, the aerobic system makes a greater contribution to ATP resynthesis. Note the increase in the percentage contribution of the aerobic system at the 1-minute mark, and that this becomes the most active system at the 3-minute mark. By this point the body has increased oxygen supply to the working muscles through increased respiration and heart rate.

## Energy systems in action

Each sport and physical activity has its own unique energy demands. Each movement sequence has its own intensity, and each game has a specific duration. When studying a physical activity, you need to think about the interplay of the three energy systems and how that will affect play.

Consider the interplay of energy systems when a player performs the specialised movement sequences involved in a game of touch football. A typical player might:

- tap the ball to start the game
- run 5–10 m before getting touched
- play the ball
- be involved in several rucks, passes and sidesteps to advance the ball up the field
- move back quickly to get onside
- defend for a set of six touches.

They may have to do this for several minutes before substituting off the field to recover. Without realising it, the athlete has used all three energy systems to provide the energy so muscular contractions of the working muscles (mainly legs) can continue and play can be effective.

A 1500m runner would also utilise all three energy systems in their event but the interplay of energy systems would occur differently in response to the intensity and duration of the event. The athlete uses the ATP–PC system during the first 10seconds of the race. When PC stores run low, the lactic acid system takes over to provide the energy for the athlete to continue at high intensity during the first two minutes of the race. Once the heart and lungs have increased oxygen delivery to the working muscles, the athlete can work aerobically to use carbohydrate stores to provide energy for the second half of the race. For the final lap, the athlete needs to use the anaerobic systems again, as intensity increases when they make the final surge to the line. The athlete then uses the aerobic energy system in the recovery phase to resynthesise ATP and clear blood lactate.

Table 6.4 outlines the main energy systems in use during different physical activities. In some cases, more than one system is used to provide energy for ATP resynthesis and muscular work.

**Table 6.4** The interplay of energy systems in different sports.

| Duration of activity | Main energy system | Fuel | Example sport |
|---|---|---|---|
| 1–4 seconds | ATP–PC | ATP in muscles | Power lifting |
| 4–10 seconds | ATP–PC | ATP and PC | 50 m sprint |
| 10–45 seconds | ATP–PC<br>Lactic acid | ATP and PC<br>Muscle glycogen | 50 m swim |
| 45–120 seconds | Lactic acid | Muscle glycogen | 200–400 m run |
| 120–240 seconds | Lactic acid<br>Aerobic | Muscle glycogen<br>Carbohydrates | Round of boxing |
| 240–600 seconds | Aerobic | Muscle glycogen<br>Fatty acids | 1500 m run |

**Figure 6.17**
Players in a touch football game rely on all three energy systems.

## Check your understanding 6.4

1 Explain why the aerobic system is mostly used during periods of low-intensity activity.
2 What is the difference between oxygen deficit and oxygen debt?
3 Explain what is meant by the interplay of energy systems.

## Apply and analyse
energy system interplay

LEARNING EXPERIENCE
KEY OBJECTIVES
1, 3, 4

1 Consider the physical activity you are currently studying, and select five or six specialised movement sequences, movement strategies or body and movement concepts from that activity.
2 Figure 6.18 shows the range of energy use – from high intensity and short duration, to low intensity and long duration. Place the movement sequences, movement strategies, and body and movement concepts along the arrow, based on their intensity and duration.

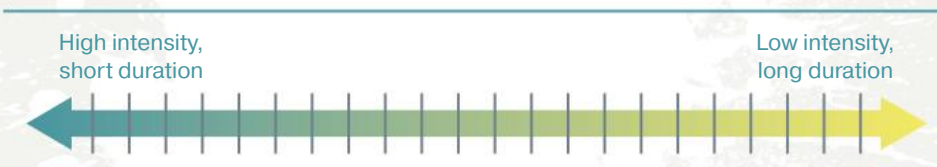



**Figure 6.18**
The range of energy use.

3 Apply your knowledge and understanding of the specialised movement sequences, movement strategies, and body and movement concepts to identify how the interplay of energy systems occurs in your chosen physical activity. Use the examples in Table 6.4 to help you.

# Chapter review

## Key questions and responses

**[6.1] How does the body provide energy for physical activity?**

The body contains an energy-rich molecule called ATP that releases energy when it breaks down and drives the functions of the body, such as physical activity. ATP is found in cell mitochondria in limited amounts. Once it breaks down it must be put back together, or resynthesised, using other fuel sources in the body. This occurs via three different energy pathways.

**[6.2] What are the fuel sources used to keep producing ATP for physical activity?**

There are four fuel sources used by the body to provide the energy to resynthesise ATP. The first is an energy-rich molecule called phosphocreatine (PC) that is broken down to release energy for ATP resynthesis. The other three are food fuels – carbohydrates, fats and (in extreme cases) proteins – that, when broken down, can be used via the energy pathways to provide the energy to resynthesise ATP.

**[6.3] How do the three energy pathways, known as energy systems, produce ATP?**

There are three energy systems that the body uses to resynthesise ATP. These systems are described as either anaerobic or aerobic (taking place without or with oxygen). The ATP–PC system is anaerobic and uses the energy from phosphocreatine (PC) to resynthesise ATP. The lactic acid system is also anaerobic and uses the stored form of carbohydrates to resynthesise ATP. The third and most efficient system is the aerobic system; it uses the carbohydrates as glucose or fats as fatty acids and glycerol in the presence of oxygen to resynthesise ATP.

**[6.4] How does the intensity and duration of a physical activity affect which energy system is contributing most to the production of ATP?**

The three energy systems contribute to providing energy for physical activity in varying amounts, depending on the intensity and duration of the activity. The higher the intensity, the greater the involvement of the anaerobic systems, as they quickly resynthesise ATP in the absence of oxygen within the muscle cell. This can only be sustained for a short-to-moderate duration. During prolonged activity of a lower intensity, or during lower intensity efforts between bouts of high intensity (such as in a team sport), the aerobic system contributes more significantly to resynthesise ATP in the presence of oxygen using the body's food fuel sources.

# Exam-style questions

## Section A: Multiple-choice questions

KEY OBJECTIVES
1

**1** Which pair of physical activities would rely on energy from high-energy phosphates?
- **a** golf, hockey
- **b** weightlifting, walking
- **c** 100 m race, 800 m race
- **d** football, pistol shooting

**2** Which pair of fuel sources supplies energy to maintain the body's stores of ATP?
- **a** free fatty acids and ADP
- **b** triglycerides and glycogen
- **c** adipose tissue and muscles
- **d** phosphocreatine and mitochondria

**3** What are the by-products of aerobic glycolysis?
- **a** pyruvate, lactic acid, ADP
- **b** water, heat, carbon dioxide
- **c** carbon dioxide, lactate, heat
- **d** water, pyruvate, carbon dioxide

**4** What level of intensity does the ATP–PC system provide energy for?
- **a** rest
- **b** maximal
- **c** submaximal
- **d** low intensity

**5** A high aerobic capacity is useful for:
- **a** removal of lactate.
- **b** increased $VO_2$max.
- **c** improved muscle strength.
- **d** decreased ATP production.

**6** Which sport relies predominantly on the lactic acid system?
- **a** soccer
- **b** baseball
- **c** marathon
- **d** 400 m relay

**7** When the heart rate and breathing rate of an athlete remain high, even after they have finished an activity, it is called:
- **a** $VO_2$max.
- **b** oxygen debt.
- **c** oxygen deficit.
- **d** anaerobic threshold.

**8** The lactic acid system becomes the main source of ATP resynthesis during physical activity when:
- **a** there is an increase in intensity and not enough oxygen.
- **b** PC stores have run low and there is not enough oxygen.
- **c** lactic acid stores have run low and lactate has increased.
- **d** glycogen stores have run low and there is enough oxygen.

**9** Which of the following lists shows the order in which food fuels are used as an energy source for ATP resynthesis?
- **a** carbohydrates, proteins, fats
- **b** carbohydrates, fats, proteins
- **c** fats, proteins, carbohydrates
- **d** fats, carbohydrates, proteins

**10** When exercise begins, your body responds to the increased demand for oxygen by:
- **a** making more ATP.
- **b** increasing intensity.
- **c** decreasing heart rate.
- **d** increasing stroke volume.

## Section B: Short-response questions (150–250 words)

KEY OBJECTIVES
1, 4, 7

**1** Explain how the duration of exercise, the intensity of exercise and your aerobic fitness affect which energy system is predominantly in use to provide the energy to resynthesise ATP during a physical activity.

**2** For two different energy systems, compare the fuel sources, rate and yield of ATP, causes of fatigue, and duration of exercise they occur in. Support your response with examples from the physical activity you are currently studying.

# Section C: Extended response to stimulus (400 words)

KEY OBJECTIVES
4, 5, 6, 7

In 2011, scientists Ferran Rodriguez and Alois Mader researched the interplay of energy systems in freestyle swimming over a variety of event distances. Some of the data they gathered is included below.

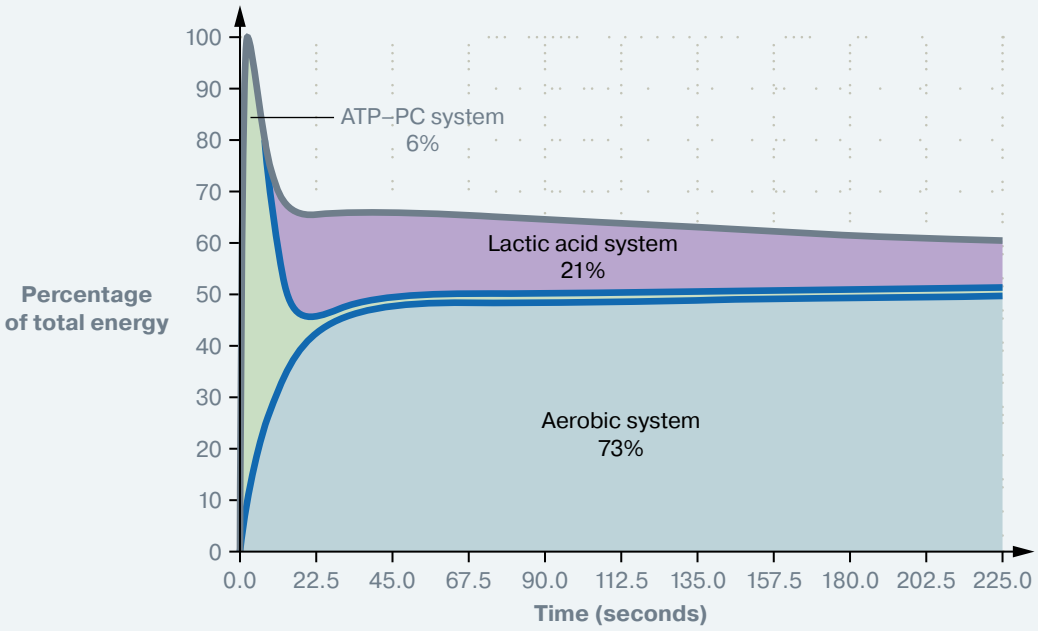



**Figure 6.19**
A computer simulation of the percentage contribution of the three energy systems at different times during a 400 m swimming race.

Source: Seifert, L, Chollet, D and Mujika, I (eds), 2011, *World Book of Swimming: From Science to Performance*, Nova Science Publishers, Inc.

**Table 6.5**
Computer simulation of the percentage contribution of the three energy systems during different swimming events, shown as percentages of the total energy output.

| Distance | Time* (min:s) | ATP–PC (%) | Lactic acid (%) | Aerobic (%) |
|---|---|---|---|---|
| 50 m | 0:22.0 | 38 | 58 | 4 |
| 100 m | 0:48.0 | 20 | 39 | 41 |
| 200 m | 1:45.0 | 13 | 29 | 58 |
| 400 m | 3:45.0 | 6 | 21 | 73 |
| 800 m | 7:50.0 | 4 | 14 | 82 |
| 1500 m | 14:50.0 | 3 | 11 | 86 |

*Times used are the 2008 times for top-level male swimmers. The patterns of energy use are assumed to be similar for female swimmers.

Source: Seifert, L, Chollet, D and Mujika, I (eds), 2011, *World Book of Swimming: From Science to Performance*, Nova Science Publishers, Inc.

Analyse the graph in Figure 6.19 and Table 6.5, showing the share of energy systems during freestyle events. Comment on the interplay of energy systems across the range of freestyle events from 50 m to 1500 m. Explain the importance of this knowledge to the coach and swimmer.

# 7 ASSESSING FITNESS REQUIREMENTS

**Figure 7.1**
The power behind an explosive action in netball is just one component of physical fitness.

Fitness is relevant to everyone, from the average person to elite performers and their coaches. But there are multiple components to fitness, each of which contributes to health or performance. For athletes, fitness testing is needed to identify areas of strength and areas for improvement, which can then be addressed through a targeted training program.

In this chapter, you will investigate seven different components of fitness and consider the importance of each in different activities. You will also learn about, and possibly complete, various fitness tests that are used to evaluate each component of fitness.

## KEY QUESTIONS

**7.1** How is fitness testing important for athletic development?

**7.2** What is the purpose of breaking fitness down into components?

**7.3** Why is aerobic capacity described as the foundation of fitness?

**7.4** How do our muscles contribute to fitness?

**7.5** Which components of fitness are related to moving quickly?

## YOUR CHAPTER PLAN


7.1 Relevance of fitness testing

7.2 The components of fitness

7.3 Aerobic capacity

7.4 Strength, endurance and power

7.5 Flexibility, agility and speed

Chapter review

# 7.1 Relevance of fitness testing

Fitness testing is not just for elite athletes. It can be used in schools and even in the workplace. For example, if you want to join the armed forces you have to pass a range of fitness tests. It's the same if you apply for the Queensland Fire and Emergency Services.

For anyone who is interested in sport-related fitness, fitness testing is essential. Testing can:

- identify strengths and weaknesses
- give feedback about the effectiveness of training
- determine what exercise you should perform
- provide training incentives and motivation
- identify if you have attributes necessary for a sport, such as speed
- assess recovery from injury
- provide benchmarks for comparison to future fitness tests.

The fact that fitness testing is used by major sporting organisations, such as the AFL, shows how useful it is to athletes, coaches and governing bodies.

## Selecting a fitness test

The phrase 'fitness testing' can be misleading, because there are many different components to fitness (as you will discover later in this chapter). No single test can give results about every component; instead, multiple tests are used for each component of fitness. This means you have to choose the right fitness test for a given situation.

To choose the most suitable fitness test, you have to consider how well it measures the specific components of fitness important to the particular sport. For example, an activity that requires running should be tested with a run or treadmill test. These tests would be less relevant to cyclists, rowers or swimmers, so different tests should be used for them.

**valid**
having a sound basis in fact

There are also several other criteria that you need to think about for testing to be **valid**, accurate and suited to your purposes. These are:

- specificity: is the test well suited for the specific sport and situation?
- quality control: are all aspects of the test well designed and effective?
- feedback: does the test provide results that you can interpret and discuss?
- accuracy and reliability: will the test provide the same results if you repeat it under the same conditions?
- practicality: is it practical to perform the test in the conditions available?
- variability: can external factors affect the outcome of the test?

It's rare that a single test is perfect in all criteria. In particular, it's difficult to perform a test with complete accuracy *and* practicality.

The fitness tests used most often for most athletes are *field tests*, as they can be conducted on the field or court, or in the pool or gym. Field tests are:

- low-cost
- simple to run
- don't need much equipment
- can be delivered to large groups.

*Laboratory tests* give much more accurate measures of physiological capacities and have standardised norms for comparison. However, they can depend on having expensive and complex equipment that requires technical skill to operate, which makes such testing impractical in many situations.

## Specific fitness tests

Standard fitness tests measure the fitness component for which they have been designed, but individual coaches or sports often find it more useful to design their own sport-specific tests. These tests then get added to the growing range of available fitness tests.

For example, the Yo-yo intermittent recovery tests measure an athlete's capacity to repeatedly perform high-intensity aerobic activity. These tests were originally developed for soccer but are now used widely for many team sports, such as cricket, that require intermittent bouts of high-intensity activity.

The wide variety of sport- or activity-specific fitness tests means that coaches can develop a **battery** of tests, allowing them to test multiple components of fitness, or to test one component in multiple ways to gather more reliable data.

**battery**
a group of similar items to be used together

An excellent example of this is the testing performed at the national AFL draft camp. Every year, talented young Australian football players are put through a battery of fitness tests at the draft camp to show their levels of fitness. They hope to impress recruiters from the AFL clubs, including Queensland-based teams the Brisbane Lions and the Gold Coast Suns.

Table 7.1 lists some of the draft camp tests, some of which were specifically designed to assess Australian football players and highlight young players with talent.

| Tests | Comments |
|---|---|
| Standing vertical jump | The player jumps as high as possible from a standing start. This test measures leg power. |
| Running vertical jump | This is similar to the standing jump test, but the player takes a few strides first before leaping off one leg. |
| AFL agility test | The player weaves around obstacles at speed over a 40 m course. |
| 20 m shuttle run ('beep test') | Players run 20 m legs back and forth, in the time between a beep sounds. As the test progresses, the time between beeps decreases, until eventually the player cannot keep up. |
| 3 km time trial | Players run 3 km without a break, usually around a track. |
| 6 x 30 m repeat sprint | This test considers both speed and endurance. However, it was removed from the testing battery in 2017, as it increased the risk of injury during the draft. |

**Table 7.1** Battery of tests completed by up-and-coming Australian football players.

As well as fitness tests, the draft camp also tests aspiring players' football skills. Several tests were created with the input of veteran players, such as the Nathan Buckley kicking test and the Matthew Lloyd clean hands test, specifically to match Australian football skills. Finally, the players' physical measurements are taken – their height, weight, arm length, flexibility etc. A player can be fit and have excellent skills, but still fall short of the exacting requirements of the professional league.

**Figure 7.2** Zac Foot performs the vertical jump test during the 2018 AFL Draft Combine.

## Check your understanding 7.1

1. Outline three reasons why fitness testing is essential if you are interested in sport-related fitness and in developing the specialised movement sequences of a physical activity.
2. Identify the advantages and disadvantages of field fitness tests.
3. List the criteria for choosing a fitness test that will identify relevant information for a particular athlete.

# 7.2 The components of fitness

Fitness is generally seen as the ability to carry out everyday activities without becoming too fatigued and still having enough energy left to deal with emergencies and join in active leisure. But in the context of sport and physical activity, fitness is a more complex concept.

You will have seen through your own experiences in sport and physical activity that some people are stronger, faster, can run for longer or are more flexible. Each of these abilities relates to a specific *component* of fitness.

## The seven components

There are many components of fitness. In this Unit, you will consider seven specific components:

- aerobic capacity
- strength
- muscular endurance
- power
- agility
- speed
- flexibility.

Some of these are necessary for general health, and these are the 'health-related' components. The others are the 'skill-related' components of fitness. These are evident in athletes who excel at certain types of sports or physical activities.

For example, a touch football player needs speed and agility, while a sprinter needs speed and power. Athletes in competitive sports and physical activities need to train to develop and improve the components of fitness that are relevant to their physical activity to maximise performance.

Table 7.2 summarises the different components of fitness and lists some of the physical activities that most rely on them.

| Fitness component | Definition | Related physical activity |
|---|---|---|
| Aerobic capacity | The ability to persist in physical activities that rely heavily on oxygen for energy production | Jogging, long-distance running |
| Muscular endurance | The ability of a muscle to perform repetitive work over a prolonged period of time | Long-distance swimming or running, gripping a tennis racquet for a game |
| Speed | The rate of travel of a body without regard to direction | 100 m sprint, many team sports such as Australian football |
| Strength | The capacity to apply force against a resistance | Athletic field events, weightlifting |
| Power | The ability to use strength in rapid, explosive muscle contractions | Athletic field and jump events |
| Flexibility | The range of motion (ROM) of the body's joints | Gymnastics, aerobics |
| Agility | The ability to change the position of the body quickly and precisely and still retain balance | Touch football, netball, Australian football |

**Table 7.2** The components of fitness.

**Figure 7.3** To be successful at high jump, you need several components of fitness, including power and flexibility.

**dexterity** the ability to perform a difficult action quickly and skilfully

Some of these components may be related, such as strength and power. To keep it simple, you can think of them as coming under three broad categories – *aerobic*, *muscular* and ***dexterity***. Later in this chapter, you'll explore each category in more depth, along with the components within it.

It's important to note that these categories are broad, and mostly useful in understanding the components. An individual athlete may be very fit in one component, such as strength, but significantly less fit in another component in the same category, such as muscular endurance.

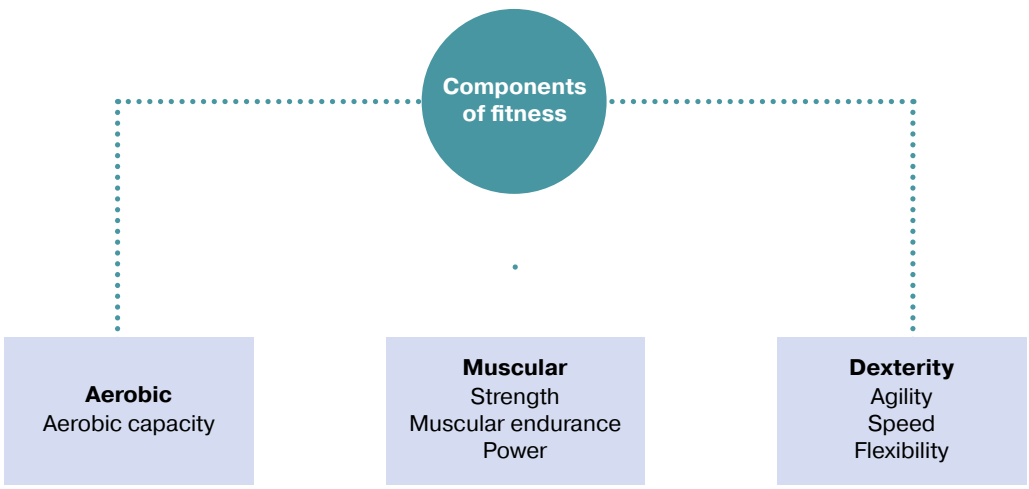



**Figure 7.4** The seven components of fitness can be grouped into three categories.

# Fitness components and energy systems

As you learnt in Chapter 6, the energy you use when you move is produced through three energy systems. Two of these are anaerobic (without oxygen) and one is aerobic (with oxygen).

Different components of fitness draw on different energy systems (Table 7.3). This reflects the needs of the body during physical activity, and the different parts of the body that are at work. Coaches and athletes use their understanding of how the components of fitness use different energy systems when they develop tests and training programs.

| Fitness component | Energy system |
|---|---|
| Aerobic capacity | Aerobic |
| Strength | Anaerobic: ATP–PC |
| Muscular endurance | Anaerobic: lactic acid<br>Aerobic (for activities of longer duration) |
| Power | Anaerobic: ATP–PC |
| Agility | Anaerobic: ATP–PC |
| Speed | Anaerobic: ATP–PC, lactic acid (for activities of slightly longer duration) |

**Table 7.3** Fitness components and energy systems.

## Check your understanding 7.2

1. Explain the difference between muscular endurance, power and strength.
2. Explain why muscular endurance can use both the anaerobic and aerobic systems to provide energy for ATP resynthesis.
3. Identify which components of fitness would be classed as necessary for health, and which would be necessary for developing excellence in a particular sport.

## Apply and analyse
relevant components of fitness

**LEARNING EXPERIENCE**

KEY OBJECTIVES
1, 3, 4

1 Identify the two most relevant components of fitness for each physical activity in the table that follows.

2 For the physical activity you are currently studying, explain which two components you identified as most relevant and why. Give examples to show why you chose these components, using the specialised movement sequences required in that physical activity.

| Activity or sport | Strength | Power | Muscular endurance | Aerobic capacity | Agility | Speed | Flexibility |
|---|---|---|---|---|---|---|---|
| Tennis | | | | | | | |
| Cricket | | | | | | | |
| Touch football | | | | | | | |
| Australian football | | | | | | | |
| Netball | | | | | | | |
| Softball | | | | | | | |
| Water polo | | | | | | | |
| Basketball | | | | | | | |
| Volleyball | | | | | | | |
| Soccer | | | | | | | |
| Aerobics | | | | | | | |
| Archery | | | | | | | |
| Golf | | | | | | | |
| Futsal | | | | | | | |
| Badminton | | | | | | | |
| Triathlon | | | | | | | |
| Lawn bowls | | | | | | | |

# 7.3 Aerobic capacity

**Aerobic capacity** (also referred to as aerobic fitness or aerobic endurance) is an essential component of fitness. It relates to stamina or heart–lung fitness, which is why it is a health-related component of fitness.

**aerobic capacity** the ability to persist in physical activities that rely heavily on oxygen for energy production

As the name implies, aerobic capacity is the ability to keep producing energy aerobically. Aerobic energy is used to perform tasks that involve the whole body for extended periods of time. If you have good aerobic capacity then you have good heart–lung (cardiorespiratory) efficiency, both in delivering oxygen to the working muscles and removing wastes such as carbon dioxide.

Your ability to effectively consume oxygen for energy production is called your **oxygen uptake**, or $VO_2$. Your highest possible oxygen intake is called your $VO_2$max or maximal oxygen uptake. $VO_2$max is an excellent measure of your aerobic capacity.

**oxygen uptake** the ability to utilise oxygen to produce energy

Oxygen uptake is related to your body size, and reflects your oxygen consumption per minute. It is given in millilitres of oxygen consumed per kilogram of body weight per minute (mL/kg/min). It is also affected by age, sex and your genetic make-up.

$VO_2$max
p. 168

## Physical activities and aerobic capacity

A high aerobic capacity is never a bad thing. Even people who don't regularly play sport or do a lot of physical activity still gain health benefits from having a high $VO_2$max.

For almost all athletes, though, aerobic capacity can be extremely important. Athletes who are good at endurance sports have a greater capacity for *aerobic transfer* — the ability to generate energy for the aerobic resynthesis of ATP. In other words, they have a greater capacity to take up, deliver and transfer oxygen to the working muscles, and to remove carbon dioxide and other by-products. This means that, no matter the sport, $VO_2$max is a good measure of an individual's capacity to exercise.

Many elite athletes record a $VO_2$max well over 60 mL/kg/min, depending on their sport. The highest recorded male $VO_2$max was 94 mL/kg/min and female 77 mL/kg/min – both were cross-country skiers. Table 7.4 shows the typical $VO_2$max levels of world class and domestic professional cyclists; this is a good indication of the importance of aerobic capacity at the elite level.

| Skill level | Typical male $VO_2$max (mL/kg/min) | Typical female $VO_2$max (mL/kg/min) |
|---|---|---|
| World class | 75–90 | >60 |
| Domestic pro | 68–80 | 50–60 |
| Category One | 58–73 | 45–55 |
| Category Two | 50–63 | 40–50 |
| Category Three | <50 | <40 |

**Table 7.4** Typical $VO_2$max levels of professional cyclists.

## Effects of aerobic capacity

You can see how important aerobic capacity is once an athlete begins to exercise for more than 30 seconds. Oxygen is vital for the athlete to keep producing energy from this point on (p. 174). To rapidly increase oxygen delivery to the working muscles ($VO_2$), the athlete's body increases the:

- respiratory rate (number of breaths taken per minute)
- tidal volume (depth of each breath)
- heart rate (number of beats per minute – bpm)
- stroke volume (volume of blood in millilitres pumped from the left ventricle per beat or stroke)
- cardiac output (amount of blood pumped by the heart per minute in litres, calculated by multiplying stroke volume by beats per minute)
- arteriovenous oxygen difference (sometimes shortened to a–$vO_2$ diff.).

Note that arteriovenous oxygen difference is the difference between oxygen concentration in **arterial blood** and in **venous blood**. It shows how much oxygen is used by the tissues of a muscle.

**arterial blood**
blood pumped from the heart that is high in oxygen

**venous blood**
blood flowing back into the heart that is low in oxygen

Aerobic capacity is needed most for activities such as distance running, swimming, surfing and cycling. While endurance athletes benefit from a higher aerobic capacity, so do most team sport athletes, as they need a solid base of aerobic fitness so they can recover rapidly between periods of high-intensity effort.

Aerobic activities also require local muscular endurance.

**Figure 7.5** The Tour de France demonstrates why elite cyclists need to have a high aerobic capacity.

# Aerobic capacity tests

Aerobic capacity is the component of fitness that is most often tested. There are a number of tests you can use to find approximate $VO_2$max without using expensive laboratory equipment. They include:

- the Multi-stage fitness test
- the Yo-yo intermittent recovery test
- Cooper's 12-minute run test
- 30–15 intermittent fitness test

Let's consider two of these tests in more depth.

Yo-yo intermittent recovery test
http://mea.digital/qpe34_4

## 12-minute run test

The original run test was the 12-minute run, developed in 1968 by Kenneth Cooper for the US military.

This test was based on laboratory treadmill data taken from groups of people with varying fitness levels. The data showed a **linear relationship** between the distance an individual could run in 12 minutes and the amount of oxygen they consumed (their $VO_2$max). This means that the distance an athlete can run in 12 minutes can be used to predict their $VO_2$max.

**linear relationship**
a straight-line relationship between two factors; when one increases, so does the other by a constant amount

### 12-minute run test

**Category:** N/A
**Physical activity:** Running

**Purpose**

1. This activity involves completing the 12-minute run test to calculate $VO_2$max.
2. The primary fitness data you collected could be used to support your project–folio assessment.

**Preparation**

**Time:** one or two lessons

**Location:** 400 m track marked with a cone every 50 m

**Equipment:** recording sheet, stopwatch, heart-rate monitor

**Setup**

1. Get into pairs for this field test. One person (the runner) will complete the test, while the other records data.
2. Participate in a complete warm-up, involving jogging and dynamic lower body stretches, to prepare the muscles for the run.
3. Equip the runner with the heart-rate monitor and the data recorder with the stopwatch and recording sheet.

**INTEGRATING MOVEMENT**

KEY OBJECTIVES
2, 3, 4

Sample response:
pp. 311–312

### Performance

1. The runner runs, jogs or walks around the track for 12 minutes, at their own pace.
2. Once the runner is finished, the runner and data recorder swap roles and complete another field test.

### Data recording

1. The data recorder takes a note of:
   - **a** laps completed
   - **b** heart rate at each lap
   - **c** activity of the runner when their heart rate was recorded (e.g walking, jogging, running)
   - **d** the total number of metres run by the participant at the end of the test.

### Tasks

1. Provide your partner with their performance data, and vice versa.
2. Use Table 7.5 to identify your rating, based on the distance you achieved in metres.
3. Convert the distance covered to kilometres and calculate the $VO_2$max using the following formula:
   $VO_2max = (22.351 \times km) - 11.288$
   e.g. $(22.351 \times 2.25) - 11.288 =$
4. Use Table 7.6 to identify your $VO_2$max rating.
5. Use the figures calculated to explain what your $VO_2$max indicates about your aerobic capacity.
6. Interpret this information in the context of the activity you're studying, and suggest how or whether it would be reflected there.

**Table 7.5** Ratings for the 12-minute run test for male and female participants, based on metres covered.

| Rating | Male runners | | Female runners | |
|---|---|---|---|---|
| | Age 15–16 | Age 17–20 | Age 15–16 | Age 17–20 |
| Excellent | >2800 m | >3000 m | >2100 m | >2300 m |
| Above average | 2500–2800 m | 2700–3000 m | 2000–2100 m | 2100–2300 m |
| Average | 2300–2499 m | 2500–2699 m | 1700–1999 m | 1800–2099 m |
| Below average | 2200–2299 m | 2300–2499 m | 1600–1699 m | 1700–1799 m |
| Poor | <2200 m | <2300 m | <1600 m | <1700 m |

**Table 7.6** $VO_2$max ratings for male and female participants (values in mL/kg/min).

| Sex | Very poor | Poor | Fair | Good | Excellent | Superior |
|---|---|---|---|---|---|---|
| Female | <25.0 | 25.0–30.9 | 31.0–34.9 | 35.0–38.9 | 39.0–41.9 | >41.9 |
| Male | <35.0 | 35.0–38.3 | 38.4–45.1 | 45.2–50.9 | 51.0–55.9 | >55.9 |

## 30-15 intermittent fitness test

The 30-15 intermittent fitness test (usually referred to as the 30-15 IFT) was developed by Martin Buchheit in 2008. It is another field test that looks at aerobic capacity, particularly $VO_2$max.

This test is also relevant to an athlete's ability to make changes of direction, their anaerobic capacity and their ability to recover between intermittent efforts. As a result, it is suited to many physical activities, such as touch football, soccer, hockey, netball and basketball. These are known as *intermittent sports*, where periods of high-intensity effort are followed by periods of recovery or lower intensity. Intermittent sports such as these are both aerobic and anaerobic.

In this field test, you perform high-intensity running for 30 seconds, followed by 15 seconds of recovery (walking) over a 40 m distance. This is repeated at increasing speeds until you reach exhaustion. This work-to-rest ratio of 30 to 15 seconds (2:1) is often reflected in intermittent sports.

The 30-15 IFT is also one of several tests known as *beep tests*, because they are managed using a series of timed beeps. During the test, you must continue to run for 30 seconds between the two end lines at a speed controlled by the beeps. You must reach the next 3 m zone by each beep. You will then get a 15-second recovery period.

If an athlete fails three times in a row to reach a 3 m recovery zone by the beep, they are withdrawn from the test. Their score is recorded as their speed for the last level they completed. This score is commonly called their velocity – intermittent fitness test ($V_{IFT}$). The $V_{IFT}$ can then be used to work out the athlete's $VO_2$max.

30-15 IFT is a free app that provides four versions of this fitness test. http://mea.digital/qpe34_5

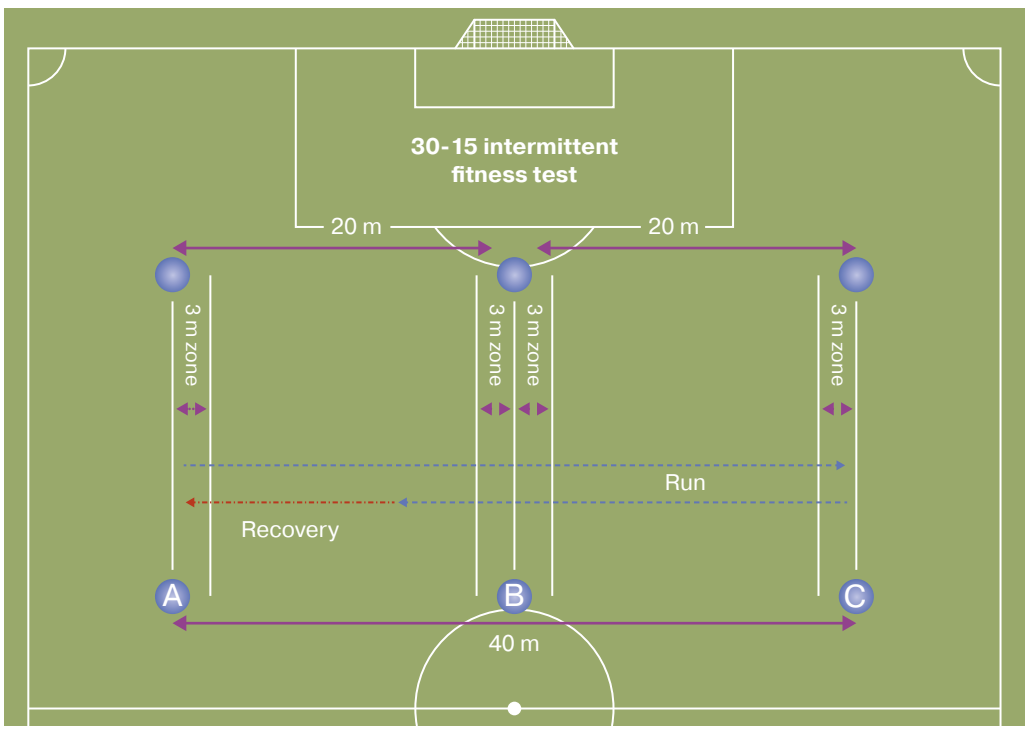



**Figure 7.6** The layout of the field for the 30-15 intermittent fitness test.

## Check your understanding 7.3

1. Identify which test out of those covered here would be most suitable to test aerobic capacity for the physical activity you are currently studying and explain why.
2. List the advantages of the 30-15 intermittent fitness test.
3. Explain how the body responds during exercise to increase oxygen supply to the working muscles.

## Apply and analyse differences in $VO_2$max

**LEARNING EXPERIENCE**

KEY OBJECTIVES
1, 3, 4

This table is an example of data that shows some of the factors affecting $VO_2$max and the differences in trained and untrained people. The data comes from a laboratory study of six college students – two who underwent physical training before testing, two who stayed in bed before testing, and two who acted as a control, with no unusual rest or activity before testing.

| Factors | College students | | | World class athletes |
|---|---|---|---|---|
| | Control | Bedrest | Training | |
| $VO_2$max (L/min) | 3.3 | 2.4 | 3.9 | 5.3 |
| Maximum ventilation (L/min) | 191 | 201 | 197 | 219 |
| Arterial $O_2$ (mL $O_2$/100 mL blood) | 21.9 | 20.5 | 20.8 | 22.4 |
| Arteriovenous oxygen difference (mL $O_2$/100 mL blood) | 16.2 | 16.5 | 17.1 | 18.0 |
| Maximum cardiac output (L/min) | 20.0 | 14.8 | 22.8 | 30.4 |
| Maximum heart rate (bpm) | 192 | 197 | 190 | 182 |
| Stroke volume | 104 | 74 | 120 | 167 |

Source: https://courses.washington.edu/conj/exercise/vo2_2011.htm

1. Calculate the cardiac output ($Q$ = the amount of blood pumped out of the heart's left ventricle) for the control students, given that:
   cardiac output ($Q$) = stroke volume × heart rate.
   (Note: $Q$ is recorded as litres per minute.)
2. Explain why there is a marked difference in the $VO_2$max for the world class athletes, compared to the college students.
3. All values for the world class athletes are higher except for maximum heart rate (bpm). Explain why.

# 7.4 Strength, endurance and power

Strength, muscular endurance and power all use high-intensity muscular contractions and rely on the anaerobic energy pathways. However, they have differences that you should understand, so you can target the most appropriate components of fitness when training in your chosen physical activity.

## Strength

**Strength** is the force that a muscle or group of muscles can exert against a resistance in a single maximal contraction.

**strength**
the force that a muscle can exert against resistance

Physical activities that require strength include:

- gripping a hockey stick, tennis racquet or golf club when hitting the ball
- weightlifting
- jostling for position in basketball or soccer
- tackling in rugby or Australian football
- field events involving throwing.

Strength is the foundation of muscular power and is vital in preventing injury to your muscles, tendons and ligaments. Strength activities rely on the ATP–PC anaerobic energy production within the muscles.

ATP-PC energy system: p. 163

**Figure 7.7** Weight training develops strength in multiple different muscle groups.

**muscle fibres**
long cells that make up the tissues of muscles

There are two major types of skeletal **muscle fibres** that affect the application of strength, called slow twitch and fast twitch. Your genetic makeup tends to give you different amounts of these fibre types, which affects your speed and endurance potential.

Slow-twitch fibres are suited to aerobic endurance work, as they contract slowly and are slow to fatigue. Fast-twitch fibres are speed/strength fibres; they are suited to anaerobic work, as they contract rapidly but are easily fatigued.

**myoglobin**
iron- and oxygen-binding protein found in muscle tissue

**capillary**
very fine, branching blood vessels

Slow-twitch muscle fibres are red in colour because they contain high levels of **myoglobin** (oxygen-binding protein). They also have many fine blood vessels, called **capillaries**, to provide them with oxygenated blood. Inside these muscle cells are high numbers of mitochondria, where the aerobic breakdown of glucose for energy production occurs.

Fast-twitch muscle fibres, on the other hand, are light pink (or even white) in colour because they have less myoglobin and lower capillary density. They are less effective at generating energy, so while they allow more application of strength and speed, they fatigue quickly.

Figure 7.8 shows the difference in muscle fibre types in the context of long-distance, middle-distance and sprint running, while Table 7.7 further outlines the differences between fast-twitch and slow-twitch muscle fibres.

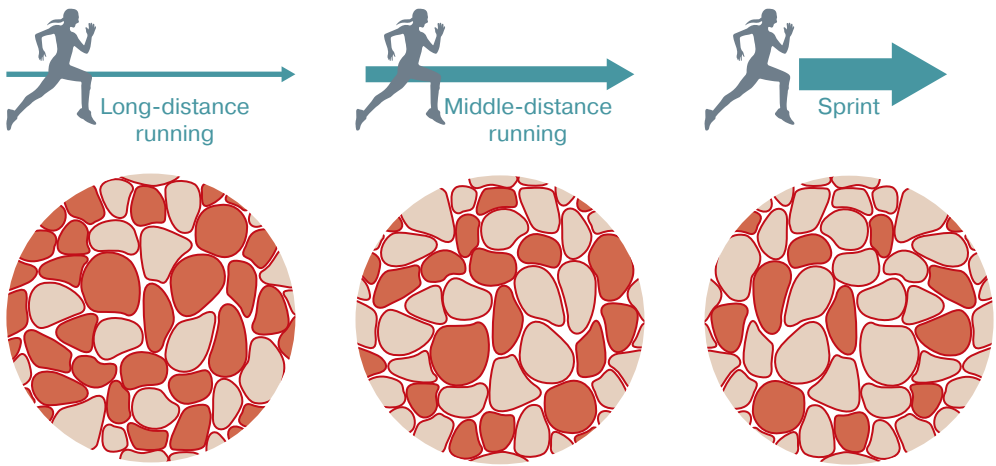



**Figure 7.8** Slow-twitch (red) fibres support long-distance running, while fast-twitch (light pink) fibres are more important for sprinting.

**Table 7.7** Differences between fast-twitch and slow-twitch muscle fibres.

| Characteristic | Fast-twitch muscle fibres | Slow-twitch muscle fibres |
|---|---|---|
| Contraction time | fast | slow |
| Force of contraction | high | low |
| Aerobic capacity | low | high |
| Anaerobic capacity | high | low |
| Capillary density | low | high |
| Force of contraction | high | low |
| Most useful in | sprint-type activities | endurance-type activities |
| Distribution in athletes | high in non-endurance athletes | high in endurance athletes |
| Onset of fatigue | rapid | slow |

## Factors affecting the application of strength

There are six factors that affect the application of strength:

1. the number of muscle fibres activated: when more are activated, the force of the muscular contraction is greater
2. the cross-sectional area of a muscle: the larger the muscle, the greater the strength potential
3. pre-stretch: muscles that are slightly stretched have a greater capacity to generate force
4. balance of muscle fibre types: people who excel at sports that need strength may have a higher ratio of fast-twitch fibres to slow-twitch fibres
5. age: the greatest strength and muscle gains occur between the ages of 10 and 20 years, when you have the most rapid growth and development
6. sex: testosterone generally gives men more muscle tissue than women.

## Strength tests

Fitness tests for **strength** are straightforward; you only need simple equipment, such as weights. Common tests include:

- weightlifting: a 1 RM bench press, back squat or leg press (1 RM, or *repetition maximum*, is the amount of force that can be generated in one maximal contraction)
- the seven-stage single-rep sit-up test: this tests abdominal strength
- hand-grip dynamometer test.

**strength**
the force that a muscle can exert against resistance

### Engage and understand
hand-grip dynamometer test

LEARNING EXPERIENCE

KEY OBJECTIVES
1

This field test measures the strength of the muscles of the fingers, hand and forearm, using a device called a hand-grip dynamometer.

1. Hold the dynamometer in your hand, palm up, with your arm raised and parallel to the floor. Make sure the pointer has been reset to zero.
2. Squeeze the grip as hard as possible for several seconds. A downwards thrust is allowed, but if your hand, arm or elbow touches your body or any other object while performing the test, the test is invalid.
3. Record the best trial from three attempts for your dominant and non-dominant hands.
4. Compare your results with the norms shown in the table.

| Rating | Males | | Females | |
|---|---|---|---|---|
| | Non-dominant | Dominant | Non-dominant | Dominant |
| Excellent | >57 | >61 | >36 | >40 |
| Good | 51–56 | 55–60 | 31–36 | 35–40 |
| Average | 45–50 | 49–54 | 25–30 | 29–34 |
| Fair | 39–44 | 43–47 | 19–24 | 23–27 |
| Poor | <39 | <43 | <19 | <23 |

## Muscular endurance

**muscular endurance**
the ability of a muscle to sustain repeated contractions against resistance for an extended period

**Muscular endurance** is the ability to work a muscle for long periods at less than maximum effort. What limits your muscular endurance is local fatigue, when your specific muscle group gets tired, rather than you being exhausted overall.

Actions that can be repeated 30 or more times without rest are classed as needing muscular endurance. Some examples include:

- paddling a canoe (muscular endurance in the arms)
- distance swimming (muscular endurance in the arms and shoulders)
- jogging (muscular endurance in the legs)
- gripping a tennis racquet for a whole set (muscular endurance in the forearm).

Muscular endurance activities rely on a combination of aerobic and lactic acid anaerobic energy production, depending on the intensity and frequency of muscle contractions you have to perform.

**Figure 7.9**
Lap swimming requires muscular endurance in the arms and shoulders.

## Factors affecting muscular endurance

Muscular endurance is greatest when you have:

1. low intensity of muscle contractions (slow contraction time and low contraction force, so the action can be repeated many times without fatigue)
2. high numbers of slow-twitch muscle fibres, which have high blood supply and high levels of aerobic energy production
3. high ability to tolerate lactate and other by-products of energy production.

## Muscular endurance tests

Like strength tests, it's pretty easy to run fitness tests for muscular endurance without special equipment. Common tests include:

- the flexed arm hang
- the wall squat test
- the sit-up test
- the Bosco repetitive jump test
- the push-up test.

The *push-up test* is used to test for muscular endurance of the chest, shoulders and triceps. (There are many similar endurance tests, such as the incline push-up test.) The person being tested does as many push-ups as possible in 60 seconds.

To perform a push-up test:

1. Start in the push-up position with your weight on your hands and toes. Your hands should be just wider than shoulder-width apart, and your back and legs kept straight at all times.
2. Lower your body to the floor until your elbows are at 90 degrees.
3. Push back up to the start position. This is one repetition.
4. Repeat as many times as possible. The push-up does not count if your chest does not come to just off the floor.

| Rating | 16–19-year-old males | 16–19-year-old females |
|---|---|---|
| Excellent | >56 | >35 |
| Good | 35–56 | 21–35 |
| Average | 19–34 | 11–20 |
| Fair | 11–18 | 6–10 |
| Poor | <11 | <6 |

**Table 7.8** Ratings for the push-up test.

# Power

**power**
the ability to exert maximal force in a short period of time

Muscular **power** is the ability to use strength quickly to produce an explosive effort.

Power depends on a trade-off between strength and speed. Slow muscle contractions produce maximum force. During quick contractions there is not enough time to develop a large force. You produce maximum power when both the speed and force of contraction are about 35% of maximum.

Sporting activities that need power include:

- throwing events
- jumping events
- sprint starts
- dunking a basketball
- kicking a ball for distance.

Power activities rely on ATP–PC anaerobic energy production, and so power athletes require high proportions of white (fast-twitch) fibres in their muscles.

## Power tests

Fitness tests for power often need more equipment and preparation than strength and endurance tests, but you can still do them in the field. Common tests include:

- standing backward overhead throw
- vertical jump test
- basketball throw
- Wingate anaerobic test
- Margaria-Kalamen stair climb

**Figure 7.10** The basketball slam dunk is a classic example of power in sport.

*Stair-sprinting field tests*, such as the Margaria-Kalamen stair climb, are safe, inexpensive tests that use very little equipment. Large groups can do these tests quite quickly, giving a valid measure of each person's power output. These tests give a reliable method of comparing changes in leg power as a result of training.

To carry out a stair-sprint test, you need:

- a stopwatch
- recorders
- a flight of 12 steps about 17.5 cm high
- weighing scales.

The steps of the test are as follows:

1. Place markers on the third, sixth and ninth steps, and mark out a start line 6 m from the first step.
2. Record the weight of each participant.
3. Make sure the participants warm up adequately, and allow them to practise running up the flight of stairs three steps at a time.
4. To begin, each participant stands at the start line, in line with the flight of steps.
5. On 'Go!', the athlete sprints to and up the flight of steps, stepping only on the third, sixth and ninth steps, moving as quickly as possible
6. Record the time they take to get from the third to the ninth step. Start the stopwatch when their foot first comes in contact with the third step, and stop when the foot contacts the ninth step.
7. Conduct three trials of the test, with a 2–3-minute recovery between each trial.

To calculate the power generated by the participant's legs, use the formula

$$P = \frac{M \times D \times 9.8}{t}$$

where $P$ = power (watts), $M$ = body mass (kg), $D$ = the vertical distance between the third and ninth steps (metres), and $t$ = time (seconds). (The number 9.8 in the formula is the constant of gravity.)

## Check your understanding 7.4

1. Explain the differences between muscular endurance, strength and power.
2. Explain the difference between fast-twitch and slow-twitch muscle fibres.
3. Compare the factors affecting the application of strength and endurance.

# 7.5 Flexibility, agility and speed

The final three components of fitness all relate to moving quickly and effectively. They are often grouped together under the heading of dexterity. These three components have more differences between them than those grouped together as muscular fitness. One big difference is that they draw on different energy pathways.

## Flexibility

**flexibility** the ability to perform large joint movements easily

**Flexibility** is the ability of your muscles, ligaments and tendons to allow large movements of the joints. It is often called mobility or suppleness. Flexibility can be increased by stretching the muscles regularly. To a limited degree, stretching also increases flexibility in the tendons and ligaments.

Physical activities that need flexibility include gymnastics, hurdling, high jump, tackling in team sports, and most kinds of dance.

There are two types of flexibility:

- static or passive flexibility – flexibility displayed when holding a stretch without moving for a certain period, e.g. 30 seconds. Static stretching improves the full range of motion (ROM) for a specific joint
- dynamic or active flexibility – flexibility displayed during movement. Dynamic stretching improves the ROM that is possible when you meet resistance during movement.

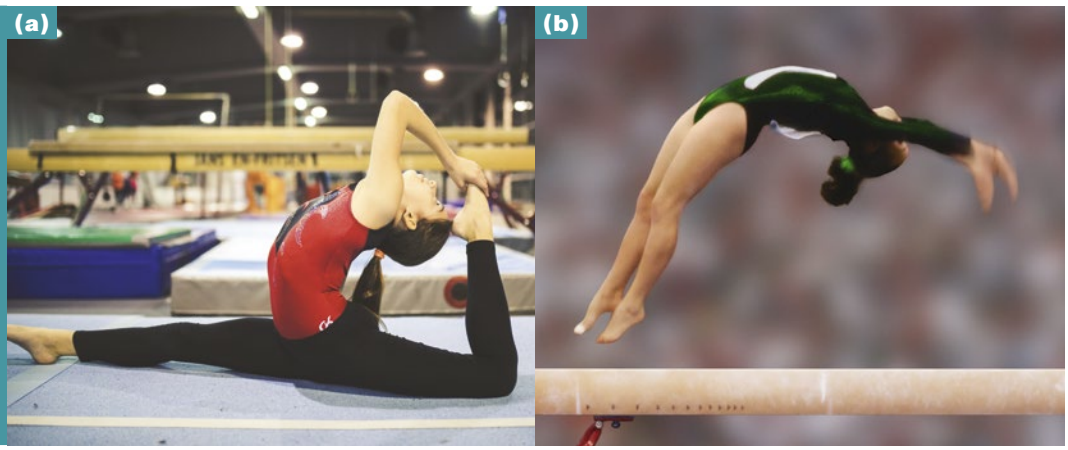



**Figure 7.11** Gymnasts need high levels of both **(a)** static and **(b)** dynamic flexibility.

### Factors affecting flexibility

There are eight factors that can affect flexibility.

1. The type of joint: specific joints have either strength, mobility or a combination of both. For example, the shoulder joint has excellent mobility but can dislocate easily, whereas the hip joint is highly stable and as a result less mobile.
2. The resting length of the muscles: if muscles at rest are shortened, then flexibility is limited; this can occur in the hamstrings in a job that requires a lot of sitting. When you are weight training, it's important to put a joint through its full ROM so as not to shorten the muscles being trained.

3 The resting lengths of the ligaments and **joint capsule**: if you stretch the structures around the joint during training, it can increase joint flexibility.
4 Body type: endomorphs may have limited flexibility because of their extra bulk. Mesomorphs also may have limited flexibility if they have trained with a limited range of movement or because of extra muscle tissue. Ectomorphs generally have quite good flexibility because they have less body tissue.
5 Muscle and joint temperature: warming up before physical activity can increase:
   - the ROM of joints
   - blood flow to the muscle
   - body temperature, which activates and mobilises the muscles.
6 Sex: hormonal differences mean that women are generally more flexible than men.
7 Age: as you age, your flexibility decreases.
8 Injury: if you get an injury, you may not be able to move a particular body part, which will make it less flexible.

**joint capsule**
the envelope of cartilage, ligaments and fluid surrounding each joint

Body types: >
Units 1+2, pp. 288–9

## Lack of flexibility

While not all sports need you to have high levels of flexibility, it is still important in most physical activities. There are multiple problems associated with lack of flexibility. Tight, short muscles can:

- tear and strain much more readily during sports activities than flexible muscles. Footballers who have short hamstrings, or who do not stretch their hamstrings, often pull these muscles when kicking.
- produce bad body posture. Tight pectorals can cause a cramped chest and round shoulders.
- produce health problems. Tight hip flexors can pull on the lumbar vertebrae, producing lower back pain.
- prevent competitive players from fulfilling their potential. A hurdler with limited hip flexibility might have to jump 10 cm higher to clear the hurdle than someone with flexible hips, and will thus be slower; a swimmer with poor shoulder flexibility has a reduced distance over which to develop force in an arm stroke.

It's important to stretch to improve flexibility, and this component of fitness is often overlooked.

Static stretching is excellent as part of cooling down. In contrast, dynamic or active stretching, such as leg swings, air squats, side lunges and arm circles, are critical in preparing the athlete during a warm-up, and can actually enhance speed, power and agility. This is because dynamic stretches involve movements that repeatedly put the muscles through the ROM that the athlete will perform during the physical activity.

**Figure 7.12** Soccer stars Cristian Ronaldo and Joao Mario know the value of dynamic stretching as a part of their pre-game warm-up.

## Flexibility tests

Field tests for flexibility often look at static flexibility, as it's simpler to test flexibility when the participant is not in full motion. Dynamic flexibility tests are more likely to require special equipment. Common tests include:

- sit-and-reach test
- the bend, twist and touch test
- shoulder rotation test
- groin flexibility test.

The *sit-and-reach test* measures the bending of your body and the ability to stretch the lower back muscles and hamstring muscles. It uses minimal equipment – just a bench with a rigid base and a metre ruler. However, it is best carried out after a total body warm-up, which you can do by completing an aerobic submaximal test first. The sit-and-reach test can be done on a single leg or both legs together.

To perform a sit-and-reach test:

1. Place the metre ruler on top of the bench so that the 0 cm mark is at the edge.
2. Sit on the floor with your feet on either side of the ruler and pressed against the front board at the base of the bench.
3. Keep your knees straight, bend at the trunk and reach as far forward as possible. When you cannot stretch any further, hold the position for 3 seconds.

4 Take three readings and record the best measure. Distances before the edge (not able to touch your toes) are expressed as negative scores; those beyond the edge are expressed as positive scores.
5 Compare your result with the norms shown in Table 7.9.

| Rating | 16–19-year-old females | | | 16–19-year-old males | | |
|---|---|---|---|---|---|---|
| | Left | Right | Both | Left | Right | Both |
| Excellent | >24 | >24 | >23 | >23 | >23 | >22 |
| Good | 22–23 | 22–23 | 22–23 | 21–22 | 21–22 | 20–21 |
| Average | 21–22 | 21–22 | 20–21 | 20–21 | 20–21 | 19–20 |
| Fair | 20–21 | 20–21 | 19 | 19–20 | 19–20 | 18 |
| Poor | <19 | <19 | <18 | <18 | <18 | <17 |

**Table 7.9** Ratings for the sit-and-reach test (shown in centimetres).

**Figure 7.13** Another way to conduct the sit-and-reach test is with a specialised sit-and-reach box with a built-in ruler.

## Agility

**Agility** is the ability to change the position of your body quickly and precisely and still keep your balance. If you are agile, you are able to accelerate quickly, turn, dodge and weave. Agility relies on anaerobic energy for speed, and requires muscular power and flexibility.

**agility** the ability to change position quickly while maintaining balance

Agility is essential in team sports to avoid the opposition, to change direction rapidly to follow play, and to be able to recover quickly from a collision or fall. Contact sports such as boxing, wrestling, judo and martial arts, as well as dance, gymnastics and ball sports, all require great agility.

**Figure 7.14** Agility is essential in sports such as badminton.

## Agility tests

Testing for agility is often less straightforward than testing other components of fitness, because different sports involve different movements and body positions. Each athlete should be assessed using an agility test that mirrors the demands of the sport they play, in terms of intensity, movement patterns and dominant energy systems. For this reason, many sports at the elite levels have developed their own sport-specific tests for agility.

Another factor is that many sports require athletes to be agile and produce bouts of high-intensity effort repeatedly. Athletes have to be agile even when they are fatigued and feeling discomfort from increased blood lactate and low glycogen stores (e.g. towards the end of a game). This means that the ATP–PC system and lactic acid system often influence agility during performances and games, and tests need to be designed with this in mind.

Some common agility tests include the:

- Illinois agility test
- 505 agility test
- Semo agility test
- glycolytic agility test.

The glycolytic agility test was specifically developed for sports that involve forwards, backwards and sideways running over a moderate period of time, such as touch football and rugby league. The duration of the test is designed to make demands on both of the anaerobic systems, but particularly the lactic acid system.

While the test doesn't require anything more than a stopwatch, markers and room to move, the space needs to be set up in a specific course beforehand, as shown in Figure 7.15 (on the next page).

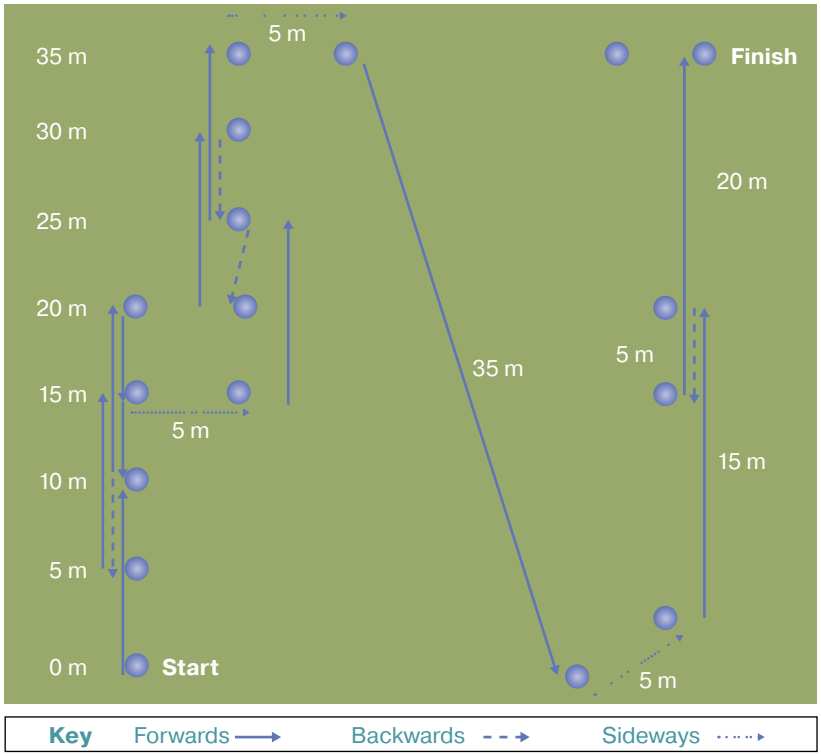



**Figure 7.15** Glycolytic agility course.

To perform the glycolytic agility test:

1. Start on the outside of the cones. On 'Go!', run forward 10 m to the second marker and then back 5 m to the first marker. (The stopwatch is started on 'Go!'.)
2. Continue running up 10 m and back 5 m until you have been to all the markers in the first line.
3. Slide sideways to the next row of markers and continue running up 10 m and back 5 m until you have been to all markers.
4. At the last marker in the second line, slide 5 m right to the third line, and turn around this marker to run 35 m to the bottom marker.
5. Turn and slide 5 m right to the next line of markers. Run forward 15 m, backwards for 5 m and then forward to the finish for 20 m.
6. The stopwatch is stopped when you cross between the two finishing markers.

Compare your time in seconds with the ratings for senior high school students in Table 7.10.

| Rating | Girls | Boys |
|---|---|---|
| Excellent | <45.44 | <41.69 |
| Good | 45.44–50.58 | 41.69–44.56 |
| Average | 50.59–55.73 | 44.57–47.43 |
| Fair | 55.74–61.08 | 47.44–50.31 |
| Poor | >61.08 | > 50.31 |

**Table 7.10** Glycolytic agility test results (in seconds) and ratings for senior high school students.

# Speed

**anaerobic capacity** total amount of energy provided by the anaerobic energy systems

Just as aerobic capacity is the ability to keep producing energy aerobically, **anaerobic capacity** is the ability to keep producing energy anaerobically. You use this method of energy production to put body parts into motion quickly and to sustain high-intensity efforts – in other words, to move at speed and sustain that speed. While speed is about moving quickly, it's also closely related to both strength and power, because you need to be able to generate a lot of force to move quickly.

Sporting activities that need anaerobic (speed) fitness include:

- sprinting (e.g. in running or swimming)
- javelin throw
- speed skating
- long jump
- triple jump.

**Figure 7.16** Usain Bolt demonstrates his high level of anaerobic capacity in the semi-final of the 100 m at the 2016 Olympics.

## Factors affecting speed

There are five factors that can affect your speed.

1. Energy production: to sprint you need a rapid release of energy within the muscle to produce a rapid and repetitive production of force.
2. Muscle fibre type: having more fast-twitch fibres will increase your speed, because they produce increased force and power output.
3. Duration of the activity: the limited supply of anaerobic energy available in the muscles means that you can only keep doing high-speed activities for a short time.
4. Speed of transmission of nerve impulses: the faster your reaction time, the greater your speed.
5. Flexibility: having greater flexibility or ROM leads to increased stride or stoke length, which means you can reach further with each stride or stroke, increasing your efficiency and, ultimately, your speed.

## Speed tests and anaerobic capacity

As there are two anaerobic energy systems, we classify speed tests according to the energy system the athlete uses to complete the test.

Short speed tests depend on the ATP–PC system. They test the capacity of the ATP–PC system to supply energy quickly for high-intensity efforts. Common ATP–PC speed tests include:

- the 40 m sprint
- phosphate recovery testss

Lactic acid tests are slightly longer, testing the capacity of the lactic acid system to supply energy for high-intensity activities over that period. Often these high-intensity efforts are repeated throughout the course of the physical activity, such as in touch football, Australian rules football or netball. Common lactic acid speed tests include:

- the T30 (timed 30-minute swim)
- the running-based anaerobic sprint test (RAST).

### Check your understanding 7.5

1 Explain the links between between flexibility, speed, power and agility.
2 Identify why coaches in many physical activities have developed their own specific fitness tests to determine agility.
3 From the physical activity you are currently studying, describe two different movement sequences that require agility and use either the ATP–PC or lactic acid system.

**Figure 7.17** Soccer requires many components of fitness, including the ability to repeat efforts at speed.

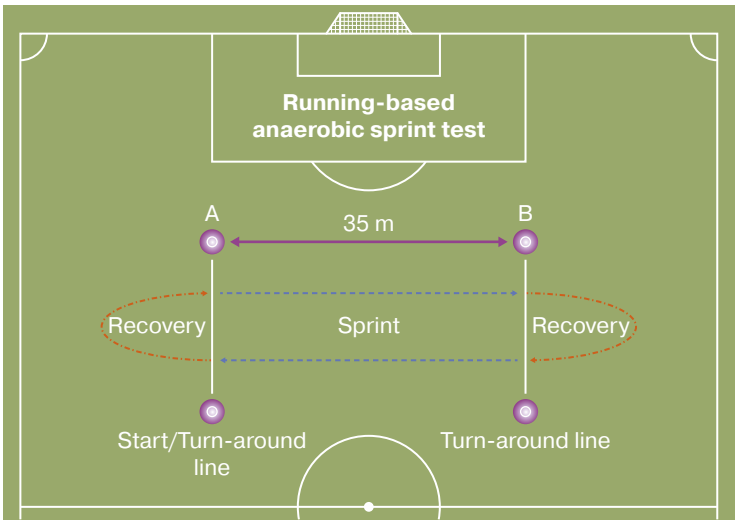



**Figure 7.18** The layout of the field for the running-based anaerobic sprint test (RAST).

## Apply and analyse
### running-based anaerobic sprint test (RAST)

LEARNING EXPERIENCE
KEY OBJECTIVES 1, 3, 4

The running-based anaerobic sprint test measures anaerobic power and capacity, and is an excellent test for sports such as soccer and handball. It is a simple field test that requires little equipment but has very high validity and reliability, so it is commonly used by coaches and athletes to monitor performance.

**Equipment**

- Track or running area of at least 50 m in length
- Test administrators (minimum of 2). One administrator times the duration of each sprint, while the other times the 10-second recovery periods.
- Weighing scales
- Measuring tape (⩾35 m)
- Stopwatch
- Marker cones

**Procedure**

1. Lay out the marker cones on the field as shown in Figure 7.18.
2. Record the participant's body weight (no shoes).
3. Before testing, the participant must warm up sufficiently. Allow a 3–5-minute break between the warm-up and the test.
4. The participant readies themselves in a 'standing start position' at one end of the 35 m sprint track (position A). One administrator stands at the start line, and a second administrator stands at the end line.
5. Administrator 2 counts down the start of the test ('3 – 2 – 1 – Go!'). On 'Go!', both administrators press the start button on their stopwatches, and the participant sprints with maximal effort to the end of the 35 m track (position B).

6 As soon as the participant crosses the 35 m line, Administrator 2 shouts 'Clear' and stops the clock, and records the sprint duration.

7 Administrator 1 begins the countdown of the 10-second recovery. During this recovery period, the participant gets ready to perform another 35 m sprint back to where they started.

8 Repeat this procedure for a total of six sprints (with five 10-second recovery periods). The administrators record the duration of all six sprints individually to the nearest hundredth of a second.

**Task**

1 Use the data from the test to calculate the results and complete the table.

| Value | Meaning | Result |
|---|---|---|
| **Peak Power Output (PPO)** | The power generated by the participant, calculated for each sprint<br>$PPO = \frac{\text{body mass} \times \text{distance}^2}{\text{time}^3}$ | Sprint 1:<br>Sprint 2:<br>Sprint 3:<br>Sprint 4:<br>Sprint 5:<br>Sprint 6: |
| **Fatigue Index (FI)** | The rate at which power declines in the performance. The lower the value the better.<br>$F1 = \frac{\text{maximum power} - \text{minumum power}}{\text{total time for all 6 sprints}}$ | |
| **Relative Peak Power Output (RPP)** | This allows for a fairer comparison between participants of various weights and sizes.<br>$RPP = \frac{\text{maximum power}}{\text{body weight}}$ | |
| **Anaerobic Capacity (AC)** | The total work completed during the test<br>AC = sum of all six PPO values | |

2 Describe what occurred in terms of time and power output from the first sprint to the sixth sprint. Use your primary data to identify any pattern.

3 Compare your Relative peak power output with the value of another classmate and analyse the significance of any similarities or differences.

4 High anaerobic capacity and the ability to repeat bouts of high-intensity effort at speed are a benchmark of many team sports. Analyse your suitability for such sports, using the primary data collected as evidence.

## Evaluate and justify
test result analysis

LEARNING EXPERIENCE

KEY OBJECTIVES
1, 5, 6

Determine your level of fitness by choosing and completing a range of fitness tests suitable to the physical activity you are participating in. Your results from the battery of fitness tests you choose can form primary data for your project–folio assessment.

1. Select the fitness tests that are relevant to the physical activity you are currently studying, and complete these tests as per the instructions.
2. Record your results for the fitness tests completed.
3. Compare your results against the given norms for each fitness test. Decide on areas of strength and areas to be worked on.
4. Explain why it is important to evaluate test scores against norms.
5. Determine how effectively the fitness tests you selected were able to identify the essential requirements of the physical activity you are studying.
6. Evaluate which component of fitness and which energy system/s you would target if you designed a personalised competition-phase training strategy to target the specialised movement sequences and strategies of your chosen activity. Justify your strategy design by referring to primary data from fitness test results and ratings.

**Figure 7.19** Sprint tests can determine fitness levels.

## Components of fitness

**INTEGRATING MOVEMENT**

KEY OBJECTIVES
1, 2, 3, 5, 6

**Category:** Invasion
**Physical activity:** Any Invasion game

### Purpose

1. This activity involves manipulating specialised movement sequences to highlight their importance in the physical activity and the impact on the outcome of the game.
2. The primary data you collect can be used to support your project–folio assessment task.

### Preparation

**Time:** one or two lessons

**Location:** playing area

**Equipment:** ball, markers, data capture devices

### Setup

1. This is a whole-class activity.
2. Organise students into two teams for playing the Invasion game.
3. Students not participating in the teams will act as data recorders and video capture the game.

### Performance

1. Play a game in which one team is only allowed to run in straight lines in attack and defence.
2. Play a game where one team has to jog in attack in certain parts of the field; the players cannot sprint.

### Data recording

1. Students recording the game will have better results if they can record from an elevated position.
2. After the game variations, all students watch the footage of the game and note the impact of the variations on the outcomes of the game in both attack and defence.

### Tasks

1. Compare the impact of the two variations on the outcomes of the game.
2. Analyse and evaluate the importance of agility (personally and for implementation of game strategies as a team) using specific game references.
3. Analyse and evaluate the importance of speed/aerobic energy system in use, using specific game references.
4. In your response, use the primary data gathered and references to the specialised movement sequences and movement strategies to assist your judgements.

# Chapter review

## Key questions and responses

**[7.1] How is fitness testing important for athletic development?**

Fitness testing is an essential part of athletic development. Selecting valid appropriate tests that are specific to the physical activity is a reliable way to gather data on an athlete's capabilities.

**[7.2] What is the purpose of breaking fitness down into components?**

Fitness is a broad concept that is divided into components of fitness, which are known as being both health and sport-related. Recognising and testing different components of fitness allows coaches and researchers to focus on those components that are most relevant to a specific sport or activity.

**[7.3] Why is aerobic capacity described as the foundation of fitness?**

Aerobic capacity is a health-related component of fitness that is essential for a healthy life, and as a foundation upon which the other components of fitness are built. Aerobic capacity is the ability to keep producing energy aerobically. This energy is used to perform tasks that involve the whole body for extended periods of time.

**[7.4] How do our muscles contribute to fitness?**

The components of fitness that relate to the muscles include strength, power and muscular endurance. All of these have a role in determining your capacity for a particular physical activity.

**[7.5] Which components of fitness are related to moving quickly?**

To move and respond quickly in a particular physical activity an athlete has to have good dynamic flexibility and agility. They also need a high anaerobic capacity, which allows them to move at speed and maintain that speed.

# Exam-style questions

## Section A: Multiple-choice questions

KEY OBJECTIVES
1

**1** The vertical jump is used to test:
- **a** power.
- **b** strength.
- **c** anaerobic capacity.
- **d** muscular endurance.

**2** For a fitness test to be valid, accurate and suited to the athlete's purpose, one of the criteria that must be met is:
- **a** games analysis.
- **b** quality control.
- **c** training incentive.
- **d** talent identification.

**3** Aerobic capacity is also referred to as:
- **a** stamina.
- **b** cardiac output.
- **c** oxygen uptake.
- **d** arteriovenous oxygen difference.

**4** Cardiac output is measured as litres of blood pumped out the left ventricle per minute, and is a result of:
- **a** stroke volume and heart rate.
- **b** heart rate and respiratory rate.
- **c** stroke volume and tidal volume.
- **d** respiratory rate and tidal volume.

**5** Fast-twitch muscle fibres are characterised by their:
- **a** low anaerobic capacity and capillary density.
- **b** high aerobic capacity and force of contraction.
- **c** high anaerobic capacity and force of contraction.
- **d** light pink colour, due to having high levels of oxygen.

**6** Dynamic flexibility is essential to develop which components of fitness?
- **a** speed and power
- **b** power and stamina
- **c** aerobic capacity and speed
- **d** agility and aerobic capacity

**7** Agility relies on which three components of fitness?
- **a** power, flexibility, speed
- **b** flexibility, speed, strength
- **c** power, strength, muscular endurance
- **d** speed, strength, muscular endurance

8 $VO_2$max is described as:
   - **a** heart–lung efficiency.
   - **b** maximal oxygen consumption.
   - **c** aerobic and muscular endurance.
   - **d** ability to persist in physical activities that rely on oxygen for energy production.

9 If an athlete gets excellent results in the 12-minute run test and stair-sprint test, which physical activity would they be most suited to?
   - **a** basketball
   - **b** tennis
   - **c** archery
   - **d** 1500 m run

10 Factors affecting speed include:
   - **a** flexibility, age, sex.
   - **b** muscle fibre type, slow-twitch fibres, age.
   - **c** muscle fibre type, energy production, sex.
   - **d** energy production, duration of the activity, flexibility.

## Section B: Short-response questions (150–250 words)

KEY OBJECTIVES
1, 4, 7

1 Discuss why fitness testing is essential if you want to understand your sport-related fitness. Use your own experiences to justify your response.

2 Refer to the specialised movement sequences and movement strategies that are specific to the physical activity you are currently studying. Identify the relevant components of fitness that are essential for you to succeed at them.

## Section C: Extended response (400 words)

KEY OBJECTIVES
4, 5, 6, 7

Imagine you are a coach in the physical activity you are currently studying. Write a proposal to the Head of Sport about your intention to run fitness tests on the players in the coming season. Justify your decision through analysis of your reasons, including:

- benefits to be gained
- your proposed battery of fitness tests
- relevant components of fitness and energy systems.

# 8 MANIPULATING TRAINING PRINCIPLES

**Figure 8.1**
The Brisbane Lions AFLW team trains to develop their skills and fitness.

When athletes follow a training program that observes the principles of training, it ensures that the way they train is effective and improves their performance. Different training methods are used in line with the principles so that the specific components of fitness and ability are trained and improved.

In this chapter you'll explore the key principles of training and identify a variety of training methods to optimise performance. You'll be able to apply some of these methods directly to your own performance, which will mean they are relevant to your project–folio assessment task. You'll also apply these principles and methods in the next chapter, when you design training programs and strategies.

## KEY QUESTIONS

**8.1** How do the principles of training help ensure training is successful and the training objective is achieved?

**8.2** Why is continuous training the foundation of all sport-related and health-related training programs?

**8.3** How do resistance and flexibility training improve muscles and joints?

**8.4** How can interval training be adapted to suit different sports and physical activities?

## YOUR CHAPTER PLAN

8.1 The principles of training
8.2 Aerobic training
8.3 Muscular and joint-based training
8.4 Interval training
Chapter review

# 8.1 The principles of training

Training for a specific event or physical activity, or for general health and fitness, is a long-term process. Whatever area of ability or performance you are training for, it takes time to improve it, and to ensure that gains in improvement are lasting.

Athletic training has three aims, and each of these uses a different type of program:

1. Training to improve skill effectiveness: this depends on learning and developing specialised movement sequences and strategies.
2. Training to improve competition performance: this depends on developing psychological qualities such as confidence and teamwork.
3. Training to increase working capacity: this depends on increasing physical fitness to improve the efficiency and capacity of the body's energy systems.

Improving your motor skills and learning specialised movement sequences is the focus of Chapters 1–3 in this book, while you learnt about sport psychology and performance training in Unit 2. In this chapter and the next, the focus will be on the third aim: training to increase the working capacity of the body's energy systems.

**principles of training**
vital factors that must be included in a training program to achieve performance outcomes

A successful training program must address all the **principles of training**. There are three groups of principles to consider:

- time-based principles relate to the frequency and duration of training
- load and exertion principles relate to the intensity of training and the use of progressive overload
- personalised training principles relate to how specific the training is for the physical activity and the individual, and how much variety it contains.

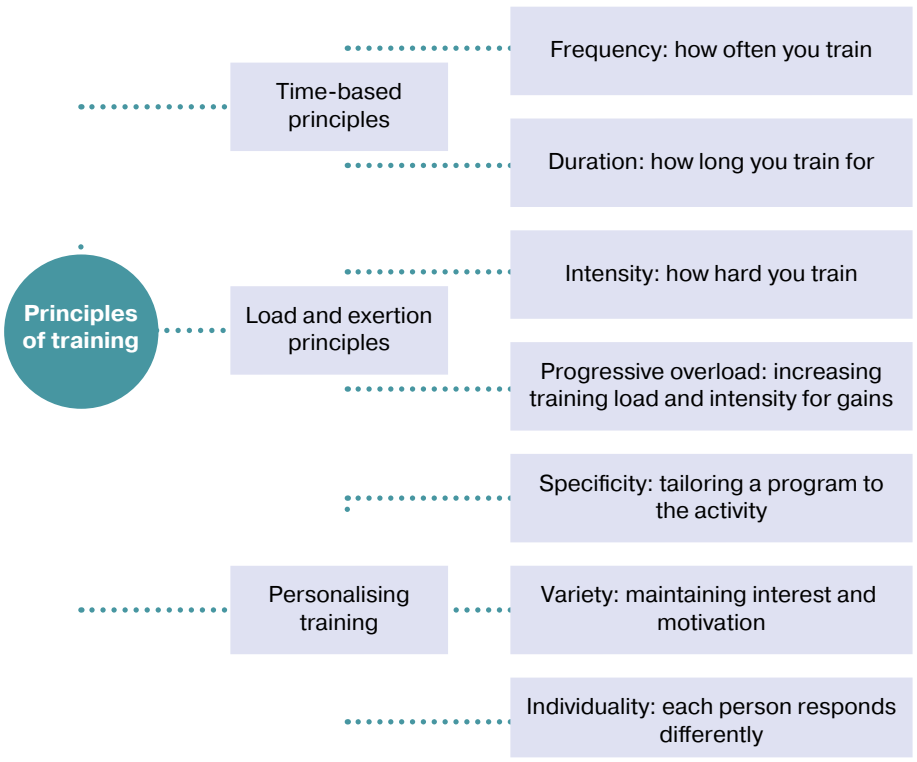



**Figure 8.2** The principles of training.

These principles are what determines:

- your choice of training methods
- the content of each session
- your rate of improvement
- your level of motivation
- the overall effectiveness of your program.

Coaches, trainers and individuals will get the best results when they follow these principles to plan a training program and maximise its effect.

## Individuality

The principle of **individuality** acknowledges that each athlete is different, and so training should consider their specific traits. These include not just their abilities (physical skills and fitness), but also their:

**individuality**
relating to a specific individual's needs

- gender
- motivation
- goals
- maturity
- culture
- psychological needs
- learning styles.

Individuality also means thinking about the specifics of their physical activity and, in team games, the specifics of their position. This last factor is particularly difficult for a single coach to manage. This is why many elite teams have an overall coach but also specialised coaches for various skills or positions, such as the goalkeeper in soccer or the back row in rugby union. Often in elite teams there is also a general fitness trainer, who works together with the other coaches and specialists to get the best out of individual athletes as well as the whole team.

Individuality also means understanding that each athlete's responses to training will vary.

## Specificity

**Specificity** of training is the main principle that guides training programs. Whether you are trying to increase your general fitness or you are training for a particular physical activity, specificity is important. It can be summarised as 'You get what you train for'.

**specificity**
how much an action belongs or relates uniquely to a particular activity

A successful training program will bring about adaptations (changes or improvements) that suit the physical activity being targeted. This will only happen if the program is specific to the physical activity's:

- predominant energy systems
- components of fitness
- most used muscle groups and body parts
- skills.

Adaptations occur in response to stress placed on the body, but only in those areas of the body that experience the stress. This is commonly referred to as the SAID principle (specific adaptations to imposed demands).

By identifying the physical activity's requirements and then specifically targeting them through the training program, there is a greater chance that the training program will be effective and the athlete will meet their performance goals.

For example, resistance training (p. 231) requires that the particular muscle groups used in the physical activity are trained, and exercises should replicate similar movements of that physical activity. If using resistance training for swimming, the program could include 'lat pull downs' as a strength exercise; this replicates the pulling movement of swimming and targets the muscle group involved in that action.

Imagine that you want to design a program to train for track and field. You might go about it this way:

- Analysis of this activity shows it has a specific requirement for leg power and aerobic capacity.
- To specifically assess these components, you perform the vertical jump and multistage 20m shuttle tests.
- After your fitness testing, you decide to use circuit training (p. 244) to specifically develop both your aerobic capacity and your leg power.
- You design a 3-lap, 10-exercise individual circuit to develop your aerobic capacity; as one of the 10 exercises, you include *box jumps* to specifically develop leg power.

By applying specificity, you develop a training method that will produce the specific effects you need: improved cardiorespiratory (aerobic) efficiency, and increased development of the white (fast twitch) muscle fibres in the legs (for power).

**Figure 8.3** The box jump is an exercise that can increase speed, power and aerobic capacity.

**Apply and analyse**
specificity

LEARNING EXPERIENCE

KEY OBJECTIVES
1, 3, 4

1 Select one physical activity, including the one you are currently studying, from each of these categories:

Net and court: badminton, volleyball, tennis
Invasion: Australian football, basketball, futsal, netball, soccer, touch football, water polo
Performance: duathlon, aquathlon, triathlon, swimming, track and field

2 Create a table to compare what needs to be targeted in each of the following categories, for each physical activity, to make a training program effective:

- key energy system
- components of fitness
- muscle groups
- body parts and skills.

## Variety

Variety adds spice to your training program and helps you maintain your motivation, making it more likely that you will achieve long-term fitness gains.

You can make initial gains in fitness quickly. However, fitness levels tend to build to a point, then plateau and stay at one level. A plateau in performance can last for an extended period. When a plateau happens and you can't see any gains in fitness, it can be demotivating. Introducing variety to the training sessions helps shorten plateau periods and maintain your motivation.

Strategies to vary training sessions include:

- Vary how you train: aerobic capacity can be developed through swimming, running or circuit training.
- Vary where you train: do beach runs, hill runs, park runs, road runs; train in the gym; swim at the local pool.
- Vary how hard you train: two easy days, one hard day, two easy days, and so on.
- Vary the selection of people you train with: schoolmates, friends, family, teammates or workmates.
- Vary the types of training that you do: a combination of aerobic training and resistance training increases muscular strength and aerobic capacity.

However, you need to make sure that any changes still keep you working towards your training goals and remain specific to your physical activity. For example, for a runner, varying aerobic conditioning by going for a bike ride instead of a run is good as a one-off, but too many bike sessions would be counterproductive.

# Intensity

Training intensity refers to how hard a session is. Many coaches say it is the most important training variable. Coaches and athletes should carefully monitor intensity to make sure that training is effective.

The intensity you start at depends on your beginning fitness, as identified in pre-tests. As you progress through a training program, the intensity increases because of progressive overload (p. 224).

You can measure the intensity at which you are working during a training session or during competition in several ways. You may know some of these:

- energy expended per unit time (e.g. 37.8 kJ/min)
- absolute exercise level or power output (e.g. 147 watts)
- percentage of $VO_2$max (e.g. 85% $VO_2$max)
- rate of perceived exertion (RPE). This is a numerical scale from 6 to 20 where the individual rates their own feelings of exertion as a level (e.g. RPE 14).
- exercise heart rate, often called target heart rate (THR), is a percentage of maximum heart rate (MHR) (e.g. 80% maximum heart rate).

## Target heart rate and maximum heart rate

Training intensity is most accurately measured by measuring oxygen consumption and blood lactate levels. This uses expensive testing equipment that the average athlete cannot access.

A practical alternative is to use your heart rate, and specifically your THR, to determine exercise intensity. This is effective because your heart rate increases linearly with increasing intensity of exercise during continuous exercise; the harder you exercise, the more your heart rate increases. Also, because percentage $VO_2$max and percentage heart rate relate in a predictable way in everyone, you can estimate $VO_2$max just by monitoring heart rate, making it even more useful.

Given the variety of heart-rate monitors and training watches that are available, THR is an easy way to identify intensity. What your THR should be depends on what you are training for, along with your individual needs. You can use a heart rate chart (Figure 8.4) to check the MHR for your age and a range of THR for effective exercise.

Some general rules-of-thumb about intensity:

- The lowest THR that will produce aerobic fitness improvements is 70% of MHR.
- For most endurance sessions, THR is in the range of 70–85% of MHR.
- For sprint (anaerobic) training programs, THR should be 85–100% of MHR.

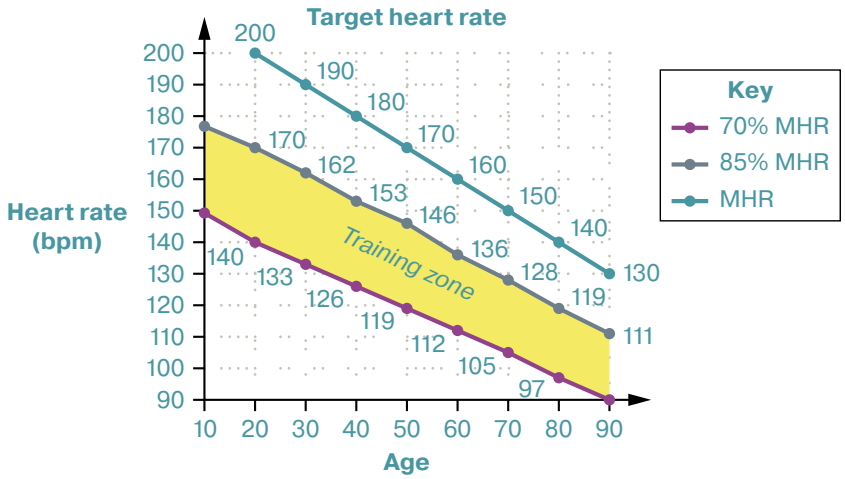



**Figure 8.4** Maximum heart rates and training zones for aerobic training of people of different ages.

## Intensity zones

In 2019, researchers Tudor Bompa and Carlo Buzzichelli identified six intensity zones for training. These zones are based on the main energy system in use and the duration of the physical activity. The zones are useful for describing intensity, and also for understanding the interplay of energy systems at work, based on the intensity and duration of the physical activity.

| Zone | Duration (sec/min) | Intensity | Main energy system | Anaerobic (%) | Aerobic (%) | Other information |
|---|---|---|---|---|---|---|
| 1 | <6 sec | Maximum | ATP–PC | 100–95 | 0–5 | Creates large oxygen deficit due to demand for energy |
| 2 | 6–30 sec | High | ATP–PC and lactic acid | 95–80 | 5–20 | After 10 seconds, ATP stores are depleted by 50%, so reliance on glucose stores increases |
| 3 | 30 sec – 2 min | Moderately high | Lactic acid | 80–50 | 20–50 | Large amounts of lactate may be produced |
| 4 | 2–3 min | Moderate | Lactic acid & aerobic | 50–40 | 50–60 | Shift from anaerobic to aerobic metabolism |
| 5 | 3–30 min | Moderately low | Aerobic | 40–5 | 60–95 | A strong aerobic capacity is crucial for activities in this zone |
| 6 | >30 min | Low | Aerobic | 5–2 | 95–98 | As the duration continues, muscle glycogen stores deplete, leading to an increasing reliance on fat stores and making it difficult to maintain intensity |

**Table 8.1** Bompa and Buzzichelli's intensity zones.

## Progressive overload

**progressive overload** the gradual increase of stress placed on the body during training

**Progressive overload** simply means doing more over time, and it governs all fitness training. It is the systematic and gradual increase of the stress (load) placed on the body, and it improves your fitness.

The principle behind this is simple – to improve, you must exercise at an intensity greater than your existing capacity. When a training load exceeds the load that your body is used to, your body will adjust physiologically, improving your fitness. But once your body has got used to that load, it stops improving, so over time you have to use higher loads to get further improvement.

You need to increase the load gradually and also vary it depending on the athlete's needs. Otherwise, you risk causing injury, fatigue or demotivating the athlete (e.g. when a session is too hard and cannot be completed). Progressive overload in training programs for team sports can be challenging, because (as per the principle of individuality), each athlete's physiological capacity, psychological abilities and work tolerance might be different.

When planning progressive overload, you should consider these factors:

- the individual's current level of fitness
- whether the overload is enough to cause improvement
- whether the overload still reflects the training objectives.

There are many variables you can change to overload a training session, such as:

- duration of training
- distance
- repetitions and/or sets completed
- intensity
- resistance
- range of motion
- frequency of training.

However, you should never overload all of these variable at once! For effective overloading, just change one or two variables at a time.

For example, a training session targeting speed and developing the ATP–PC system could include 8 × 50 m sprints at 95% MHR. The overload could be applied by doing one of the following:

- increasing the number of repetitions
- increasing intensity of the effort (100% MHR)
- increasing the distance sprinted
- decreasing the recovery between efforts.

If you were changing either of the last two variables, you would have to keep the training objective (the ATP–PC system) in mind. Increasing the distance and reducing recovery may mean the athlete is no longer targeting the ATP–PC system, and may result in them instead focusing on the lactic acid system.

Not every training session should be an overload session, and changes should be gradual. When working out training overloads, you should follow the Roux principle: small increases are useless, moderate increases are useful and excessive increases are harmful.

**Figure 8.5**
To increase the intensity during a resistance training program, the individual could increase the number of sets, repetitions, weight or range of motion.

**Apply and analyse**
introducing overload

LEARNING EXPERIENCE
KEY OBJECTIVES
1, 3, 4

In the following training scenarios, suggest ways an individual could introduce overload to the training session.

1. Soccer player: two training sessions per week involving 3 sets of 6 × 40 m shuttles, with 20 seconds for recovery between repetitions and 4 minutes for recovery between sets.
2. A 10 km runner: two sessions per week of 15 km jogs around her local area at 75% MHR.
3. An elite netball player: 3 sets of 3–4-minute games played 4 v 4, interspersed with 2 minutes of passive recovery.
4. A volleyball player attempting to improve leg strength: one exercise (barbell squat) in the resistance training session includes 3 sets of 6 repetitions, 50% of 1 RM with a recovery of 3 minutes between sets, twice per week.

## Frequency

You experience training improvements because of physical adaptations caused by the stress of regular exercise. The more often you train, the greater your fitness improvement will be, although all programs have to include rest days to allow your body to recover.

Many training programs set the frequency of exercise in three cycles:

- macrocycle: the entire period of training, which could be as long as an entire year
- mesocycle: a specific block of training sessions designed to accomplish a set goal; a typical mesocycle is 3–4 weeks
- microcycle: the shortest block of training sessions, focusing on one specific outcome; a typical microcycle is a week.

The frequency of training involves both the distribution of training sessions within a cycle and the number of times training occurs in that cycle. The intensity and duration of training sessions affect frequency, as they have a major effect on how much time you need for recovery before the next training session. Generally, the greater the workload, the greater the time needed to recover; however, recovery does not have to be complete before you can undertake another training session.

Other factors that can affect the time needed between training bouts include the person's:

- training status (whether they are generally fit and accustomed to training)
- age
- nutrition
- state of recovery.

When you are increasing the frequency of sessions, the obvious way to allow recovery is to vary the workload across a microcycle. This may include a session where the load is not increased ('underload') – that is, doing what the athlete is accustomed to or doing less, rather than increasing the load.

Training frequency varies according to the activity, but it's possible to make a few generalisations.

- For fitness to improve, the minimum number of sessions per week is three. However, fitness can be maintained in two sessions per week. So if you wish to develop a fitness component, you must train at least three times a week; if you just want to maintain that component, you must train twice a week.
- To improve aerobic capacity, the ideal training frequency should be 4–5 days per week; runners, swimmers and triathletes may need to increase this to 6–7 days per week. Training for two sessions per day is not necessarily more productive than training for only one session per day.
- Improving strength, power and speed (anaerobic components) requires less frequent training, with the ideal being 3–5 days per week.

**Figure 8.6** A training program needs to set both the frequency of training sessions within a week and the purpose for each week.

## Duration

Duration can refer to several different concepts in training:

- the length of a training program
- the length of each session
- the length of work intervals within a training session.

The minimum duration of any fitness program to develop training effects is 6 weeks. Aerobic fitness improvements tend to take longer to develop than other fitness components, so aerobic fitness programs should run for not less than 12 weeks, and anaerobic fitness programs should run for 8–10 weeks.

Duration also refers to the length of time of each training session. Generally, 20–30-minute sessions at a minimum intensity of 70% MHR can improve your aerobic capacity. So it's important to look at duration and intensity together; an athlete will only improve their fitness if they are working at the required intensity for the required amount of time.

The duration of work intervals within a training session is also important, as it ensures you are targeting the right energy system. If you want to train the ATP–PC system, you should keep repetitions to approximately 10 seconds at maximal intensity. If they are any longer, say up to 30 seconds, the energy to resynthesise ATP will be provided through anaerobic glycolysis, not phosphocreatine (PC), and the energy system being targeted would be the lactic acid system.

You can use various strategies to vary the duration of training:

- increase the duration of the training session; if an athlete completes three sessions of 60 minutes, increase the sessions to 75 minutes each
- increase the number of repetitions, sets or drills per training activity or session
- increase the distance travelled or the duration per repetition of drill.

### Check your understanding 8.1

1. List the factors you need to think about to allow for the principle of individuality (athlete differences) in planning a training program.
2. Explain the principle of progressive overload and why it can improve your performance of a physical activity.
3. Explain why intensity and duration of a training session have a major effect on how much recovery time you need and on the frequency of training sessions.

# 8.2 Aerobic training

Training methods are the various types of training that can be included in a training program. Which methods you choose will depend on which components of fitness you've identified as essential to your sport. Each training method can be used to develop specific fitness components and energy systems.

Let's begin by considering training methods that target the aerobic energy system, to improve aerobic capacity and endurance.

## Continuous training

**continuous training** physical training that involves activity without rest intervals

Lactate threshold p. 164

**Continuous training** is sustained physical activity without rest for a period. It is the foundation of all sport-related and health-related training programs. The purpose of continuous training is to improve aerobic endurance through increasing aerobic capacity, raising the lactate threshold 2 level and improving muscular endurance. It is sometimes referred to as 'cardio training', submaximal exercise (because the individual exercises at less than maximal intensity), or 'conversation' exercise, because you can carry on a conversation and still continue to exercise.

Any kind of continuous low- or medium-intensity activity can be used as the basis of a continuous training program. Running is a very common option, but you can also use swimming, cycling, cross-country skiing, kayaking, surfing and team sports.

Athletes and coaches use continuous training as part of the pre-season, and in the off-season, to keep up aerobic endurance. It is commonly used by recreational athletes, in the form of long, slow, distance running, in order to achieve health-related fitness benefits.

**Figure 8.7** Jogging, cycling and swimming are excellent forms of continuous training that improve aerobic capacity and can add variety to a training program.

## Benefits of continuous training

While you can strengthen parts of your body during continuous training (such as developing stronger calf muscles through jogging), the purpose of the training is to improve your aerobic endurance.

Continuous training is focused on the heart; this organ is a muscle, and like any muscle, it can be strengthened. Continuous training must be intense enough to increase the heart's stroke volume and cardiac output. In other words, it must increase the ability of the heart to deliver oxygen to the working muscles.

Other physiological benefits of continuous training include:

- improved **pulmonary** function and oxygen transport
- increases in the number of blood vessels
- improvement in the oxygen-carrying capacity of the blood
- increases in the size of the left ventricle of the heart
- improved lung diffusion and maximum ventilation (breathing rate).

**pulmonary**
relating to the lungs

All of these **cardiorespiratory** responses to training are the body's way of trying to deliver more oxygen, more quickly and more efficiently, to the working muscles, so they can produce aerobic energy.

**cardiorespiratory**
relating to the heart, lungs, blood vessels and blood

## The FITT formula

To correctly use continuous training as a method of improving aerobic capacity, you need to apply the FITT formula:

- **F**requency
- **I**ntensity
- **T**ime
- **T**ype.

### Frequency

To develop your aerobic capacity through continuous training, you need to take part in sessions three or four times per week.

### Intensity

Heart rate (HR) increases linearly with exercise effort, so HR is generally used as a measure of intensity. For continuous training to improve aerobic capacity, you need to reach and stay in a specific training zone throughout training. Athletes interested in higher levels of aerobic fitness must combine training sessions within the 75–85% HR maximum zone with more intense sessions of 85–95% HR maximum to increase lactate threshold 2 and $VO_2$max.

### Time

The minimum length for an effective aerobic session is 20 minutes of continuous activity. For health-related fitness, 30 minutes is sufficient as a maximum. For sport-related fitness, the specific sport may demand sessions up to 1 hour long, or for running, over 10 km.

### Type

To develop aerobic capacity, the only suitable activities are whole-body activities where you use large muscle groups and you keep up the activity for at least 20 minutes. These activities are:

- running and jogging
- cycling
- swimming
- power walking
- fitness classes
- in-line skating.

## Fartlek training

*Fartlek* is a Swedish word meaning 'speed play'. It is continuous training, usually cross-country running, but with regular changes of pace (intensity). These changes of pace may occur because of natural obstacles, such as hills and sand, or because of deliberate short bursts of speed every few minutes.

If you use it correctly, fartlek training can overload all three energy systems (depending on the intensity and duration of the surges), because it is a blend of continuous and interval training (see p. 237). The athlete has the freedom to decide when to increase intensity; if they feel sufficiently recovered, they can surge ahead at an increased pace. During the lower intensity efforts, the aerobic system is heavily used to resynthesise ATP so the performer is ready for the next surge of high intensity.

**Figure 8.8** Fartlek training often takes place in areas like forest or bushland, so that natural obstacles cause changes of pace.

However, this freedom can also be a disadvantage if the athlete is not disciplined enough to work at the higher rates of intensity needed for using the lactic acid and ATP–PC systems.

This form of training can also add variety and may be a good way to avoid boredom within a training program.

### Check your understanding 8.2

1 Describe the physiological benefits of continuous training.
2 Explain the FITT formula.
3 Explain the difference between continuous training and fartlek training, including the benefits and limitations of each.

# 8.3 Muscular and joint-based training

## Resistance training

Resistance training is the key to developing the fitness components of muscular strength, power and endurance. It involves exercising a muscle or muscle group against external resistance, such as weights, equipment or your own body.

For sport-related fitness programs, resistance training is essential for:

- improving fitness and skill performance
- protecting players against injury
- improving body composition by increasing muscle tone and mass.

As strength is needed for many physical activities, resistance training is often important for improving performance. But it's not just strength that can benefit from this training. Muscular development helps you to:

- generate and apply explosive effort for power
- achieve faster movement (speed)
- improve agility.

So working to gain greater muscular strength through resistance training is a valuable component of any training program.

### Developing resistance programs

With any resistance program, it's important you begin with light resistance and a general program. Once you have established a good base, you can increase resistance progressively and use exercises specific to your particular physical activity. These exercises should mimic the specific movements of the physical activity, e.g. throwing or kicking actions.

To design a resistance program, you need to understand how muscles and tendons work so you can choose the right exercises to achieve the desired effect (this is the principle of specificity). The exercises should mirror the activity's movements in terms of velocity, range, joint angle and type of contraction. Physical activities that have a speed or power component should use resistance exercise at a similar velocity. For example, to improve at the leaps needed in Australian football, you could use **plyometric** exercises with the body weight as the resistance.

In general, athletes should have a strength foundation before introducing power-type exercises and training methods.

**plyometric**
describing exercise that involves jumping and rebounding to increase muscle power

## Weight training

The most common form of resistance training is weight training, in which you perform a series of resistance exercises, using either free or machine weights, to stress particular muscle groups. This is a very effective way to increase your maximal strength, muscle **hypertrophy** (size), muscular endurance and power.

**hypertrophy**
the enlargement of an organ or tissue due to an increase in size of its cells

The key terms used in weight training are shown in Table 8.2. Because weight training is so popular, you will hear these terms used for resistance training in general, and even in other forms of training (whether or not that usage is correct).

**Table 8.2** Key weight training terms.

| Term | Information |
|---|---|
| Repetition (rep) | • A rep is one performance of an exercise, e.g. one push up or bicep curl.<br>• The higher the load, the lower the number of repetitions.<br>• The number of repetitions depends on the component of fitness targeted. |
| Set | • A set is a number of repetitions performed consecutively without rest, e.g. 8 bicep curls is 1 set of 8 reps, or 1 × 8.<br>• Multiple sets are superior to single sets for strength development. |
| Repetition maximum (RM) | • This is the maximum weight you can lift a certain number of times:<br>– 1 RM is the maximum weight you can lift once<br>– 10 RM is the maximum weight you can lift 10 times (but not 11).<br>• RM depends on training intensity (load).<br>• Athletes should not perform repetitions to the point of failure, because this does not maximise strength gains. Instead, they should work to their RM limit, then adjust this limit as they grow stronger. |
| Volume | • Volume is the amount of work performed, shown (for example) as:<br>– total training hours<br>– number of kilograms lifted<br>– total weight lifted per training session (weight by number of sets and repetitions)<br>– phase of training year<br>– number of sets and repetitions completed.<br>• If the workout is one continuous effort, the duration and volume are identical. If the workout has periods of work and rest, the volume is the sum of the work times.<br>• Knowing the volume of the training session (i.e. total amount of weight lifted) can help with monitoring progressive overload. |

**Figure 8.9** The weighted squat is a common weight training exercise, as the weight (resistance) can be easily manipulated to suit the individual.

## Developing weight training programs

Weight training is based on performing sets of RMs, and can be used to develop muscular strength, muscle bulk, power or muscular endurance. Depending on your fitness target, you can change:

- the weight lifted
- the number of reps
- the number of sets
- the speed of movement (Table 8.3).

Overload is achieved by increasing the weight at regular intervals.

| Fitness target | Weight (% 1 RM) or RM | Reps | Sets | Speed | Rest between sets | Frequency per week |
|---|---|---|---|---|---|---|
| Power | Very heavy 80–95% or 1–3 RM | 2–10 | 3–5 | Fast | 5–8 min | 4–6 |
| Strength | Heavy 70–80% or 3–8 RM | 2–6 | 3–5 | Slow | 3–5 min | 3–5 |
| Hypertrophy | Medium 60–80% or 8–15 RM | 6–12 | 4–6 | Slow | 1–2 min | 3–5 |
| Endurance | Light 40–60% or 15–20 RM | 15–40 | 1–3 | Fast | 30–60 sec | 2–3 |

**Table 8.3** Tailoring weight exercises to target fitness components.

The order in which you do exercises in a weights program can affect how well the session works. When planning a weights program, ensure that the same muscle groups are not stressed by several exercises in succession. You can do this by:

- rotating through exercises that use different muscle groups
- alternating between upper and lower body exercises
- doing large-mass, multi-joint exercises, such as weighted squats, early in the session when you are not tired, then moving on to small-mass, single-joint exercises, such as bicep curls.

If your aim is to develop muscular strength, your program should begin with an endurance phase, then a hypertrophy (bulk) phase, and finally the strength phase. When you are targeting strength, the length of recovery between sets is longer to allow the restoration of ATP and PC, get rid of lactate, and restore the force-generating capacity of the muscles. If you use recovery periods of 2–5 minutes, you should be able to sustain training intensity across several sets.

If your aim is to develop power, your program should follow this same sequence (endurance, bulk, strength) and then end with power exercises. To maximise strength and power, you should perform explosive exercises after each large mass multi-joint exercise – for example, back squats followed by jump squats or a short (10 m) sprint. This form of resistance training is called post-activation potentiation and is best suited to highly trained individuals.

## Frequency and duration

You can make solid gains in muscle strength with 6 weeks of training. The more frequently you train (i.e. the more sessions per week or microcycle), the greater the gains in strength.

- For beginners or intermediate individuals, 2–3 days per week is optimal.
- Advanced individuals benefit from 4–5 sessions per week.
- Athletes who are doing other training to improve their performance should do 2–4 weights sessions per week.
- The phase that you are in affects the frequency of resistance training: during preparation, you can do more weights training than during the competition phase.

You need to vary strength training programs and intensities to avoid getting stale and to keep stimulating improvement. For example, you can mix it up by using microcycles with different intensities and volumes of training throughout the program. And you can have other forms of resistance training, such as circuits (p. 244), to provide variety and take care of the sport-specific development of other components of fitness.

## Safety

For any weight training program, there are common safety precautions and training guidelines that must be followed:

- Always stand close to the bar.
- Bend your knees to pick up the weight.
- Keep your back straight and your head up. (Never hollow or round your back.)
- Use your legs to lift.
- Breathe in during the lowering (relax) phase of each repetition and breathe out during the press (effort) phase of each repetition.
- Always use correct technique. Do not cheat in an exercise in order to lift more.
- Always use a full range of movement so that flexibility is improved rather than lost.
- Train large muscle groups first.
- Allow 48 hours between workouts for any given muscle group.

Machine weights are safer than free weights because the movement is more controlled and performed in the correct range of motion, so they are good for beginners. Free weights allow movements more specific to sporting actions, a greater range of motion and more weight to be lifted. Cable weights allow movements to be performed under constant load.

Weight training can be safe and helpful for pre-adolescents (10–14 years old), provided it is supervised, correct technique is taught, and weights of 10–15 RM are used.

# Flexibility training

Flexibility refers to the range of motion around your joints. If you look at some sport-specific skills (such as drop kicking a ball in rugby, making a lay-up in basketball or doing a bicycle kick in soccer), it's easy to understand why it's important in so many physical activities. Yet flexibility training is possibly one of the most undervalued forms of training.

Increasing your flexibility is good because it:

- increases your mobility (e.g. consider a lunge in tennis to return a serve and how difficult this would be to do quickly and effectively with tight muscles through the hips and groin)
- increases your range of motion, which may reduce the risk of injury
- corrects any imbalances you might have from the overuse of one particular side of the body.

Strength and flexibility are interdependent, since both depend on the amount and type of movement across a joint. Strength training helps you to stabilise a joint, while flexibility training helps increase free movement around a joint. To improve performance you should target both these things in a balanced program.

Flexibility training mainly means stretching. Just as there are two forms of flexibility, dynamic and static (p. 202), stretching exercises are either dynamic or static (passive).

**Figure 8.10** Most sports involve dynamic movements and thus require flexibility as well as strength or speed.

## Dynamic stretching

Dynamic stretching means movements that you perform quickly within the full range of motion of the joint, such as arm circles or swinging the leg forwards and backwards. They can be compared to stretching a rubber band then letting it return to its normal length.

Usually, you use this kind of stretching as part of a warm-up before physical activity. It allows your muscles and tendons to go through a specific range of motion that is like the movements you will use during training or competition, such as in kicking a ball or lunging to catch a ball.

Dynamic stretching is an effective way of warming up and increasing flexibility because it:

- mirrors the type of activities that you will be performing during the game
- increases your body temperature, as activities usually involve whole-body movement
- maximises the range of motion of a joint
- increases your body awareness.

However, dynamic stretching can place stress upon joints. You should follow these safety precautions:

- Build from movements of low intensity to more intense exercises that put your muscles and joints through their full range of motion.
- Make sure you do a whole-body warm-up, such as light jogging, before you do dynamic stretches.
- Do dynamic stretches that are like the movements that you will perform in a game. For example, to get ready for an Australian football game, you could do hip flexion and extension actions, such as knee drives, leg swings and rotations.

## Static stretching

In static (or passive) stretching, you take a muscle to its greatest range of movement and hold the position for a period of time, such as 30 seconds. This is probably the type of stretching you are most familiar with, as it's traditionally been used in warm-ups and cool-downs.

However, this doesn't mean that it's always the best choice as part of your warm-up for physical activity. Some recent studies suggest that passive muscle stretching can have a negative effect on skills that need repetitive high-power outputs, such as jumping and sprinting. There is also no real evidence that static stretching before performance reduces injuries or delays when your muscles start to get sore. Static stretching can still be useful, but dynamic stretching is possibly better for preparing athletes for activities of high power and intensity.

The advantages of static stretching, compared to dynamic stretching, are:

- it requires less energy
- it is less likely to damage connective and muscle tissue
- it can prevent muscle pain and soreness, and relieve any existing pain and soreness
- it may be useful as a part of the cool-down process.

Static stretching is very safe; the only precaution you should take is to never bounce, jerk or move quickly when you are in a stretched position.

## Check your understanding 8.3

1. Describe two ways of deciding the order of the exercises in a weight training session so you do not stress the same muscle group.
2. Explain why resistance training is useful for improvement in performance of most physical activities, not just strength-based ones.
3. Explain what is meant by the statement 'strength and flexibility are interdependent'.

# 8.4 Interval training

**Interval training** is a form of training in which work intervals are followed by rest intervals. It is designed to improve your speed, power and agility, as well as aerobic and anaerobic capacity. It can target different energy systems and fitness components, depending on the:

- length of the work period
- length of rest or recovery period between repetitions
- intensity of the work period
- types of activities within the work period.

**interval training** physical training made up of alternating periods of high- and low-intensity activity

Interval training is the best way to improve your ability to play team sports such as netball, soccer, basketball or field hockey, as it simulates the demands of the game. These sports all have periods of activity or work (e.g. chasing the ball), followed by periods of rest or recovery (when the ball is down the other end of the field). It is a very versatile form of training that can be tailored to specific energy systems and physical activities.

**Figure 8.11** Interval training mimics the demands of sport such as netball.

## Designing interval training programs

The great advantage of any type of interval training is that it allows you to perform high-intensity work without the fatigue you get in a continuous session of equal intensity. For example, equal work can be gained from:

- one continuous 400 m sprint in 60 seconds (high fatigue and low quality)
- 10 repetitions of 40 m, each in 6 seconds, with a 30-second recovery interval (low fatigue but high quality).

Interval training lets you work at higher intensities, because a rest period will follow. During the work interval of most interval training sessions, the heart rate should reach lactate threshold 2 or above (>85% MHR).

Interval training programs are usually 2–15 weeks, with a training frequency of 1–2 sessions per week. Although it varies in intensity, it is still an intense form of training and it's best if you do it with other forms of training so you don't suffer from fatigue, demotivation or injury.

## Key variables in interval training

You need to consider several factors when you plan an interval training session, such as the duration of work and recovery intervals, the intensity of exercise, the work:rest ratio and the number of sets and repetitions. Table 8.4 explains each of these factors in more detail.

**Table 8.4** Key variables in interval training.

| Variables | Explanation | Example |
|---|---|---|
| Work interval | • Distance and duration of the work<br>• Should be designed to suit the demands of the physical activity | • 50 m in 6 seconds |
| Recovery interval | • Time between efforts (repetitions)<br>• Also refers to type of recovery – passive or active<br>• The specific energy system and fitness component being targeted determines what the heart rate should be during recovery<br>• As a general guide, 140 bpm or less would be appropriate | • 36 seconds of standing (passive) or walking/ slow jog (active)<br>• Sprinters perform intervals with complete recovery so they can work at their highest intensity |
| Work intensity | • How hard each effort is, usually measured as a % MHR or a target time<br>• Target times used for short distance intervals, because heart rate is not a reliable measure for anaerobic effort.<br>• Intensity of work interval must activate the target energy systems | • 95% MHR or 50 m in 6 seconds |
| Set | • Group of work and recovery intervals | • 2 sets of 10 × 50 m |
| Repetition (rep) | • One individual work interval is one rep | • 10 × 50 m (10 reps of 50 m) |
| Work:rest ratio (W:R) | • The interval of work in relation to the interval of rest<br>• This should mirror the demands of the physical activity<br>• Manipulating the work:rest ratio changes the intensity and so affects the training adaptation (what will be improved) | • A work:rest ratio of 1:6 mimics a soccer game<br>• A work:rest ratio of 1:1 mimics many periods of play in futsal |

## Interval periods

Another advantage of interval training is that you can target and develop all three energy systems during training. This can be done by changing the length of the work interval and the work:rest ratio. Variations like this are called long, intermediate and short interval training sessions.

In Australian football, all three types of interval training are used to target the three energy systems, as shown in Table 8.5.

| Session | Energy system | Intensity | Repetitions | Work:rest ratio | Frequency per week | Example program |
|---|---|---|---|---|---|---|
| Long interval | Aerobic | 70–85%+ MHR | 2–4 | 1:1<br>1:0<br>2:1 | 4–5 | 5 × 1 km repeats completed in 3 min, 90 seconds active recovery |
| Intermediate interval | Lactic acid | 85–95% MHR | 6–10 | 1:3<br>1:2 | 3 | 5 × 300 m sprints in 40 seconds with 80 seconds recovery |
| Short interval | ATP–PC | Maximal | 6–15 | 1:5+ | 3 | Short sprints up to 10 seconds, 5 × 70 m with walk/jog recovery |

**Table 8.5** Interval training in Australian football.

You can see from the table that different sessions have different effects. For the examples in the table, each session would have a specific purpose.

- *Short interval session*: build aerobic capacity and lactate threshold
- *Intermediate interval session*: increase anaerobic capacity and lactate threshold
- *Long interval session*: develop speed and target ATP–PC system with full or near full recovery

**Figure 8.12** AFL coaches use long interval training, such as 1 km runs, to build players' aerobic capacity.

## Long interval training

Long interval training includes maximal aerobic intervals and lactate tolerance intervals. It develops both aerobic and anaerobic energy pathways and is typically used if you do:

- physical activities with efforts of 1–6 minutes
- middle-distance running
- team games.

During recovery periods of long interval training, you should continue with light activity (walking or slow jog) because it helps you have a faster recovery. The active recovery can help blood lactate to be removed and muscle cells to resynthesise ATP and PC.

**Table 8.6** An example of long interval training.

| Component | Description |
|---|---|
| Set 1<br>2 × 400 m; easy pace in 80–90 s | 2–3 min jog recoveries;<br>work:rest ratio 1:1, 1:2 |
| Set 2<br>2 × 800 m; easy pace in 2 min 45 s – 3.00 min | 5–6 min jog recoveries;<br>work:rest ratio 1:2 |
| Set 3<br>2 × 400 m; easy pace in 80–90 s | 2–3 min jog recoveries;<br>work:rest ratio 1:1, 1:2 |
| Total distance = 5 km approx. | |

## Intermediate interval training

Intermediate interval training is designed to develop the lactic acid energy system. This is essential for events such as 400 m and 800 m runs, 200 m and 400 m swims, and team sports played on large fields or during which the player has little rest.

In this type of interval training you get an increase in lactate concentrations in blood and muscle, and your muscles experience fatigue due to the effects of lactate build-up. It therefore must be followed by recovery training or rest days.

| Set | Repetitions | Distance (m) | Time (s) | Recovery (s) | Work:rest ratio |
|---|---|---|---|---|---|
| 1 | 10 | 100 | 15 | 45 | 1:3 |
| 2 | 5 | 200 | 32 | 96 | 1:3 |

**Table 8.7** An example of intermediate interval training.

## Short interval training

Short interval training develops the ATP–PC energy system, which you need for successful performance in most team sports. Since the intervals are shorter, you get increased work intensity (maximal) and longer recovery periods, to allow your cells to restore ATP and PC levels and get rid of lactate.

Short interval training sessions can also include agility training, such as shuttle runs, obstacle sprints, and sprints starting from lying, sitting and kneeling positions.

**Figure 8.13** Soccer players in an interval agility training session.

# High-intensity interval training

High-intensity interval training (HIIT) is a form of interval training where you make near maximal efforts – that is, greater than 80% (often 85–95%) of MHR. It is a time-efficient method of increasing your aerobic capacity, with results similar to those achieved through slow, long-distance continuous training. To make sure you are developing aerobic capacity through development of the cardiovascular system, you have to spend several minutes at intensities of 90% $VO_2$max.

HIIT is one of the most effective training methods for improving aerobic capacity and physical performance of athletes, untrained people and people wanting general health benefits. The mix of short-to-long bouts of high-intensity activity, interspersed with recovery periods, means it's also beneficial for physical activities that require many high-intensity efforts, such as soccer, netball and tennis.

The general fitness benefits of HIIT are that it:

- improves your $VO_2$max (aerobic capacity)
- increases your cardiorespiratory fitness
- improves your exercise performance
- increases the capacity of your muscles to use oxygen
- decreases your body fat.

Because they use intense work intervals, HIIT sessions should feel hard.

There are two varieties of HIIT, called aerobic interval training and sprint interval training. Each targets different energy systems and requires different setups to succeed.

- Aerobic interval training (AIT) targets the aerobic energy system. Athletes work at around 80–95% of $VO_2$max, with work:rest ratios of 1:1 or slightly less.
- Sprint interval training (SIT) targets the two anaerobic systems. Athletes work at supramaximal (all out) intensity, at or near 100% of $VO_2$max, with work:rest ratios of 1:5 or more.

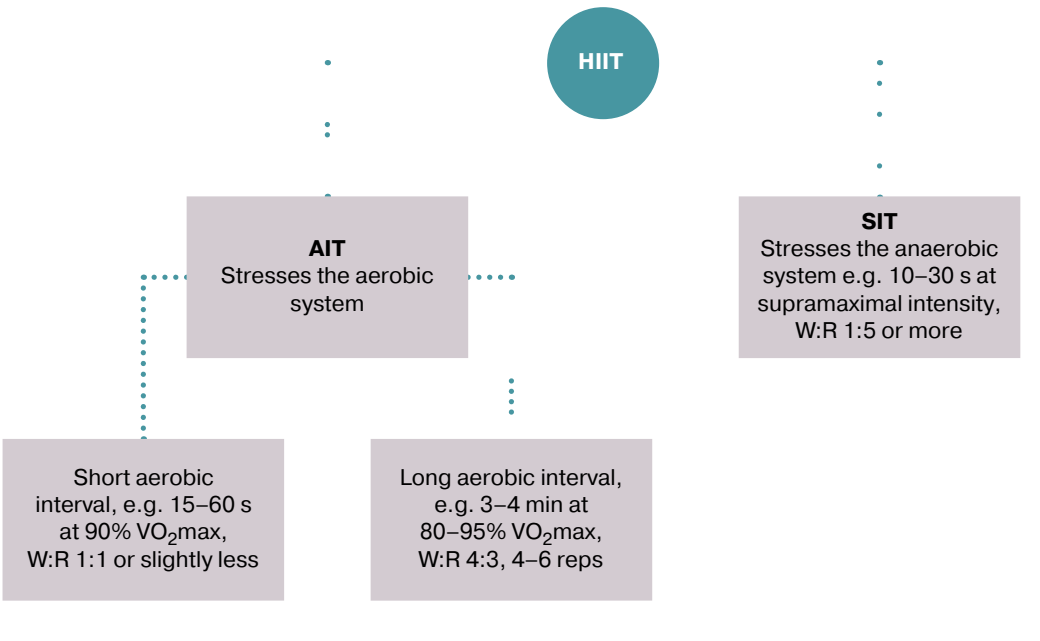



**Figure 8.14** Varieties of high-intensity interval training (HIIT).

You need to know which energy systems are dominant in a physical activity to choose which form of HIIT to use in training. For an activity that relies heavily on anaerobic energy systems you would pick SIT, while AIT is more suited to physical activities that depend on the aerobic energy system.

## Apply and analyse
interval training and heart rate

**LEARNING EXPERIENCE**

KEY OBJECTIVES
2, 3, 4

The theory behind interval training is that the athlete can work at a high intensity, stressing the anaerobic systems, and then use the aerobic system during the recovery intervals.

In pairs, complete the two interval sessions below on separate days. One member of the pair should record data in both sessions, while the other member trains.

### Sessions

**a** 1 × 400 m (maximal effort) **b** 10 × 40 m (maximal effort) with walk back recovery 1:5

### Equipment

- stopwatch
- heart-rate monitors
- tape measure

### Procedure

1. One person performs the interval sessions.
2. The other notes their partner's heart rates at different periods and records them in the table.

| Training session | Resting HR | HR before activity | Post-exercise HR | Post-exercise HR 1 min | Post-exercise HR 5 min |
|---|---|---|---|---|---|
| 1 × 400 m | | | | | |
| 10 × 40 m | | | | | |
| Sprints<br>1<br>2<br>3<br>4<br>5<br>6<br>7<br>8<br>9<br>10 | | | | | |

3. Create two separate graphs, plotting the results of heart-rate changes (*x*-axis) as a result of recovery and time (*y*-axis) for the two sessions.
4. Analyse the effect of the two types of training on heart rate during the work effort and recovery.
5. In which training session did the subject recover more quickly (towards regaining their resting heart rate)? Explain why this was the case.
6. Determine which energy system/s were being targeted in each training session, using your understanding of the energy systems, intensity of work intervals and duration of work.

# Circuit training

Circuit training is a form of interval training that combines continuous and resistance training. A circuit consists of a series of exercises (usually 10), arranged in order and designed to develop health-related or specific sport-related fitness. Circuit training differs from pure interval training, because circuits focus on what you are doing (i.e. picking the right exercises to target your fitness goals) while interval training focuses on the intensity of what you are doing.

Circuit training is an excellent training method, with the potential to develop your aerobic and anaerobic capacity, strength, power, muscular endurance and agility. Because circuits are so versatile, they have become popular with both the general public and elite athletes. Circuit training has several advantages:

- You can do circuit training in a limited space, in limited time and with little equipment.
- You can achieve progressive overload in several ways, such as by increasing exercise resistance, the number of repetitions or the difficulty of the exercise.
- You can maintain motivation by varying the circuit exercises or type of circuit, or by introducing skill work with equipment (e.g. rebound passing).
- You can add variety and intensity by using a wide range of equipment, such as resistance bands, exercise balls, skipping ropes, benches, dumbbells or punching pads and gloves.
- It is a good form of training for the beginner, and when well-structured it can be a great tool for targeting specific components of fitness.

## Guidelines

The key to a successful circuit-training program is the selection of exercises involved. You need to select and sequence exercises that target appropriate components of fitness and draw on appropriate energy systems.

If the circuit is designed for health-related fitness, choose circuit exercises that use several muscle groups and vary in terms of intensity, e.g. step-ups, sit-ups, burpees and push-ups. This will then improve both aerobic and anaerobic capacities.

If the circuit is designed for sport-related fitness, exercises that work the specific muscles and components of fitness required for the physical activity must be chosen. A volleyball circuit, for example, would include jumping and agility exercises to work the specific muscle groups used in volleyball, and to develop power.

Circuit exercises should use little or no equipment, and each exercise should be able to be performed rapidly, which rules out flexibility exercises. If you swap between resistance type exercises and high-intensity activities (e.g. high knees, skipping), you can improve strength, power and aerobic fitness. Exercises should be put into an order that allows body parts a chance to 'recover' within the circuit – for example, a leg exercise is followed by an arm exercise, then a trunk exercise and so on.

## Circuit types

While circuit training can contain many different exercises, there are actually only two different types of circuits.

In a fixed-load circuit, everyone does the same amount of work, no matter their fitness level or ability. Table 8.8 shows a typical fixed-load circuit in which each person begins with circuit A and tries to complete three laps within a time limit. Once they have achieved this, the participant tries to do circuit B in their next session, and so on.

| Exercise station | Circuit number | | |
|---|---|---|---|
| | A | B | C |
| 1 Shuttle runs | 10 | 15 | 18 |
| 2 Medicine ball rebound | 20 | 30 | 40 |
| 3 Sit-ups | 25 | 30 | 40 |
| 4 Skipping | 85 | 100 | 120 |
| 5 Squats | 15 | 20 | 30 |
| 6 Push-ups | 10 | 15 | 18 |
| 7 Lying leg raises | 15 | 20 | 25 |
| 8 Bench push-ups | 10 | 15 | 20 |
| 9 Bench jumps | 10 | 15 | 20 |
| 10 Bench dips | 10 | 15 | 20 |

**Table 8.8** Training program for a fixed-load circuit.

In a fixed-time circuit, individuals begin at different points of the circuit and, after a starting signal, complete as many repetitions at that station as possible within a fixed time, such as 1 minute. At the end of each minute, you move on and begin the next exercise minute. The aim is to perform more repetitions at each station in the set time over a number of sessions. Intensity can be adjusted by modifying the exercise, e.g. doing squats with a medicine ball or push-ups off your knees instead of toes.

**Figure 8.15** A fixed-load circuit versus a fixed-time circuit.

## Check your understanding 8.4

1. Explain why interval training is such a good way to improve your ability to play team sports.
2. List the three periods used for interval training, and briefly describe the training done in each and its benefits.
3. Compare and contrast circuit training with other forms of interval training. Why is it so popular with athletes and non-athletes?

## Evaluate and justify
design a circuit

**LEARNING EXPERIENCE**

KEY OBJECTIVES
2, 5, 6

1. In pairs, create a 10-exercise fixed-time circuit to develop the components of fitness, predominant energy system and specialised movement sequences for the physical activity you are studying.
2. Try out the circuit with your partner. Wear a heart-rate monitor and note down the intensities you are working at during the circuit.
3. Evaluate how effective the circuit was in achieving your training objectives. Use heart-rate data, examples of the exercises completed and your understanding of the fitness requirements of your physical activity to justify your evaluation.

The data you collected in this activity could support your project–folio assessment.

## Fitness analysis

**Category:** Invasion, Performance, Net and court
**Physical activity:** Any

**INTEGRATING MOVEMENT**
KEY OBJECTIVES
2, 3, 4, 5, 6

Sample response >
pp. 313–315

### Purpose

1. This activity aims to gather primary data about the fitness requirements for the physical activity you are currently studying.
2. The data you collect can support your project–folio assessment.

### Preparation

**Time:** one or two lessons

**Location:** performance area, e.g. oval, marked field or court

**Equipment:** playing equipment, digital capture device, heart-rate monitors

### Setup

1. This is a whole-class activity.
2. Organise the class into teams or performance groups.
3. Any students not in a team should document the game using digital capture.
4. Equip all players with heart-rate monitors.

### Performance

1. Students play a game for at least 20 minutes.

### Data recording

1. The observers gather primary data using digital capture.
2. The players/performers gather work intensity data from their heart-rate monitors.
3. Observers share their video data after the game/performance.

### Tasks

1. Using the primary video and heart-rate data, conduct a personal fitness analysis that includes the following:
   - **a** work times
   - **b** rest times
   - **c** intensity of movement
   - **d** heart rates
   - **e** other relevant data for your physical activity
2. Analyse the primary data to identify:
   - the main fitness components involved
   - the main energy systems used, based on duration and intensity
   - the work:rest ratios
   - specialised movement sequences
   - movement strategies.
3. Compare your analysis of the primary data you measured with secondary data, to identify any similarities and differences.
4. Put together all of the data collected to select the most appropriate training methods to develop performance in the physical activity you are studying.

# Chapter review

## Key questions and responses

**[8.1] How do the principles of training help ensure training is successful and the training objective is achieved?**

There are seven principles of training – time-based principles (frequency and duration), load and exertion principles (intensity and progressive overload) and personalisation principles (individuality, variety and specificity). Following these principles allows a coach to develop a program that meets the needs of the individual and their sport, and that targets appropriate components of fitness and energy systems for the training objective.

**[8.2] Why is continuous training the foundation of all sport-related and health-related training programs?**

Continuous training improves aerobic endurance by increasing your aerobic capacity, raising your lactate threshold 2 level and improving your muscular endurance. Aerobic and muscular endurance are valuable for all sports and in personal health and fitness, making continuous training valuable for all training programs. To get the best out of continuous training, you need to apply the FITT formula – frequency, intensity, time and type.

**[8.3] How do resistance and flexibility training improve muscles and joints?**

Resistance training exercises a muscle or muscle group against external resistance. By putting your muscles under stress, this training increases maximal strength, muscle size and bulk, muscular endurance and power. Flexibility training mainly involves stretching muscles, and it increases mobility and range of motion. Strength training stabilises joints, while flexibility training increases the ability of a limb to move freely about the joint.

**[8.4] How can interval training be adapted to suit different sports and physical activities?**

Interval training involves several key variables – the duration and intensity of the work interval, the duration of the recovery interval, the work:rest ratio, and the number of reps and sets in the training session. You can manipulate these variables, usually by changing the length of the work interval and the work:rest ratio, to make interval training highly specific to a particular energy system or physical activity.

# Exam-style questions

## Section A: Multiple-choice questions

KEY OBJECTIVES
1

**1** The target heart rate for an endurance training session should be:
- **a** above 90% of the athlete's maximum heart rate.
- **b** above 80% of the athlete's maximum heart rate.
- **c** between 70% and 85% of the athlete's maximum heart rate.
- **d** approximately 220 beats per minute minus the athlete's age.

**2** Which group of factors has the most influence on the specificity of training?
- **a** rest duration, work duration, frequency, intensity
- **b** rest duration, frequency, variety, number of repetitions
- **c** work duration, frequency, intensity, number of repetitions
- **d** rest duration, work duration, intensity, number of repetitions

**3** What is the main difference between fartlek training and continuous training?
- **a** Frequency: fartlek training should be performed 6–8 times per week, while continuous training should be 3–4 times per week.
- **b** Intensity: fartlek training has periods of higher intensity efforts, while continuous training is performed at a submaximal effort.
- **c** Duration: fartlek training should be performed for at least 60 minutes per session, while continuous training should be performed for at least 90 minutes.
- **d** Specificity: fartlek training is specific to running, while continuous training can be designed for running, triathlon and swimming.

**4** Which is the correct order to cycle through exercises for a resistance weight training program?
- **a** chin-ups, seated row, bench press, flys
- **b** chin-ups, bench press, squats, crunches
- **c** leg extension, squats, crunches, hanging leg raises
- **d** chin-ups, seated row, bench press, hanging leg raises

**5** If the aim of a resistance weight training program is to improve power, then the four phases of training should be in which order?
- **a** endurance, hypertrophy, strength, power
- **b** endurance, hypertrophy, power, strength
- **c** hypertrophy, power, strength, endurance
- **d** power, strength, hypertrophy, endurance

**6** A short interval training session of 8 × 50 m sprints at maximal intensity targets speed and the ATP–PC system, and can be overloaded by:
- **a** decreasing the volume.
- **b** increasing the number of repetitions.
- **c** increasing the recovery between efforts.
- **d** increasing the sprints to 30 seconds' maximal effort.

**7** Rate of perceived exertion, percentage of maximum heart rate and percentage of $VO_2$max are all ways that an athlete can check:
- **a** their lactate threshold
- **b** the rate of progressive overload
- **c** the intensity they are exercising at
- **d** the duration of the exercise session

**8** High-intensity interval training (HIIT) is an effective training method for improving fitness, because it has been shown to:
- **a** improve $VO_2$max and increase blood lactate build-up.
- **b** increase cardiorespiratory fitness and improve $VO_2$max.
- **c** decrease cardiorespiratory fitness and increase body fat.
- **d** increase the muscles' capacity to use oxygen and decrease its ability to store glycogen.

**9** Which group of the following circuit-training exercises would be effective for a touch football player?
- **a** squats, step-ups, lunges
- **b** agility ladder, lunges, bicep curls
- **c** bicep curls, jump squats, agility ladder
- **d** jump squats, agility ladder, up and backs

**10** An individual is completing an interval training session of 5 × 70 m high-intensity efforts with a work:rest ratio of 1:6. What work:rest ratio should they use to target the lactic acid system?
- **a** 1:1
- **b** 2:1
- **c** 1:3
- **d** 1:5

## Section B: Short-response questions (150–200 words)

KEY OBJECTIVES
1, 4, 7

**1** Jiang, a 10 km endurance runner, starts a new HIIT training program in the lead-up to a competition. Among other elements, it includes 3–4-minute AIT sessions with 3-minute recovery periods. As the competition phase approaches, some of these sessions are replaced by 30-section SIT sessions with 2-minute recovery periods.
- **a** Given that Jiang is an endurance athlete, explain why she is doing sprint interval training (SIT) sessions.
- **b** Identify which principles of training are being addressed by introducing HIIT sessions into Jiang's training program. Explain your reasoning.

**2** Two important principles of training are 'specificity' and 'variety'. Explain how these seemingly contradictory principles can both be applied in training. Give specific examples to justify your decision from the physical activity you are currently studying.

# Section C: Extended response to stimulus (400 words)

KEY OBJECTIVES
4, 5, 6, 7

In 2001, sports researchers Young, McDowell and Scarlett carried out a study with three groups of athletes. Over 6 weeks, two of the groups undertook interval training programs:

- Group 1 did interval training that focused on intervals of straight line running for speed
- Group 2 did change-of-direction sprints (agility training).

Table 8.9 summarises the training programs for Groups 1 and 2. Group 3 was a control that continued with normal daily activities but undertook no extra training.

| Week | Reps × distance (m) | Intensity (% MHR) | Number of changes in direction (Group 2 only) | Angle of change (Group 2 only) |
|---|---|---|---|---|
| 1 | 6 × 40 | 95 | 3 | 100 |
| 2 | 8 × 30 | 98 | 3 | 100 |
| 3 | 8 × 20 | 100 | 4 | 100 |
| 4 | 5 × 40 | 100 | 4 | 100 |
| 5 | 6 × 30 | 100 | 5 | 100 |
| 6 | 5 × 30 | 100 | 5 | 100 |

**Table 8.9**
Summary of the training programs for Group 1 (speed) and Group 2 (agility).

**Source: Young, McDowell and Bentley 2001, *Journal of Strength and Conditioning Research*, 15(3), pp. 315–19**

To assess the participants, each athlete completed 7 × 30 m sprint tests over the 6-week period. Figure 8.16 shows the path of the sprint tests, which incorporated more and greater changes in direction over the 6-week study.

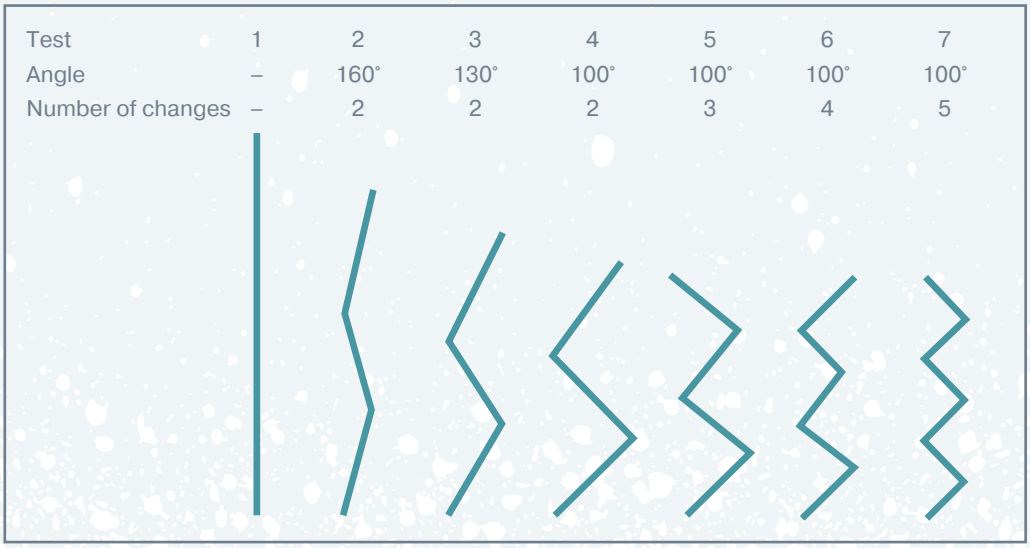



**Figure 8.16**
Paths of the 7 × 30 m sprint tests.

**Source: Young, McDowell and Bentley 2001, *Journal of Strength and Conditioning Research*, 15(3), pp. 315–19**

Predict the results you would expect to see from the three groups when completing the seven sprint tests over 6 weeks. Justify your reasons, based on the principles of training of specificity, progressive overload and intensity.

# 9 DESIGNING TRAINING PROGRAMS

**Figure 9.1** Coaches design training programs to optimise the performance of athletes.

To design an effective training program, athletes and coaches must understand the energy requirements and components of fitness of their physical activity. They can use specific fitness testing and game analysis of the individual or team to identify strengths and weaknesses, which then informs the development of the program.

In this chapter, you will consider how to design a training strategy to optimise performance of the specialised movement sequences and movement strategies for a physical activity.

## KEY QUESTIONS

**9.1** How is an annual training program divided up to get the best result for the athlete?

**9.2** What are the requirements for planning an effective training program?

**9.3** How is a training session designed to match the athlete's training objective?

**9.4** Why is it essential to evaluate a training program?

## YOUR CHAPTER PLAN


9.1 Cycles of the training year

9.2 Planning a training program

9.3 Features of an effective training session

9.4 Evaluating training programs

Chapter review

# 9.1 Cycles of the training year

Physical training is the foundation of preparation for an athlete. If the individual's physical capacity is not developed enough, it can affect their technical, tactical and psychological skills, and lead to poor performance during competition.

Whether a training program is for a competitive athlete or an individual looking for health-related fitness, it must be planned carefully so that it achieves the desired outcomes.

## Periodised training plans

Competitive athletes have to address a major factor in their training – the need to compete in organised events. While some competitions happen every few years (such as the Olympic Games), most occur every year. This means these athletes (and their coaches) need to have a year-long training plan that leads up to competition.

Any annual plan must take into account:

- the individual's fitness test results and training status (primary data)
- relevant information from recent scientific literature (secondary data)
- the dates of competitions
- the rate of progressive overload
- the fitness components and energy systems to be developed
- climate and season
- the fact that a high level of competitive fitness cannot be maintained for the whole year.

For these reasons, an annual plan must be divided into smaller phases of training. This is called **periodisation** of the training year.

**periodisation**
process of dividing an annual plan into a series of training phases

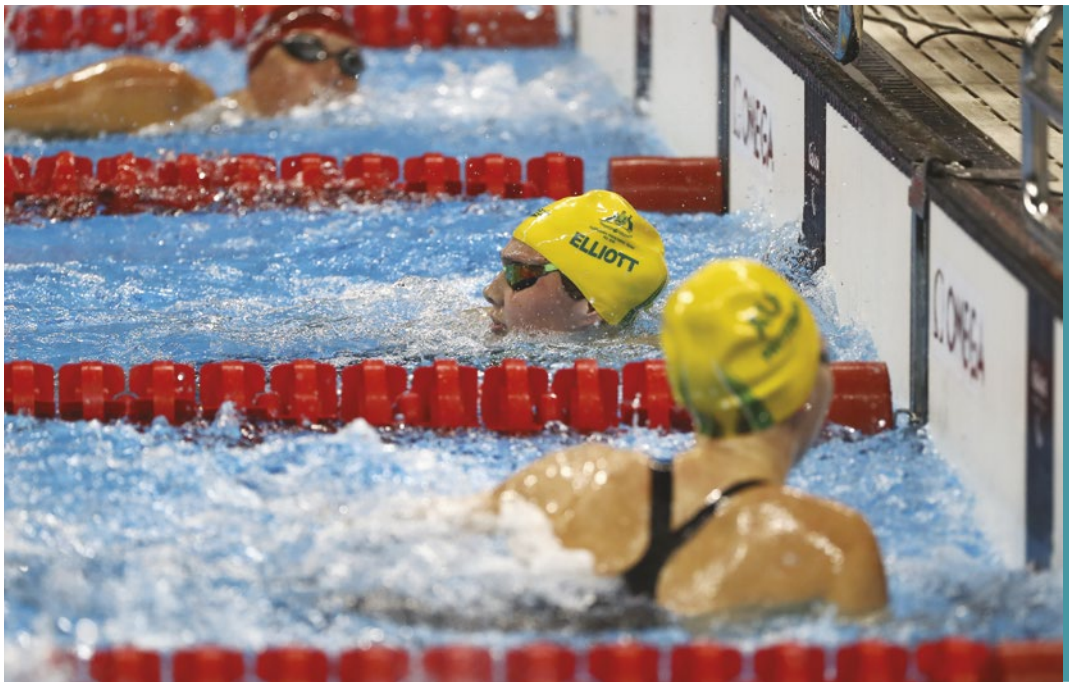



**Figure 9.2**
A periodised training plan prepared Maddison Elliott to win gold at the 2016 Paralympics.

The training year is divided into distinct training phases (periods) with very specific training objectives. Each phase achieves different goals but all have the aim of building the individual's readiness to perform at optimal levels at the right time.

Periodisation helps:

- match the most effective type of training with each phase of the training year to get optimal benefits
- manage fatigue, and avoid stagnation and overtraining
- structure training to get the best out of the athlete during competition.

The training year is divided into four main training phases:

1. Preparatory phase (pre-season), made up of two sub-phases:
   a. the general preparatory sub-phase, or fitness foundation
   b. the specific preparatory sub-phase, or game preparation.
2. Pre-competition phase
3. Competition phase
4. Transition phase.

Each phase and sub-phase (macrocycle) is divided into mesocycles and microcycles (see p. 225). Mesocycles and microcycles have specific training objectives, fitting in with the total aim of the macrocycle they are in.

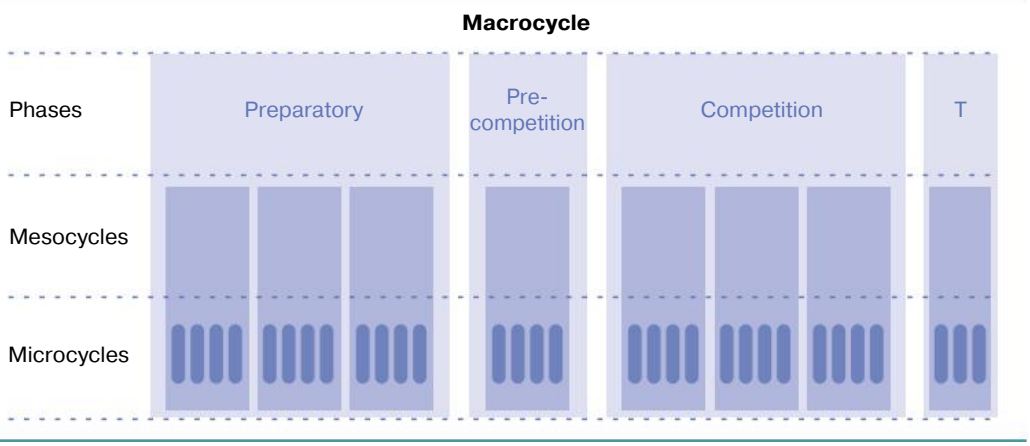



**Figure 9.3** The structure of a periodised training plan for a team sport with a lengthy season.

The length of the stages could be something like this:

- macrocycle: the entire training year, usually defined by the start and end of competition or the length of time between major competitions
- mesocycle: usually 4–6 weeks, as this is the period it takes to get a training adaptation
- microcycle: 5–7 days of training, a short period with a specific focus.

The intensity, duration, frequency and method of training also vary depending on the phase of the training year. The athlete's components of fitness, such as strength, endurance and speed, can be developed in the best order throughout the training phases by using the most suitable training methods at the right intensity.

For example, many physical activities require power, so some coaches might focus on it at the expense of strength. However, because power is the ability to use strength in rapid, explosive muscle contractions, you have to first develop strength during the early part of the preparatory phase, and then transfer your strength gains into building power for the competitive phase.

## The preparatory (pre-season) phase

All competitive team sports, including netball, rugby and Australian rules football, have a well-defined preparatory phase called pre-season. During pre-season, the emphasis is on developing your general fitness. This is probably the most important phase, because it sets you up with a physical and technical base to build on for the competitive phase. If this phase is inadequate, your ability to get through training and put in your best performance in competition will be reduced.

The general preparatory sub-phase often lasts 4–10 weeks, and is mainly about developing your aerobic energy system. During this sub-phase, the volume of training is high, but the intensity is low to start with, and increases very slowly. This is where your essential base of fitness is developed.

During the specific preparatory sub-phase, the objective is still to increase your working capacity, but there is a shift in training towards more specific game-related fitness work. The intensity of training increases while the volume slowly decreases. This sub-phase usually lasts 2–6 weeks and the main emphasis is on specific exercises related to the skills or technical aspects of the sport.

**Figure 9.4** Pre-season training for English soccer team Northampton Town brings an element of fun as well as preparing the players for the coming season.

## The pre-competition phase

The competitive season includes pre-competition and competition. For many sports, it lasts 4–6 months. During the season, the emphasis is on maintaining pre-season fitness.

After the preparatory phase, the pre-competition phase starts, with training activities that are specific to the physical activity. Training becomes more intense and volume is often decreased:

- In physical activities dominated by speed, power and strength, training intensity increases a lot but the volume of training drops back.
- In endurance events, intensity is increased and training volume can be maintained.

During pre-competition, you might use unofficial competitions (such as simulated or exhibition matches) as a training tool and to get objective feedback about how ready you are for competition.

## Competition phase

Competition is the final and most important phase. Training continues during this competitive phase, to keep the athlete performing at their best. During competition the volume of training is less (unless training for an endurance sport) but the intensity is higher. The decrease in volume and focus on intensity is especially important in physical activities that require technical mastery, speed, strength or power, such as gymnastics, and track and field jumps and throws. The training principle of progressive overload is still used in this phase.

**peaking**
being in the optimum state of readiness for competition

**tapering**
reducing training before a major event to allow for complete recovery and optimal performance

Two important concepts in this phase are peaking and tapering.

- **Peaking** refers to training that puts you in your optimum state for performance.
- **Tapering** is reducing the training load (in volume, intensity or frequency of sessions) in readiness for competition.

**Figure 9.5** During competition phase, training continues at high intensity but low volume.

Tapering helps to decrease fatigue (both physiological and psychological), while still keeping you fit for the sport. The taper is a critical stage of training as it has a major effect on the athlete's ability to perform at their best in competition.

You need to understand the interactions of training intensity, volume, frequency and duration to plan the most effective taper. The decrease in training load depends on such factors as:

- the individual athlete
- the specific physical activity they are training for
- how long the athlete has been training
- their level of fatigue
- the intensity of the training.

Coaches consider the principles of training when developing a taper.

1. Changing training intensity helps maintain your performance fitness, with some research suggesting that increasing intensity during the taper (while decreasing volume and frequency) can help.
2. Changing training volume is the most common tapering strategy and can be achieved by cutting back the duration and/or frequency of sessions; there is some evidence that cutting duration is most effective.
3. Changing training frequency is also common, and it's been shown you can reduce training frequency for 2 weeks before competition without losing fitness.
4. Setting the duration of a taper is difficult, but research suggests that 2 weeks is optimal.

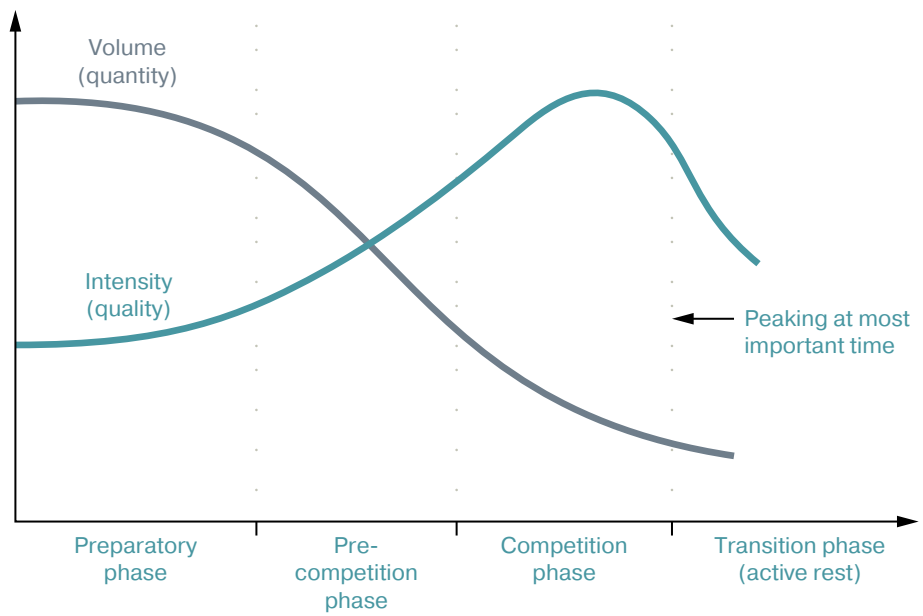



**Figure 9.6** Volume and intensity vary through the training periods, so that the athlete is peaking during the competitive phase.

Tapering has to allow for whether the athlete has a whole-year plan, or has to peak several times during a competitive phase. In team sports where the player has to prepare for a match each week, they use a microcycle that allows rest from training later in the week, to recover in time for competition day.

## The transition phase

The transition (off-season) phase should be both a psychological and physical break from the physical activity you've been competing in. It usually lasts 2–4 weeks but could be as long as 6 weeks. It allows you to rest and recover, while still maintaining a base of fitness. So it shouldn't really be referred to as an 'off-season', because you shouldn't take a complete break from training.

In this period, you should remain reasonably active without playing your chosen sport. If you are inactive, you will rapidly lose the benefits of previous training. For example, you could do low-intensity weight and running training twice weekly, and play recreational games (such as basketball, tennis and swimming) for enjoyment. You could also include specialised weight training or speed programs to remedy any diagnosed weaknesses.

Training methods that suit this phase of training include continuous training, cross training and resistance training.

### Check your understanding 9.1

1. Explain why the preparatory or pre-season phase is also called the foundation phase.
2. During the competition phase, you taper to allow for recovery from training and ensure peak fitness and readiness for competition. Describe four factors involved in tapering.
3. Identify why it is not ideal to refer to the transition phase as the 'off-season'.

### Apply and analyse
researching training phases

LEARNING EXPERIENCE
KEY OBJECTIVES 1, 3, 4

1. Use your research skills to collect at least three training programs specific to the physical activity you are currently studying.
2. Identify the phases of each training program.
3. Identify the macrocycles, mesocycles and microcycles within each program.
4. Determine a training session, drill or activity that you could use to develop your personal training strategy. It will need to help train you for the specialised movement sequences for one movement strategy and the associated components of fitness of your physical activity.
5. Apply your understanding of the requirements of the physical activity you are currently studying to analyse your selection in terms of training method, specificity, intensity and duration.

Make sure you retain your notes about the secondary data sources you researched in this activity. They will be directly relevant to your project–folio assessment task.

# 9.2 Planning a training program

Planning a training program means using all the analysis, assessment, principles and training methodology you have studied in this unit. For a training program to succeed and produce improvements in your fitness, you need to set out your training objectives and how you will achieve them in a careful step-by-step plan.

Any good training program should include:

- the purpose and goals to be achieved
- a methodical game analysis
- a pre-test and a post-test of fitness
- a training session timetable based on periodisation of training methods and incorporating all training principles
- a justification of every chosen test, training method and exercise in relation to the program's purpose and the results of the game analysis
- an evaluation of the effectiveness of the training program and modifications if necessary.

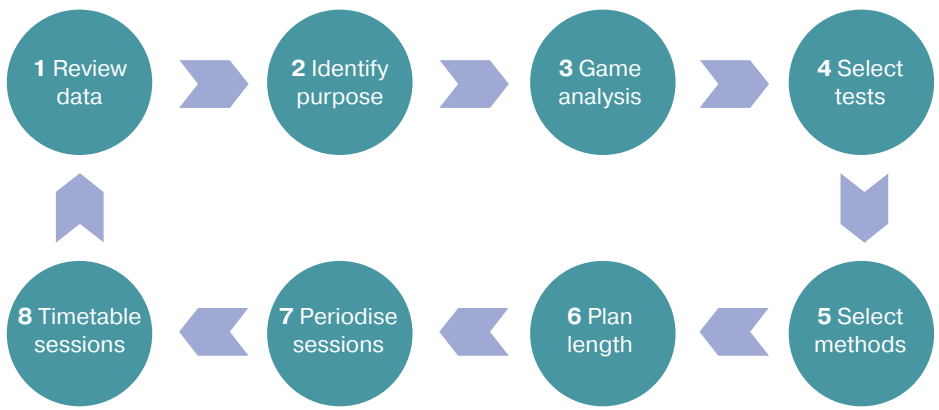



**Figure 9.7** The eight steps of planning a training program.

## Step 1: Review secondary data

The first step is to review research articles and other forms of secondary data relevant to training for the physical activity. This will inform your training plan by:

- guiding the purpose or objective(s) of the training plan
- identifying which components of fitness and energy systems need to be targeted
- determining which training methods will help you achieve the training objectives
- identifying essential aspects of the training principles, such as specificity, intensity, duration and frequency.

This data may even provide examples of training microcycles or mesocycles that you could use with little modification, as long as they are specific to your training status and training objectives.

## Step 2: Identify the purpose of the program

You need to have a purpose in mind for your training program, so everything in the program can work towards that purpose. For example, the purpose (or personal training strategy) of a program for an under-12s soccer team with a low initial fitness base could be to maximise their fitness during a 6-week period of pre-season preparation.

Another example of a purpose would be to plan a personal training strategy suited to the competition phase to optimise your performance of the specialised movement sequences for one movement strategy (e.g. setting up attack, defending against attack).

## Step 3: Conduct game analysis

**game analysis** the recording and analysis of data about an individual's or team's performance in a game

**Game analysis** is when you collect primary data about your performance in a game. It can inform you about the physical requirements and the decision-making needed for a particular physical activity.

Some advantages of game analysis in physical activities are that it:

- provides objective information about individual, team and opposition performance, which can be used to decide training needs
- provides an overview of skill and strategy strengths and weakness (team and individual), which can be used to improve performance
- acts as a record of performance so you can monitor improvements in game plans, fitness, team strategy and player performance.

**Figure 9.8** America's Loudoun County volleyball team won five state titles over six years, due in part to intense practice and extensive study of their opponents through game analysis.

### Identifying the critical elements

There are all sorts of primary data that can be collected as part of game analysis, but not all of it will be relevant to your program's purpose.

In 1984, researchers Franks and Goodman suggested three steps to help a coach identify the elements to focus on in game analysis:

1. Describe your sport from a general level to a specific focus.
2. Prioritise key factors of performance (in other words, concentrate on what you want to know about the specialised movement sequences, foundational movement skills and movement strategies).
3. Devise a recording method that is efficient and easy to use.

## Evaluate and justify
critical elements

LEARNING EXPERIENCE

KEY OBJECTIVES
1, 5, 6

Consider the advice from Franks and Goodman, and complete the three-step process for the physical activity you are currently studying:

1. Describe your sport from a general level to a specific focus.
2. Prioritise key factors of performance. (What do you want to know?)
3. Devise a recording method that is efficient and easy to use. If you have access to performance-analysis software through your school, set up the data as per your particular program and the key factors you have identified.
4. Using some video footage of your class's participation in the physical activity, test the effectiveness of your recording method (e.g. ease of use, relevance of the key elements identified to the physical activity, validity of the data collected).
5. Evaluate how effective your game analysis was in identifying and recording the critical elements of the physical activity. Use specific examples from your assessment research to justify your evaluation.

The evaluation you make in this activity will be directly relevant to your project–folio assessment task.

## Skills analysis

Game analysis has three parts. The first part, skills analysis, shows how often and how effectively a player or team uses a particular skill or movement sequence.

To gather this information, list the basic possession and disposal skills of the sport and then record both individual and team usage of each skill. You can use this information to find out skill deficiencies and shape training sessions.

For example, Figure 9.9 shows an extract from a statistics sheet for a soccer game, recording how players dispose of the ball. Player C made limited use of the outside foot when passing. This suggests that training sessions must emphasise this technique in practice, to build skill and confidence.

| Player | Disposal skill | | | |
|---|---|---|---|---|
| | Inside foot | Outside foot | Heel | Laces |
| C | 𝍸 \| | \|\|\| | \|\| | \|\|\| |

**Figure 9.9** Statistics sheet for basic soccer disposal skills.

Skills analysis is not just used to identify weaknesses, but also strengths, habits or patterns. For example, the statistics may show that a touch football player always disposes of the ball to a teammate, or that a basketballer never misses a lay-up. The coach should use this information to develop drills that give this player more possessions so that their skills can be used more effectively.

**Apply and analyse**
disposal skills analysis

LEARNING EXPERIENCE

KEY OBJECTIVES
1, 2, 3, 4

1. List the basic disposal skills for the physical activity you are currently studying.
2. Develop a disposal skills statistics sheet or game performance analysis instrument (GPAI) (you may adapt one from the example or from an online example).
3. Have someone take some video of your game play.
4. Identify the strengths and weaknesses of your disposal skills.
5. Conduct some research to find a training activity that you could use to improve your disposal skills and your use of the specialised movement sequences involved.

The data and analysis in this activity will be directly relevant to your project–folio assessment task.

## Decision-making analysis

Most game analysis focuses on fitness and skill. However, at high levels of performance, errors are often not the result of lack of fitness or skill, but of poor decision-making – the player chooses the wrong response to a situation. For example:

- a basketball player dribbles the ball when they should have passed it
- a soccer player chooses to make an angled shot at the goal when the ball should have been centred
- an Australian rules footballer runs deep into attack to receive a pass when they should have run out wide.

You can select one or more tactical elements to evaluate the decision-making performance of an individual or team. For example, these could include:

- base: how well does the performer return to a recovery (base) position between skill attempts?
- adjust: how well does the performer move during game play, either offensively or defensively?
- skill execution: how efficient is the player in using selected skills?
- support: how well does the player support teammates by moving to receive a pass?
- cover: does the player provide appropriate defensive cover, help and backup for a player making a challenge for the ball?
- guard/mark: how well does the player guard or mark an opponent?

Game performance analysis instruments (GPAIs) are useful tools for measuring players' tactical understanding and ability to solve problems. Using a GPAI is helpful because:

- it can be adapted to various physical activities and game activities, e.g. small-sided games

- it can be used to measure on-ball and off-ball skills (offensive and defensive). For example, in an Invasion game, on-ball skills might include skill execution and decision-making, and off-ball skills might be player support to teammates when in possession, player adjustments to the changing position of the ball when not in possession, player cover to provide defensive help and guarding or marking of opposition.

## Decision-making

**Category:** Invasion, Net and court
**Physical activity:** The physical activity you are currently studying

**INTEGRATING MOVEMENT**
KEY OBJECTIVES
2, 3, 4, 5

Sample response: > pp. 316–317

### Purpose

1. This activity aims to develop and implement a GPAI that could be used to gather primary data about personal performance of specialised movement sequences and movement strategies.
2. The primary data collected in this activity can be used to support your project–folio assessment task.

### Preparation

**Time:** two lessons

**Location:** classroom and playing area

**Equipment:** playing equipment; GPAI from online resources; digital capture devices

### Setup

1. This is a whole-class activity.
2. Assemble teams for a 10-minute game. Any students not playing will document the game using digital capture. The groups will swap roles later.
3. As a class, decide on the critical elements to be observed.

### Performance

1. Students play a 10-minute game.
2. Change roles so that all students have an opportunity to play and to be filmed.

### Data recording

1. When not playing, students use digital capture to record the game.
2. After the performance, all students watch the footage of the game and record in the GPAI the critical elements that have been decided on.

### Tasks

1. Analyse the primary data based on the critical elements identified.
2. Use your analysis to evaluate how effective you were in the specialised movement sequences and movement strategies for the physical activity.
3. Based on your primary data, decide which position you are most suited to and what you need to work on to improve your performance.
4. Make sure you have visual evidence from the footage to support your decisions.

## Fitness analysis

To develop an accurate fitness training program, you must conduct an individual analysis of a top performer during a competitive game, playing in the specific position in which you are interested. Once you have completed this analysis, you will know:

- the demands of a competitive game, so you can work out what you need to focus on in training to improve your competition performance
- the energy systems, fitness components and muscle groups your sport uses, so you can select training methods to improve these specific systems, components and muscle groups
- the fitness level, in each component, of a top performer, so you can set training and overload goals for yourself
- the components of fitness that you need to test to find out your current strengths and weaknesses.

Energy production p.172

The most basic information collected in any fitness analysis is the input of each energy system into the sport. As discussed in Chapter 6, the type of energy production in your muscles depends on the duration of the activity, the intensity of the activity and how well developed your oxygen delivery system is.

Information about energy systems in use is gathered by:

- analysing activity or movement patterns
- monitoring heart rate
- calculating work:rest ratios.

### Analysing movement patterns

To analyse movement patterns, you record the on-field movements of players throughout a game. The most basic method is by recording them on a chart. You can do this from direct observation at the game or, more accurately, from video of the performance and using performance-analysis software. The distances covered by each player and the intensity of each effort are also recorded. If you analyse the movement patterns together with heart rates, you can show which energy systems are being used predominantly.

### Work:rest ratio

Work:rest ratio p.238

As you saw in Chapter 8, the work:rest ratio refers to the amount of time a player is active (working) compared to the amount of time they are resting (recovering). These ratios are most applicable to intermittent physical activities such as touch football, basketball, netball, soccer, tennis, badminton or volleyball. Work periods and rest periods are totalled, and the two compared.

Important points about work:rest ratio:

- Define ‘work’ and ‘rest’ before you begin a fitness analysis. For example, work may be defined as activities of intensity greater than jogging, such as cruising or sprinting; rest might include standing, walking or jogging.
- During a 20-minute half, if a player is working for 5 minutes and resting for 15 minutes, the work:rest ratio is 1:3. This ratio is common in team sports – with time-outs, injuries, the ball out of play and other delays, players on average rest or recover for three times as long as they work.

- To meet the principles of training (specificity, intensity and duration), build the calculated work:rest ratio into your training program. You must become used to the length of work intervals and take rest intervals only in accordance with the work:rest ratio that applies during a competitive situation.

**Figure 9.10** In a Sydney Swans training session, Isaac Heeney and Ryan Clarke recover and monitor intensity through heart-rate data.

### Monitoring heart rates

Heart rate is an indicator of intensity and how much cardiovascular effort an individual player is putting into the game. Using heart-rate monitors allows you to measure heart rates in performance environments. For a continuous sport, you can then modify training drills so that athletes are working at the intensity that will be required of them during the game.

## Step 4: Select suitable tests

The choice of fitness tests to be used in a test battery should be based on:

- the results of the game analysis
- the time available for testing
- access to equipment and facilities.

Pre-testing is needed to find strengths and weaknesses, and work out a suitable starting point for program workloads.

Post-testing (at the end of the program) is important for identifying whether the program achieved its objectives and whether your specific fitness improved.

**Figure 9.11** The need to kick under pressure in Australian rules football is one reason why there is a kicking test for young players in the draft.

## Step 5: Select suitable training methods

For sport-related fitness programs, choose training methods to develop the fitness components that the game analysis has shown to be essential, or for which you have scored poorly in your fitness tests. Within each training method, select the activity or exercises that are most relevant to your sport.

You should also take into account the phase of the training year. Table 9.1 shows how a soccer training program might be periodised and adjusted for a training year.

**Table 9.1** Priority of fitness elements in a soccer training program.

| | Early pre-season | Late pre-season | In-season |
|---|---|---|---|
| Continuous training | High | Low | Low |
| Interval training | Moderate | High | Maintenance |
| Strength training | High | Moderate | Low |
| Power training | High | Moderate | Maintenance |
| Speed training | Low | High | Maintenance |
| Flexibility training | High | High | High |

## Step 6: Plan the length of the program

To achieve significant gains in fitness, your program must be 6 weeks long, with a minimum of 3 sessions per week – a minimum total of 18 sessions.

Decide which training phase applies to your program; for example, pre-season. Then decide which days of the week will be training days, taking into account outside influences such as external training, competitions, work and school commitments.

## Step 7: Periodise training sessions

For each training method used:

- calculate the total number of sessions per week
- calculate the total number of sessions over the 6 weeks
- plan the content (i.e. exercise type, volume, duration and intensity) of the warm-up, the conditioning phase and the cool-down for each session.

For example, you might decide to include 3 interval sessions each week and 2 weight sessions. You must therefore map out the content of 18 interval sessions and 12 weight sessions over the 6 weeks.

At this level, all training principles must be taken into account, particularly progressive overload and specificity.

Table 9.2 shows an example of an in-season (competition phase) training microcycle.

| Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|
| Interval training | Team training: plyometrics and sprint work | Weights session and flexibility | Team training: interval training | Rest | Match | Recovery session and flexibility |

**Table 9.2** In-season soccer training program.

## Step 8: Timetable training sessions

This is the final step in developing a training program. The idea is to combine the training sessions for each training method into a total training grid.

Table 9.3 shows a training timetable for a centre player in netball. This is a summary of a 6-week in-season training program, conducted in conjunction with skill sessions.

| Day | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 |
|---|---|---|---|---|---|---|
| Monday | Warm-up<br>Circuit<br>Intervals<br>Cool-down | Warm-up<br>Circuit<br>Intervals<br>Cool-down | Warm-up<br>Circuit<br>Intervals<br>Cool-down | Warm-up<br>Circuit<br>Intervals<br>Cool-down | Warm-up<br>Circuit<br>Intervals<br>Cool-down | Warm-up<br>Circuit<br>Intervals<br>Cool-down |
| Wednesday | Warm-up<br>Intervals:<br>2 × 600 m<br>4 × 70 m<br>6 × 30 m<br>Cool-down | Warm-up<br>Intervals:<br>2 × 600 m<br>4 × 70 m<br>6 × 30 m<br>Cool-down | Warm-up<br>Intervals:<br>2 × 600 m<br>6 × 70 m<br>10 × 20 m<br>Cool-down | Warm-up<br>Intervals:<br>2 × 600 m<br>6 × 70 m<br>8 × 30 m<br>Cool-down | Warm-up<br>Intervals:<br>8 × 70 m<br>8 × 40 m<br>8 × agility runs<br>Cool-down | Warm-up<br>Intervals:<br>8 × 200 m<br>8 × 50 m<br>8 × agility runs<br>Cool-down |
| Thursday | Warm-up<br>Circuit<br>Cool-down | Warm-up<br>Circuit<br>Cool-down | Warm-up<br>Circuit<br>Cool-down | Warm-up<br>Circuit<br>Cool-down | Warm-up<br>Circuit<br>Cool-down | Warm-up<br>Circuit<br>Cool-down |
| Saturday | Game | Game | Game | Game | Game | Game |

**Table 9.3** A 6-week netball training program for the position of centre.

In Step 7, you would have written a detailed explanation of the activities included in each of the circuit, warm-up, cool-down and intervals (intensities, recoveries and work:rest ratio).

## Check your understanding 9.2

1. Identify a training purpose or personal training strategy (Step 2) for the physical activity you are currently studying.
2. Explain why it is important to do pre-testing and post-testing of your fitness.
3. Recall three benefits of looking at published research data (secondary data) for the physical activity and for training protocols.

**Figure 9.12** Improved physical ability affects an athlete's performance.

## Evaluate and justify training timetable

LEARNING EXPERIENCE
KEY OBJECTIVES 1, 5, 6

1. Based on the netball fitness program shown in Table 9.3, identify what energy systems and fitness components are being targeted.
2. Explain what work:rest ratio should be used to make sure the netball centre player is working at the right intensity.
3. Agility is an important fitness component for many physical activities. For example, weeks 5 and 6 of the netball mesocycle list agility runs as part of the training session. Devise an agility session that is specific to the physical activity you are currently studying.
4. Decide if Table 9.3 could be a useful 6-week mesocycle to improve your fitness, considering your target energy systems and fitness components for the physical activity you are currently studying.

# 9.3 Features of an effective training session

The training session is the basic building block of all microcycles. The content of each session will depend on the target fitness components, and the mesocycle and phase you are in. However, to get maximum benefit, all sessions should follow this format:

- the warm-up
- the conditioning phase
- the cool-down.

## The warm-up

The **warm-up** should include exercises that prepare your muscles to be used and activate the target energy system. It should be related specifically to the activity that follows. For instance, sit-ups or push-ups are not useful as a warm-up for a running session. Instead, jogging followed by run-throughs and a carefully planned dynamic stretching program are the best preparation for running.

**warm-up**
combination of activities done at a low intensity to prepare the body for more vigorous exercise

**Figure 9.13**
Greg Leleisiuao and Parramatta Eels teammates prepare for training through a comprehensive warm-up.

## Warm-up procedure

A warm-up should last approximately 10–30 minutes. This adds up to a significant amount of time given you do one for every training session, so you must make warm-ups purposeful and good quality. To prevent boredom and ensure improvements in performance, use a range of exercises that activate and mobilise the right key muscles, joints and ranges of motion.

The four main components of a quality warm-up are summarised in Table 9.4, which explains the RAMP protocol:

- **r**aise
- **a**ctivate and **m**obilise
- **p**repare.

This protocol was developed by Dr Ian Jeffrey (2007) to help athletes, trainers and coaches maximise performance outcomes.

**Table 9.4** The RAMP warm-up protocol.

| | Raise | Activate and mobilise | Prepare |
|---|---|---|---|
| Purpose | • Raise body temperature, heart rate, respiration rate, joint flexibility and increase blood flow<br>• Also known as the 'pulse-raising activity' | • Activate key muscle groups<br>• Mobilise key joints and range of motion specific to the physical activity | • Prepare the body for performance by:<br>– increasing intensity to near performance level<br>– using dynamic stretches and activities |
| Method | • Include exercises or simplified sports-specific movements which are used in a session/game<br>• A jog around the field is not a valuable use of time | • Consider the fundamental movements and demands of the physical activity | • Include activities that focus on improving actual performance in the physical activity |
| Examples for soccer | • Sprint technique drills<br>• Agility drills<br>• Squatting or lunging | • Mini-band routines<br>• Balance work<br>• Squats and lunges<br>• Sumo shuffles<br>• Spinal mobility exercises (flexion, extension, lateral flexion, rotation) | • Sprint session: 5–10 m accelerations, rolling 30–40 m sprints, plyometrics<br>• Team session: plyometrics, reactive agility drills in a chaotic environment, sprints as above |

## Effects of the warm-up

Warming up produces helpful physiological changes:

- It increases the blood flow through your muscles as the small blood vessels dilate, and so increases the warmth of your muscles as well as their oxygen supply.
- It increases in your heart rate and respiratory rate, making it easier to switch to aerobic energy production.
- It makes your muscles able to contract and relax more quickly, which reduces the risk of injury.
- It increases the speed and force of contraction of your muscles.
- It increases enzyme activity within muscle fibres, due to the increase in temperature.
- It increases how far you can extend your fibres and tendons, due to the increase in temperature.
- It increases the alertness of your nervous system, preparing you physiologically and psychologically for the demands to come.

**Figure 9.14** Joanna Weston and the Australian Diamonds netball team warming up before a competition match.

### Apply and analyse
creating a RAMP warm-up

LEARNING EXPERIENCE
KEY OBJECTIVES
1, 3, 4

1. Follow the RAMP warm-up protocol to devise a suitable warm-up for the physical activity you are currently studying.
2. Describe the sports-specific activities you will use as pulse-raising activities in the first part of the RAMP warm-up.
3. List three exercises you have included to activate and mobilise the key muscle groups. Explain how they are suitable for your physical activity (talk about muscles, joints and ranges of motion).
4. Explain how the 'Prepare' part of the RAMP protocol was met.
5. Try out the warm-up and reflect on how well it prepared you for the physical activity. Determine what activities achieved their objective and what activities didn't, and suggest how you could modify them to better meet the RAMP protocol.

The warm-up routine you develop here may be useful in your project-folio assessment task.

## The conditioning phase

In the conditioning (or fitness) phase of a session, you develop the specific fitness components needed for the particular physical activity. Your activities should always follow proven training principles, such as the principle of overload.

In a well-planned training program, the following should be stated for each session:

- the training phase, macrocycle, mesocycle and microcycle for that session, e.g. pre-season mesocycle, week (microcycle) 2, session 1
- training method to be used
- intensity (the speed of the work), e.g. continuous running at 75% MHR (maximum heart rate)
- duration
- volume (amount) of work
- rest periods (recovery time between work periods) and intensity of the recovery (active or passive)
- repetitions.

There is an order you should follow to get maximum return:

- Do speed work first, allowing complete recovery between repetitions.
- Then do power and specific strength work, while you are not too fatigued.
- Finally, work on endurance of local muscles, followed by aerobic work, since these activities are very fatiguing.

## The cool-down

**cool-down** combination of activities done at reduced intensity to help the body return to pre-exercise state

**homeostasis** the systems a living organism uses to keep the conditions inside it constant, despite changes in the conditions around it

In **cool-down**, you taper off your activity after completing the training session, game or performance. Cool-down begins the recovery process and allows **homeostasis** to regulate your body temperature and removal of wastes.

The purpose of the cool-down is to allow your body to:

- remove waste products (e.g. carbon dioxide, lactate)
- replenish energy stores (ATP, PC, glycogen)
- start tissue repair
- relax the muscles
- decrease the heart rate.

After physical activity, your body doesn't immediately return to its resting state. Depending on the intensity and duration of the activity, this could take up to 48 hours. The cool-down speeds up this process. This aspect of a training session is often overlooked or rushed, but it's important for you to complete a structured cool-down.

Your cool-down should take 20–40 minutes, or long enough for your heart to recover to 100–120 beats per minute. It has three parts:

1. Active recovery: continue the activity at a much lower intensity for approximately 20 minutes. Your heart rate should be less than 50% MHR.
2. Stretching: do static stretching as an excellent way to speed up muscle recovery and reduce muscle soreness. During this time, you and your coach can reflect on how effective the session was, and fill out your training diary.
3. Refuelling: eat carbohydrates and proteins, and drink fluids, within 2 hours of training. Carbohydrates replace the glycogen stores used in the session, proteins help in the growth and repair of muscles, and fluids rehydrate the body.

# TRAINING DIARY

Day: *Sunday*

**Date** *27/6/20*

Phase of training: *Pre-season macrocycle*

**Session no.** *3*

Climate conditions: *Raining*

Psychological state: *Happy*

Location: *Basketball court and football oval*

Resting heart rate: *56*

Exercise maximum heart rate: *188*

Recovery heart rate: *86*

## Warm-up

Jog till light sweat

Stretches: *Calves, quads, hamstrings, gluteals, shoulders (front and rear)*

## Training method 1: interval training (1:1 work:rest ratio)

Grid (20 m × 20 m)

1 Walk, jog, sprint, walk
   Jog, sprint, jog, walk
   Sprint, jog, sprint, walk
2 5 × 15 m (different starting positions, e.g. sitting, lying)
3 3 × 50 m sprint

## Training method 2: circuit training

(2 laps fixed time circuit – 50 seconds on, 10 seconds off)

1 Side shuttles 5 m
2 Sit-ups
3 Burpees
4 Agility cone run 10 m
5 Push-ups
6 Step-ups
7 Dips
8 Forward back run over 10 m
9 Skipping
10 Bench jumps

## Cool-down

5-minute walk/jog

Stretches as for warm-up

## Comments on the session

*Hard. Humid conditions. Combining two methods in one session very difficult.*

**Figure 9.15** Sample page from a training diary.

## Check your understanding 9.3

1. Describe the physiological effects of the warm-up.
2. Explain why it is important to place speed and power work early in the training session.
3. Describe the purpose of the cool-down and explain why it should not be overlooked.

## Apply and analyse
training diary

LEARNING EXPERIENCE
KEY OBJECTIVES 1, 3, 4

Figure 9.15 outlines a sample page from a training diary. Use your understanding of the structure of an effective training session to complete the following.

1. Would this be an appropriate warm-up to prepare you for the physical activity you are currently studying?
2. Training method 1 in the session is an example of interval training.
   - **a** Identify what type of interval training it is, and judge how relevant the activities in it are to the physical activity you are studying.
   - **b** Recommend the training intensities and work:rest ratios for this part of the session, to make it specific to the physical activity you are studying.
3. Which components of fitness is the circuit training in this session targeting? Predict what physical activities would benefit from this type of training.
4. Modify the circuit so that it is more specific to the physical activity you are currently studying and explain the changes you made.
5. Identify how adequate the cool-down is for recovery after this training session.

Your analysis in this activity will be useful in your project–folio assessment task.

**Figure 9.16** Jumping or skipping rope is a common and effective warm-up exercise.

# 9.4 Evaluating training programs

As discussed earlier, the minimum length for an effective training program is 6 weeks. This is enough time for:

- the body to make training adaptations
- the performer to assess the difficulty and relevance of the program
- the sessions to have produced a measurable outcome.

Once the program is complete, it's important to evaluate how effective it was and whether it needs to be modified.

## Post-testing

You can evaluate training programs by looking at a number of outcomes, but the first step is always to conduct a post-test.

A post-test consists of the same battery of tests conducted in the pre-test. For the post-test to be completely accurate, the tests must be performed in the same order, in the same weather conditions and with the performers in the same state of health as for the pre-test.

Once the post-test is completed, the results from each individual test can be compared with the matching pre-test result, as shown in Table 9.5. The results for each test can then be graphed for comparison, along with the percentage change in performance from pre-test to post-test. This is essential for accurate evaluation of the program.

| Test | Component tested | Pre-test results | Post-test results | Percentage change |
|---|---|---|---|---|
| $VO_2$max 20 m shuttle | Aerobic capacity | 11.0 | 11.2 | 1.8 |
| Vertical jump | Leg power | 35.8 cm | 56.9 cm | 58.0 |
| Grip test | Hand/forearm strength | 30.5 kg | 40 kg | 31.0 |
| 3 RM bench press | Chest/arm strength | 18.2 kg | 18.2 kg | 0.0 |
| 3 RM leg press | Leg/hip strength | 54.5 kg | 63.6 kg | 16.0 |
| Phosphate recovery test | Anaerobic capacity | 3 | 8 | 166.0 |
| Sit-ups | Abdominal endurance | 41/min | 57/min | 39.0 |
| Sit and reach | Hip/lower back flexibility | 14 cm | 18 cm | 28.0 |
| Illinois agility test | Agility | 17.79 s | 17.30 s | 2.7 |
| Shoulder hyperextension | Shoulder flexibility | 41 cm | 50 cm | 21.0 |

**Table 9.5** Results of a pre-test and a post-test.

## Steps in program evaluation

Just as training programs are planned step by step, so, too, they are best evaluated in steps.

### Step 1: Review the purpose of the program

Did the program suit the special needs of the individual or team for which it was designed? To answer this question, refer to the post-test results and training diary entries.

If the training diary shows the program was not too stressful, if the post-test results are significantly improved and if the individual or team's performance has improved, then the program has achieved its purpose.

### Step 2: Review the game analysis

Shortcomings of the game analysis may be highlighted by the post-test results or the individual's feelings about their performance.

Game analysis is a difficult process that is refined through practice. During the evaluation, you need to identify errors or difficulties in the original analysis so that they can be avoided or solved in any following game analysis.

For example, if you carried out the analysis on an elite performer, you might have pitched the program at a level that was too challenging for the person using it. You might need to modify the duration, intensity and specific activities in the program.

**Figure 9.17** A game analysis of Tiger Woods would result in a training program that is too challenging for a less experienced or skilled golfer.

### Step 3: Review test selection

In this step, you need to consider the order, number and specificity of the tests, and whether any of these need adjustment.

For example, look at Table 9.5 – perhaps having 10 tests was too many in a pre-test battery. The first tests might have meant the athlete had excessive fatigue before the final couple of tests, resulting in poor results that don't really reflect their specific fitness in those areas. Perhaps the tests need some rearrangement so that the phosphate recovery test is not performed straight after the 3 RM leg press.

You also need to think about the specificity and relevance of each test. For example, the Illinois agility test may have been used to assess agility, but on reflection you might decide the 5-0-5 agility test would have been more specific to the movements being analysed. If so, next time you would modify the pre-test battery.

### Step 4: Review training methods

In this step, you need to consider training diary entries, subjective performance assessments and post-test results.

For example, the training diary might show that trying to combine weight training and a continuous run in one session is too stressful. A poor post-test result on the 20 m shuttle test may indicate you need to include more continuous training or high intensity interval training (HIIT) in any future program.

### Step 5: Review training sessions and timetable

This step should focus on individual needs. For example:

- Did the days of the week scheduled for training suit the athlete's lifestyle?
- Were the sessions spaced well to allow enough recovery between sessions?
- Were any sessions too complex or difficult?
- Would more sessions, each less complex, have been better?

Usually you will get the answers to questions such as these from a training diary. The answers can feed in to planning the next 6-week program.

### Step 6: Review training principles

Your evaluation must consider the impact of the training principles that you built into your program.

To do this, you could ask:

- Did the training diary show that the planned overloads were manageable or too stressful?
- Do the post-test results show that the chosen training methods produced the target improvements?
- Did the training diary show that the variety in training activities was enough to keep the athlete motivated?
- Do the post-test results show that the intensity was effective in developing the desired training effects?

## Program modification

Once the program evaluation is complete, you need to go back and modify the way you develop the program, as well as modifying the program itself.

You might have to modify:

- the purpose of the program: for example, if the new program is for in-season training rather than pre-season
- the game analysis: you might need more accurate information about movement patterns, or to analyse someone who is at a level more appropriate to the person or team using the new program

- the test selection: you might choose more reliable or specific tests than last time, and you might modify the order of the tests to avoid the athlete being too fatigued
- the training methods: you might need to add training methods to the program, or put more emphasis on some specific training methods
- the training sessions and timetables: for example, you could alter the recovery time between sessions if they are very physically demanding, or the type of cool-down activity to encourage more rapid recovery post-exercise
- the training principles: you might need to emphasise the principle of variety to prevent boredom, or to apply the principle of specificity more carefully in choosing interval training distances and repetition numbers.

Your aim is to plan a program that better suits the individual or team using it.

The process of developing, using and evaluating a training program is ongoing. It allows athletes and those interested in health-related fitness to steadily improve as efficiently as possible.

**Figure 9.18** Australian figure skater Harley Windsor often adjusts his strength and conditioning training after evaluating his training program with his coach.

## Check your understanding 9.4

1. Explain why you need to evaluate a training program.
2. Explain why post-testing and reviewing your test selection is an essential part of evaluating a training program.
3. Describe four possible ways to modify a program once the program evaluation is complete.

## Evaluate and justify
program evaluation and modification

**LEARNING EXPERIENCE**

KEY OBJECTIVES
1, 5, 6

If you look at the results of the fitness tests (pre-test and post-test) in Table 9.5 (p. 275), it's obvious that the training program had varying levels of success in enhancing the fitness components tested.

1. Using the Table 9.5 data, create a graph that shows the percentage change for each of the 10 fitness tests.
2. Analyse which fitness component/s you would target in the next mesocycle. Which training methods would you select?
3. Apply your understanding of training methods and components of fitness to devise a specific training session to improve aerobic capacity. Follow the training principle of specificity to make sure it is also relevant to the physical activity you are currently studying.

## Program evaluation

**INTEGRATING MOVEMENT**

KEY OBJECTIVES
2, 5, 6

**Category:** Invasion, Net and court, Performance
**Physical activity:** The physical activity you are currently studying

### Purpose

1. This activity involves implementing a training session from a training program and evaluating its effectiveness.
2. The primary data you gather in this activity should be useful in your project–folio assessment task.

### Preparation

**Time:** two lessons

**Location:** suitable training area

**Equipment:** heart-rate monitors, any equipment outlined in the session

### Setup

1. Review a range of training programs relevant to the physical activity you are currently studying.
2. Select a training session that you believe is specific to your fitness needs, the target energy systems and fitness components, movement sequences, movement strategies and required intensity to bring about a training effect for the competition phase.
3. Decide the training objective that your session will be aiming to meet.
4. Identify the target heart rate (THR) you should aim for throughout the conditioning phase of the training session so that you target the right energy system.
5. Based on the example shown in the training diary in Figure 9.15 (p. 273), write out a training session plan.

### Performance

1. Implement the training session as per the plan.
2. Note any modifications that you make to the training session, such as reduction or increase of volume or load (reduction or increase repetitions, sets, distance, work or recovery).
3. Note your heart rate during work and recovery.

### Data recording

1. Make notes/modifications on the training session plan.
2. Wear a heart-rate monitor and record intensity data.

### Tasks

1. Analyse the primary data by stating:
   - **a** whether your THR was achieved
   - **b** your maximum and minimum heart rate during the conditioning phase
   - **c** the distance/volume you completed compared to what was planned
   - **d** any modifications made.
2. Reflect on your primary and secondary data to evaluate how effective your training strategy was in achieving the training objective, including:
   - **a** meeting the energy systems and fitness component requirements of the physical activity
   - **b** using the relevant training principles and training methods
   - **c** optimising performance of the specialised movement sequences and movement strategies.

**Figure 9.19** Heart-rate monitors provide primary data on your target heart rate.

# Chapter review

## Key questions and responses

**9.1 How is an annual training program divided up to get the best result for the athlete?**

The training year for an athlete or team is divided into a sequence of smaller phases. This is called periodisation, and it means that training is structured to give the athlete the best results.

**9.2 What are the requirements for planning an effective training program?**

Planning a training program is a step-by-step process in which you must consider secondary data about the energy requirements of the physical activity, the training purpose, game analysis, specific fitness testing of the relevant components of fitness and then the selection of suitable training methods.

**9.3 How is a training session designed to match the athlete's training objective?**

A successful training session must include a warm-up following the RAMP protocol, a conditioning phase made up of relevant training methods and following proven principles of training, and, finally, a cool-down to help with recovery.

**9.4 Why is it essential to evaluate a training program?**

Evaluating a training program is essential so you can identify if the training objectives have been met. You can do this by post-testing the components of fitness and reviewing the game analysis, fitness test selection, training methods and principles of training, so you can identify the focus for the next phase of training.

# Exam-style questions

## Section A: Multiple-choice questions

KEY OBJECTIVES 1

**1** The dividing up of an annual training plan into smaller phases of training is called:
- **a** peaking.
- **b** tapering.
- **c** transition.
- **d** periodisation.

**2** A training phase lasting 4–6 weeks is called a:
- **a** mesocycle.
- **b** microcycle.
- **c** macrocycle.
- **d** training session.

**3** The pre-season phase of training is needed to prepare athletes for the competition phase and usually features:
- **a** low intensity, low volume.
- **b** high intensity, low volume.
- **c** low intensity, high volume.
- **d** high intensity, high volume.

**4** Which part of the RAMP protocol do spinal mobility exercises in a warm-up belong to?
- **a** raise
- **b** activate
- **c** mobilise
- **d** prepare

**5** During the competitive phase of a training plan, the training:
- **a** intensity increases and volume decreases.
- **b** intensity decreases and volume increases.
- **c** intensity decreases and volume decreases.
- **d** intensity increases and volume increases.

**6** The most common tapering strategy is:
- **a** reducing training volume.
- **b** increasing training intensity.
- **c** reducing training frequency.
- **d** decreasing training duration.

**7** Which two factors are most important in structuring periodisation?
- **a** fatigue management and specificity
- **b** manipulation of volume loads and specificity
- **c** specificity and progress from sport-specific to general
- **d** fatigue management and progress from general to sport-specific

**8** If you designed a high intensity interval training program for netball that focused on strength and power, you would aim to:
- **a** build power then strength.
- **b** build muscular endurance.
- **c** build strength then power.
- **d** build muscular endurance then strength.

**9** The purpose of a cool-down is to allow the body to:
- **a** replenish lactic acid.
- **b** remove waste products.
- **c** slow down the recovery process.
- **d** reduce heart rate to 85% MHR.

**10** If you found only a small change for $VO_2$max in a post-test 20 m shuttle run as part of a training program evaluation, what training methods would you add in the next mesocycle?
- **a** circuit training
- **b** fartlek training
- **c** flexibility training
- **d** resistance training

## Section B: Short-response questions (150–250 words)

KEY OBJECTIVES
1, 4, 7

**1** There are similarities and differences between the energy requirements of the different playing positions in a netball team. All players engage in short, sharp, high-intensity movements throughout the game. The centre player can move over the whole court, except the goal circles. As well as maintaining high-intensity efforts throughout the game, the centre player is constantly on the move and has significantly shorter periods of walking or standing still than the goal shooter. The goal shooter is only allowed within the goal third and must have good spatial awareness. Compared to the centre player, the goal shooter completes similar high-intensity movements but spends a significantly greater amount of time walking or standing still.

Discuss the differences in training strategies in a competition-phase training session that coaches and athletes might devise to meet the needs of the two different playing positions. Use evidence from primary and secondary data to justify your responses.

**2** Tapering is a critical part of the competition phase of training, aimed at making sure the athlete can perform at their best. This is difficult in team games, where the athlete has to prepare for a game each week. Recommend the ideal tapering for an athlete within a weekly microcycle so that they recover in time for competition day.

## Section C: Extended response to stimulus (400 words)

KEY OBJECTIVES
4, 5, 6, 7

Table 9.6 shows four training sessions from a 6-week mesocycle in the pre-season phase for an Invasion game.

Considering the training intensity, volume and activities in each, propose what order the training sessions should be used, to allow the player to peak for competition.

| Session | Description |
|---|---|
| A | • Fartlek run (3–6 km)<br>• Flexibility circuit<br>• Skill training<br>• 10–20 × 100 m (60–75% intensity jog recoveries, 1:3 work:rest ratio)<br>• Weight circuit<br>• Cool-down: flexibility exercises |
| B | • Fartlek run (total group)<br>• Flexibility circuit<br>• 10 × 150 m (75% intensity, 1:3 work:rest ratio)<br>• Weight circuit<br>• Cool-down: flexibility exercises |
| C | • Warm-up: flexibility circuit<br>• Skills training<br>• 4 × 60 m speed training, 90–95% intensity, 1:5–1:8 work:rest ratio<br>• Group activities<br>• 10 × 100 m, vary intensity from 75% to 90%, work:rest ratios 1:2–1:5<br>• Cool-down: flexibility exercises |
| D | • Jog 3–5 km (group run)<br>• Flexibility circuit introduction<br>• 6–10 × 100 m easy pace (60–75% intensity, 1:3 work:rest ratio)<br>• Exercise circuit<br>• Cool-down: flexibility exercises |

**Table 9.6**
Four training sessions from an Invasion game pre-season.

# WORKED EXAMPLE

## Unit 4 project–folio

**Your internal assessment for Unit 4, 'Energy, fitness and training and physical activity', is in the form of a project-folio. In this task you are required to devise, implement and evaluate a personal competition-phase training strategy for a 3-session microcycle. The strategy should optimise performance of one movement strategy from one principle of play, in a selected position.**

This sample response will help you to devise a training strategy by providing an example of the planning process required. It does not provide a completed example of the final, assessable project–folio for summative internal assessment 3.

Your assessment must specify a physical activity context for both the training strategy and the selected position. The context for this example is netball and the specific position is goal keeper.

The process follows the stages of inquiry framework – engage and understand, apply and analyse, evaluate and justify.

# Planning your project–folio

## Introduction

The physiological limitation I am investigating in my project–folio is my performance as a goal keeper in netball. This includes effectively implementing one-on-one defence, using specific components of fitness and energy systems for the duration of my time on court.

My fitness levels in specific components of fitness impact on my tactical ability. My fitness level is therefore the rate limiter that restricts my tactical performance. The purpose of my training strategy is to develop specific components of fitness to enhance my physiological and tactical performance in one-on-one defence. I will use selected principles of training in my planning.

One-on-one defence is part of the movement strategy of defending against attack from the principles of play. The main role of the circle defenders, both goal keeper (GK) and goal defence (GD), is to limit scoring opportunities. Both GK and GD are also required to take possession from the opposition. Part of the role is to try to ensure that shots at goal are taken from areas of the circle where the shooter is least likely to be successful.

From my previous playing experience, I know that my main functions playing as GK include:

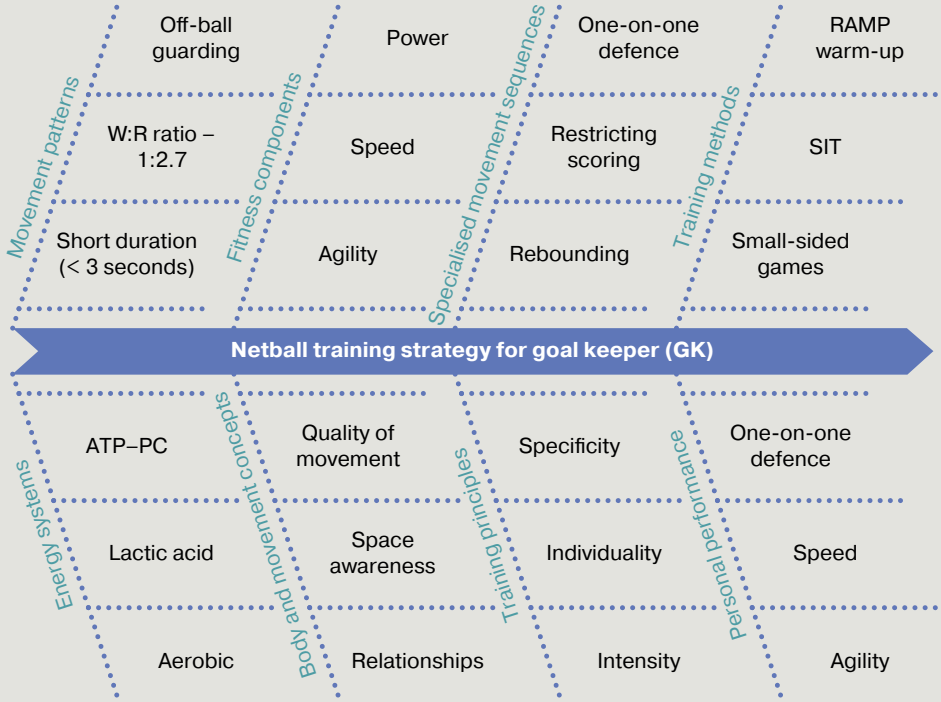
- preventing opposition shooters from scoring goals
- effecting close one-on-one defence of goal shooter (GS)
- moving out of the goal circle when appropriate to cover and contest with GS
- working with the GD to close spaces in the circle
- positioning in the circle to win rebounds
- intercepting the ball
- defending shots for goal.

Each of these functions inform the movement strategy of one-on-one defence, derived from the principle of play of defending against attack.

For the project–folio, I will devise a training strategy to enhance my performance as GK for a 3-session microcycle in the competition-phase.

I used a graphic organiser to clarify my thinking and develop a systematic approach to the development of the training strategy. This outline guided me to gather relevant primary and secondary data for analysis and synthesis.

**Figure PF1** This graphic organiser assisted me to consider all factors required in the training sessions.




## Engage and understand

### 1 Gather primary performance data

My first step is to gather primary data about my personal performance as GK. I designed a game performance assessment instrument (GPAI) to monitor my performance of the specialised movement sequences. These include:

- one-on-one defence
- interceptions
- rebounds.

Data will be recorded by my work partner as successful (S) or not successful (NS).

**Table PF1** Game performance assessment instrument for goal keeper

| | One-on-one defence | | Interception | | Rebounds | |
|---|---|---|---|---|---|---|
| Player position: goal keeper | S | NS | S | NS | S | NS |
| | | | | | | |
| Rating | | | | | | |

In addition, I need to capture detailed primary data related to one-on-one defence. This specialised movement sequence requires that my role, GK (and GD, when in the goal third), should closely mark the attacking players, GS and goal attack (GA). I designed another GPAI to monitor the distance between myself as GK and the GS who I was guarding.

Through video data capture of my performance, I used this GPAI to analyse my performance, specifically the movement patterns demonstrated and proximity to my opponent. The data was gathered over the first and fourth quarters of play to monitor my fitness.

### 2 Gather position-specific primary fitness data

I also gathered primary data, based on specific fitness testing protocols for netball (Netball Australia, 2019). These tests include the 20 m sprint, 5-0-5 agility test, vertical jump and the yo-yo intermittent recovery test. Using this test battery from Netball Australia, I achieved the following results.

**Table PF2** Results of netball fitness tests

| | 20-metre sprint | | | 5-0-5 Agility | | Vertical jump | Yo-Yo |
|---|---|---|---|---|---|---|---|
| | 5m | 10 m | 20 m | Right | Left | | |
| Goal Keeper | 1.6 s | 2.8 s | 4.9 s | 3.3s | 3.7 s | 34 cm | 960 m |

These tests were completed over two separate days during the competition season to inform the development of my training strategy.

### 3 Gather secondary data

In addition to Chapters 6–9 from this text, I investigated several sources of secondary data, including readings from Google Scholar, online media outlets and reference texts in our school library. These secondary sources will be included in my reference list.

**Figure PF2** The GK and GD have specific work:rest ratios and movement patterns, which are different from those of all other players.

Two of the most useful secondary data sources were articles from the ResearchGate website, which I found on Google Scholar: 'Understanding the Physiological Demands of Netball: a time-motion investigation' and 'Physical Demands of Training and Competition in Collegiate Netball Players'.

Another useful source was Clearinghouse for Sport, and an article that documented the fitness testing protocols used by Netball Australia.

ResearchGate articles
http://mea.digital/qpe34_PF1
http://mea.digital/qpe34_PF2

Clearinghouse for Sport article
http://mea.digital/qpe34_PF3

# Apply and analyse

Apply and analyse

### 4 Design research methodology

During analysis, I considered all three sets of primary data. Reviewing the data, looking for patterns, similarities and differences, provided me with new knowledge to inform and devise the training strategy.

In order to support later evaluation, I gathered primary data before implementation of the strategy (pre-test); I then used the same instruments and test protocols at the conclusion of the training strategy (post-test). This post-test data helped me to appraise the outcomes, implications and limitations of the training strategy.

The primary and secondary data is used for four different purposes:

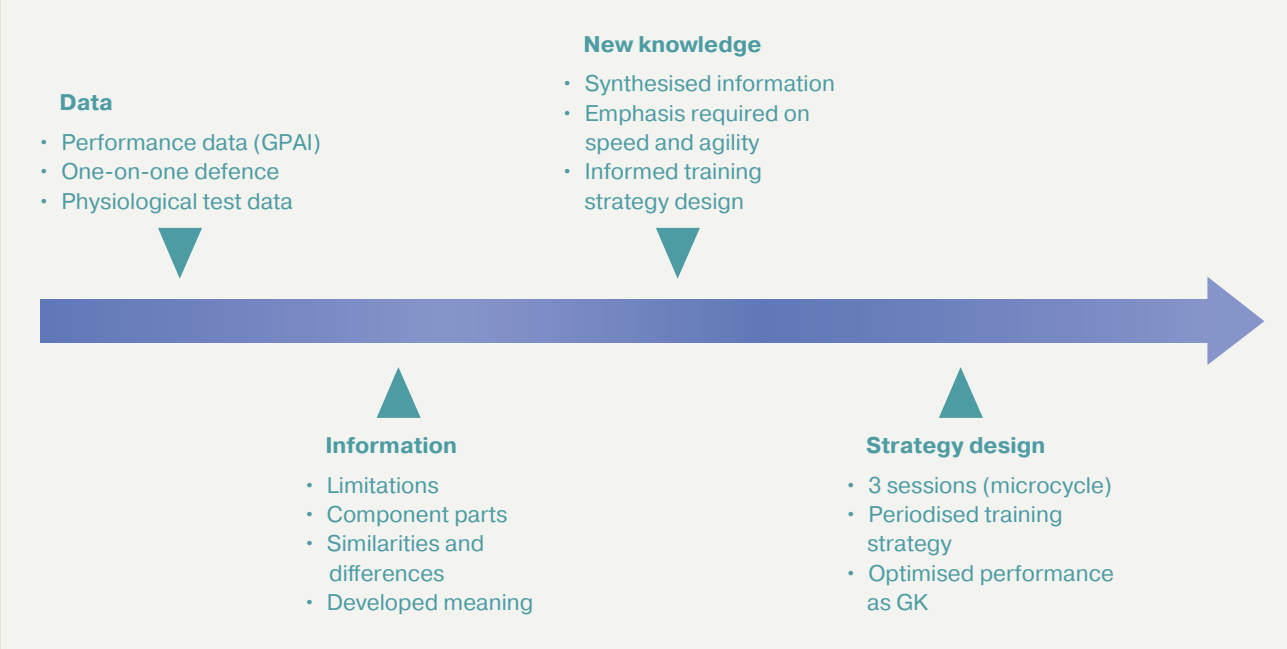
a supporting my hypothesis about my fitness levels and the GK position

b determining movement patterns, body and movement concepts, specialised movement sequences and energy systems used by the GK position in the training strategy

c devising a training strategy to address physiological and tactical limitations as GK

d refining and evaluating the training strategy to enhance my performance as GK.

**Figure PF3** Graphic organiser outlining the purpose of my data analysis



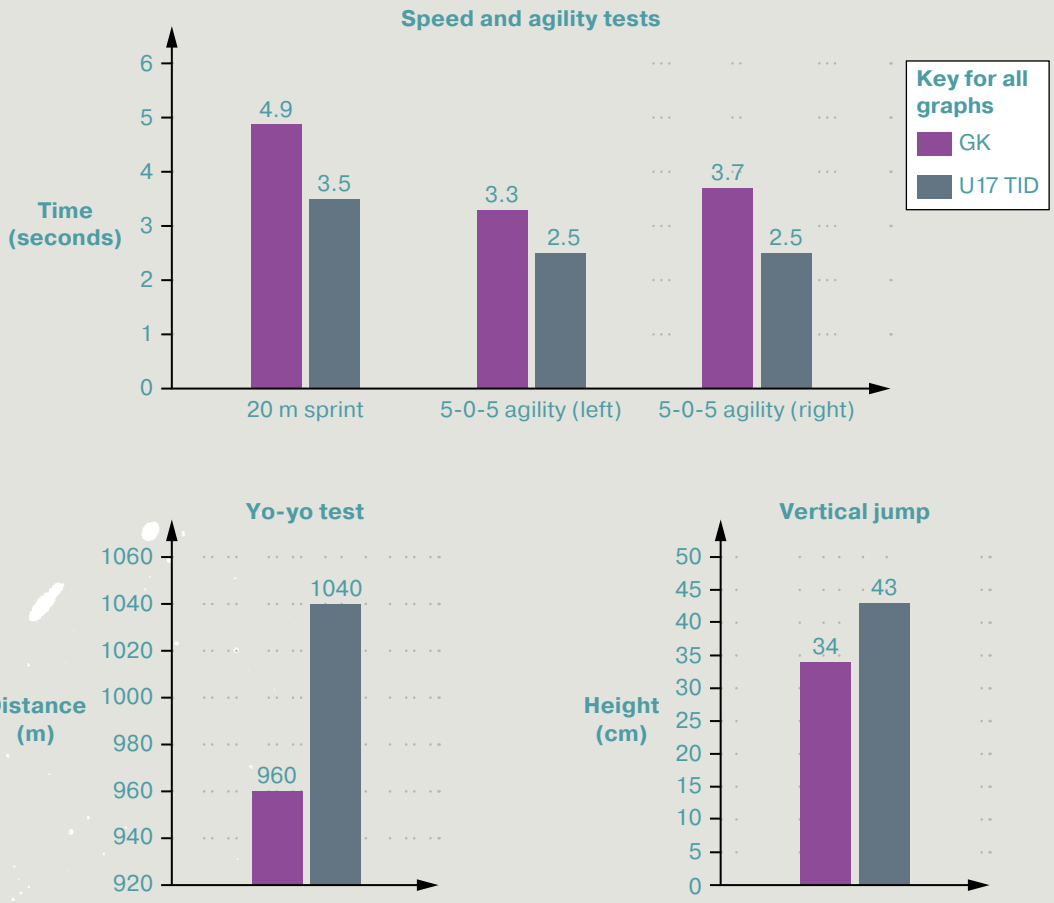

### 5 Analyse primary and secondary data

I collated my fitness test data, and compared my results with those of elite U17 national talent identification (U17 TID) squads. The results are shown in Table PF3, while Figure PF4 presents the results as column graphs.

**Table PF3** Comparison of netball fitness test results

| | 20-metre sprint | | | 5-0-5 Agility | | Vertical jump | Yo-Yo |
|---|---|---|---|---|---|---|---|
| | 5m | 10 m | 20 m | Right | Left | | |
| Goal Keeper | 1.6 s | 2.8 s | 4.9 s | 3.3s | 3.7 s | 34 cm | 960 m |
| U17 TID mean (n = 118) | 1.2 s | 2.1 s | 3.5 s | 2.5 s | 2.5 s | 43 cm | 1040 m |

**Figure PF4** Column graphs comparing my fitness test results to those of U17 TID squads




The physiological test data indicates that my endurance results are suitable for the position of goal keeper. However, my data related to speed and agility suggest that my training strategy needs to give attention to these areas.

**Table PF4** Game performance assessment instrument data

| | One-on-one defence | | Interception | | Rebounds | |
|---|---|---|---|---|---|---|
| Player position: goal keeper | S | NS | S | NS | S | NS |
| | 𝍸 \|\|\| | 𝍸 𝍸 \|\|\| | \|\|\| | 𝍸 | \|\|\| | \|\|\|\| |
| Rating | | | | | | |

Further analysis of the results of my personal performance indicate that:

- my defensive work in the circle is mostly effective, but effectiveness drops when I am fatigued
- I have difficulty intercepting passes when I become fatigued
- rebounding is mostly effective, but I lose power when fatigued.

This data indicates that my training sessions should emphasise speed and agility in small-sided games. This data is also reinforced by the physiological testing, using the Netball Australia test protocols.

This analysis is justified by additional secondary data, especially related to physiological testing. Research from a range of different peer-reviewed articles indicates how movement patterns, body and movement concepts and specialised movement sequences are performed by the GK in match and training conditions.

After synthesising the primary and secondary data, and developing new knowledge about my limitations, I decided that my training strategy should focus on building speed and agility in the microcycle. These are key attributes of successful goal keepers in netball.

### 6 Develop the training strategy

The training strategy involves planning and implementing 3 sessions within a competition microcycle, based on my synthesis of primary and secondary data. The development of the training sessions needs to consider:

a Fitness components (FC)

b Specialised movement sequences (SMS)

c Training principles (TP)

d Energy system usage

e Body and movement concepts (BMC)

f Training methods (TM)

To design each training session, I created a table to inform my planning. This enabled me to check that I considered all these factors for inclusion in the periodised sessions of the microcycle.

Research by Netball Australia (2012) and Bompa (2019) suggests that in order to develop a training effect, at least 2 sessions of the microcycle should be devoted to speed work.

I planned the third training session to have a lower load, to allow recovery before my next match in the competition phase.

**Table PF5** Session structure: planning matrix

| Activity | FC | SMS | TP | BMC | TM | Notes |
|---|---|---|---|---|---|---|
| Warm up | All | Shuffle<br>Jog<br>Sprint | Individuality<br>Specificity | Quality of movement (MQ) | | RAMP<br>All energy systems |
| Technique | All | Defensive strategy: rebounding | Individuality<br>Specificity<br>Intensity | MQ | SIT | Emphasis on starting speed from stationary and moving starts<br>All energy systems |
| Specific technique: Speed | Speed | Defensive strategy: one-on-one | Individuality<br>Specificity<br>Intensity | MQ<br>Body awareness (BA)<br>Relationships (R) | SIT | ATP-PC and lactic acid<br>Emphasis on footwork, acceleration and maximum speed<br>Rest between reps to allow CP resynthesis<br>Progressive overload across microcycle |
| Specific technique: Agility | Agility | Defensive strategy: one-on-one | Individuality<br>Specificity<br>Intensity | MQ<br>BA<br>R | Small-sided game (SSG) | ATP-PC and lactic acid<br>Emphasis on acceleration and maximum speed<br>Progressive overload across microcycle |
| Speed workout | Speed | Defensive strategy: one-on-one | Individuality<br>Specificity<br>Intensity | MQ<br>BA<br>R | SSG | All energy systems<br>Monitor game tempo |
| Agility workout | Agility | Defensive strategies | Individuality<br>Specificity<br>Intensity | MQ<br>BA<br>R | SSG | All energy systems<br>Monitor game tempo |

Each sample session in the training strategy was trialled and implemented to gather additional primary data to appraise, evaluate and justify the outcomes, implications and limitations. I used a journal to record data about frequency, intensity, time and type of training prescribed.

# Evaluate and justify

I used a logic model to evaluate the impact and effects of the training strategy. I also critically evaluated the use of the principles of training (specificity, individuality and intensity) in the microcycle. I will use these principles to appraise the outcomes, implications and limitations of my selected training methods, the use of the energy systems and the components of fitness in Netball.

My evaluation helped me to refine my strategy, as well as check the progress of my research and identify potential outcomes, implications and limitations of the training strategy.

## 7 Use a logic model

The logic model applies five steps to the evaluation process.

The first step of the process is to identify the problem. Primary data indicated that limitations were apparent in key components of fitness, specifically speed and agility. The training strategy was designed to enhance performance in these critical components of fitness.

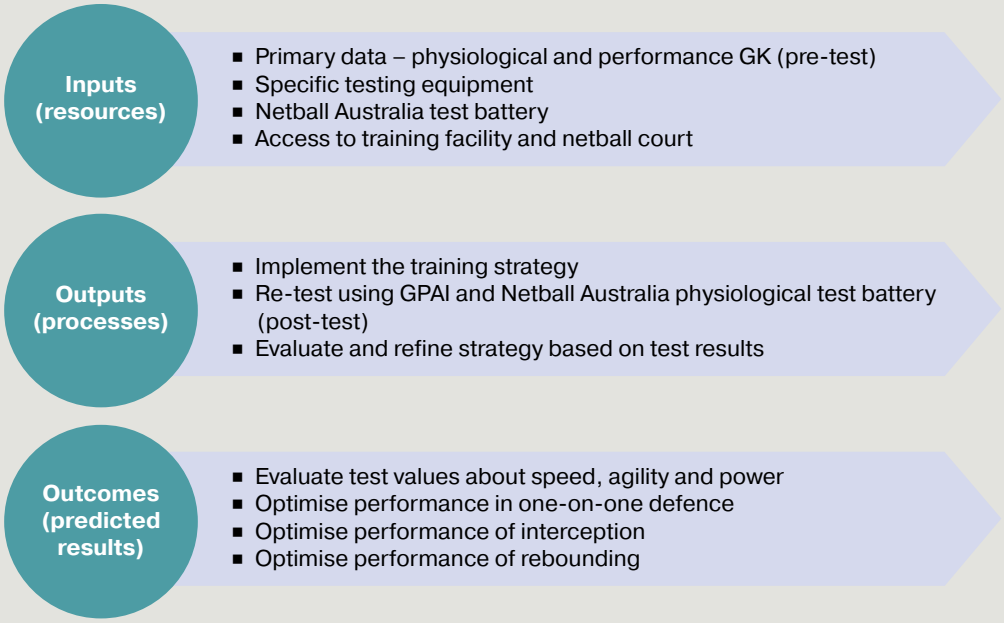
The second step requires me to review the evidence that informs my strategy. This will assist me to justify the development of the training strategy. I created a table to assist with this stage.

**Table PF6** Evidence justifying my strategy

| Strategy – what am I doing? | Evidence – why am I doing this? |
|---|---|
| Movement patterns | Secondary data – W: R ratios, intensity<br>Gather primary data |
| Fitness components | Secondary data – speed, agility<br>Gather additional primary data |
| Specialised movement sequences | Primary and secondary data<br>Goal keeper – one -on-one defence, interception, rebounding<br>Gather additional primary data |
| Training methods | Secondary data<br>Periodisation – competition phase<br>RAMP warm up<br>SIT<br>Small-sided games – authentic, specific |
| Energy system usage | Secondary data<br>Primarily ATP–PC and lactic acid |
| Body and movement concepts | Secondary data<br>Body awareness, space awareness, relationships |
| Training principles | Specificity<br>Individuality<br>Intensity |
| Personal performance | Primary data gathered through observation and GPAI |

The third stage of evaluation involved the development of the logic model. This required the development of a list of resources, processes being used and intended outcomes of the strategy. I listed these in a graphic organiser to inform my evaluation.

**Figure PF5** The resources, processes and predicted results of my training strategy




The fourth stage of the evaluation process was to monitor the logic model. This was done by continually gathering primary data during each phase of the strategy. I gathered additional feedback from my peers and teachers, as well as my own observations and reflections about training sessions, their intensity and specificity. Pre-test and post test data was used in this stage of the evaluation.

The final stage of the evaluation involved a review of the entire training strategy across the microcycle, reviewing the data and what it indicates, reflecting on observations and considering ways to enhance or adapt the strategy to suit my personal performance as GK.

## Conclusion

In my conclusion, I will justify the development of the training strategy, using evidence from primary data and secondary data. This data will include qualitative and quantitative sources, extracted from the pre- and post-tests, using the GPAI and Netball Australia test batteries. This data will be gathered through a continuous process including:

- prior to the implementation of the training strategy, then
- following the implementation stage to monitor changes in physiological tests and performance.

The intent of the training strategy is to enhance my performance as GK, through a focus on the development of speed and agility – both key fitness components for successful goal keepers.

The last part of my project–folio will be a reference list that acknowledges all the data sources I drew on in my investigation.

# UNIT 4 REVISION NOTES

You need to complete two assessment tasks for your Unit 4 studies – a project–folio (IA3) and an external examination (EA).

The external assessment may include involve a series of multiple-choice, short-response and extended response questions relating to the topics you studied in Unit 4. These revision notes summarise the key information from each Unit 4 chapter as another exam preparation tool.

## Chapter 6 revision

### Adenosine triphosphate (ATP)

- Adenosine triphosphate (ATP) is an energy-rich compound that provides fuel for the body's growth, maintenance and activities. The body's cells produce ATP to satisfy the energy demands of physical activity.
- Each ATP molecule contains a molecule called adenosine, which is linked to three phosphate groups (triphosphate) connected by high-energy bonds.
- When energy is required, an enzyme breaks off the third phosphate molecule and the trapped energy is released. This changes ATP into adenosine diphosphate (ADP).
- This process generates a rapid release of energy, but our cells only contain a small supply of ATP. Our bodies need to continually resynthesise ATP to keep fuelling biological functions.
- ATP must be continually resynthesised using another source of energy. The process of resynthesising ATP from ADP and phosphate is called phosphorylation.
- Three different pathways or energy systems interact to provide energy for muscular work, and these are dependent on the intensity and duration of the activity undertaken.

### The ATP–PC system

- The ATP–PC system produces energy anaerobically (without oxygen). The system involves phosphocreatine (PC), a high-energy phosphate stored in the muscle cells.
- The energy released when PC breaks down rapidly produces ATP through the resynthesis of ADP with phosphate from PC.
- This pathway of ATP resynthesis is rapid, making it suited to high-intensity, short-duration physical activity. However, the PC supply is exhausted in 10–12 seconds.

### The lactic acid system

- The lactic acid system also produces energy anaerobically (without oxygen). Its contribution to ATP resynthesis increases when PC stores in the muscles run out.
- This system uses blood glucose as its energy source. The glucose is broken down into pyruvate. The energy released resynthesises 2–3 ATP molecules for each glucose molecule.
- If there is not enough oxygen to break down pyruvate, it is briefly converted to lactic acid, which breaks apart into lactate and hydrogen ions ($H^+$).
- The body's inability to clear lactate from muscles is the limiting factor in this system. After a point, physical activity must stop or decrease in intensity so that the lactate can be cleared aerobically.
- The lactic acid system provides energy during high-intensity, moderate-duration activities lasting 30–120 seconds. It also supplies ATP in the early minutes of longer activity.

### The aerobic system

- The aerobic system produces energy in the presence of oxygen. It uses carbohydrates and fats as its main fuels. These are broken down within cells to produce energy.
- This energy system is slow to start, but produces an abundant supply of ATP and no fatiguing by-products as long as the supply of fuels and oxygen continues.
- The volume of oxygen needed by the aerobic system is known as $VO_2$max. $VO_2$max is a good measure of a person's capacity to maintain intense activity.
- Blood lactate levels also affect the effectiveness of the aerobic system. The lactate threshold is the blood lactate concentration at which the body can only sustain a high-intensity effort for a specific period of time.

# Chapter 7 revision

## Fitness testing

- Fitness testing can be used to identify strengths and weaknesses, give feedback about the effectiveness of training and identify specific attributes necessary for a sport.
- There are seven different components of fitness:
  1. Aerobic capacity: the ability to persist in physical activities that rely heavily on oxygen for energy production
  2. Muscular endurance: the ability of a muscle to perform repetitive work over a prolonged period
  3. Speed: the rate of travel of a body without regard to direction
  4. Strength: the capacity to apply force against resistance
  5. Power: the ability to utilise strength in rapid, explosive muscle contractions
  6. Flexibility: the range of motion of the body's joints
  7. Agility: the ability to change the position of the body quickly and precisely and still retain balance.
- Different components of fitness draw on different energy systems, and this shows in how the energy systems contribute to performance in different physical activities.
- The most important factor in selecting a fitness test is its ability to measure the components of fitness important to your sport.

## Aerobic capacity

- Aerobic capacity is the ability to keep producing energy aerobically. Aerobic energy is used to perform tasks that involve the whole body for extended periods of time.
- The ability to consume oxygen for energy production is called your oxygen uptake, or $VO_2$. The highest possible oxygen intake is the $VO_2$max, or maximal oxygen uptake.
- Oxygen uptake is expressed in millilitres of oxygen consumed per kilogram of body weight per minute (mL/kg/min).
- Athletes who excel at endurance sports have a greater ability to generate energy for the aerobic resynthesis of ATP.
- Aerobic capacity is needed most for activities of longer duration, such as distance running, swimming, surfing and cycling. Aerobic activities also require local muscular endurance.

## Strength, endurance and power

- Strength, muscular endurance and power all involve high-intensity muscular contractions and rely on the anaerobic energy pathways.
- Strength is the force that a muscle or group of muscles can exert against a resistance in a single maximal contraction. It is the foundation of muscular power.
- Muscular endurance is the ability to work a muscle for long periods at less than maximum effort. Muscular endurance activities rely on aerobic and lactic acid energy production.
- Muscular power is the ability to use strength quickly to produce an explosive effort. Maximum power is produced when both the speed and force of contraction are about 35% of maximum.

## Flexibility, agility and speed

- Flexibility, agility and speed are components of fitness that all relate to moving quickly and effectively.
- Flexibility is the ability of the muscles, ligaments and tendons to allow large movements of the joints. It can be increased by stretching.
- Agility is the ability to change the position of the body quickly and precisely and still retain your balance. It relies on anaerobic energy for speed and requires muscular power and flexibility.
- While speed is about moving quickly, it's also closely related to both strength and power, as you need to be able to generate a lot of force to move quickly.
- Speed relies on anaerobic capacity, or the ability to keep producing energy anaerobically. This energy is used to put body parts into motion quickly and sustain high-intensity efforts.

# Chapter 8 revision

## The principles of training

- Individuality: each athlete is different, and training should consider their specific traits.
- Specificity: a training program must be specific to the energy systems, components of fitness, muscle groups, body parts and skills of the physical activity.
- Variety: adding variety to a training program helps to maintain motivation, making it more likely athletes will make long-term fitness gains.
- Intensity: the difficulty of each training session should be monitored to ensure that training is effective and that the athlete is working at the appropriate levels to gain fitness benefits.
- Progressive overload: training should be designed so that there is a systematic and gradual increase in the stress (load) placed on the body, because this results in improvements in fitness.
- Frequency: the more frequent the training, the greater the fitness improvement, although all programs must include rest days to allow the body to recover.
- Duration: the minimum duration of any fitness program to develop training effects is 6 weeks, and should involve sessions of 20–30 minutes at an effective intensity level.

## Aerobic training

- Continuous training – sustained physical activity without rest for a period – is the foundation of all sport-related and health-related training programs.
- The purpose of continuous training is to improve aerobic endurance through increasing aerobic capacity, raising the lactate threshold level and improving muscular endurance.
- To correctly implement continuous training as a method of improving aerobic capacity, it is important to apply the FITT formula – frequency, intensity, time and type.
- Fartlek training is continuous training, usually cross-country running, but with regular changes of pace (intensity). These changes of pace may occur because of natural obstacles, such as hills and sand, or because of deliberate short bursts of speed every few minutes.

## Muscular and joint-based training

- Resistance training involves exercising a muscle or muscle group against external resistance, such as weights, equipment or your own body. It is important for improving strength, but also assists in developing power, speed and agility.
- The most common form of resistance training is weight training, which involves performing a series of resistance exercises, using either free or machine weights, to stress the required muscle groups.
- Flexibility training increases mobility and range of motion, and can correct imbalances due to overuse on a particular side of the body. It primarily takes the form of stretching.
- Strength and flexibility are interdependent, so both should be targeted in a balanced program when aiming to improve performance.

## Interval training

- Interval training is a form of training during which work intervals are followed by rest intervals. It is designed to improve speed, power and agility, and aerobic and anaerobic capacity.
- Interval training is a very intense form of training and must be considered in conjunction with other forms of training so as not to cause fatigue, demotivation or injury.
- High-intensity interval training (HIIT) is a form of interval training that involves near maximal efforts: that is, exercise at greater than 80% (often 85–95%) of maximum heart rate (MHR).
- Circuit training is a form of interval training that combines continuous and resistance training. It consists of a series of exercises, arranged in order and designed to develop health-related or specific sport-related fitness.

# Chapter 9 revision

## Cycles of the training year

- An annual plan must be divided into smaller phases of training. This periodisation results in a cycle of specificity, intensity and volume of training to achieve peak levels of fitness at the time required for the season or sporting event.
- Each phase and sub-phase (macrocycle) should be divided into mesocycles and microcycles, with specific training objectives for each.
- The training year is divided into four main training phases: preparatory phase (pre-season), pre-competition phase, competition phase and transition phase.
- The preparatory phase consists of a 4–10 week general sub-phase, focused on improving working capacity, followed by a 2–6 week specific sub-phase tailored to the sport.
- The pre-competition phase usually lasts 4–6 months, and emphasises maintaining pre-season fitness. As it progresses, training becomes more intense while the volume of training is decreased.
- The competitive season culminates in the actual competitive events the athletes has been training for. Training continues during this competitive phase.
- Two important concepts in the competition phase are peaking (training that result in players reaching their optimum state of readiness) and tapering (the reduction of training load).
- The transition (off-season) period is a psychological and physical break from intense physical activity. It usually lasts 2–4 weeks, and allows rest and recovery while still maintaining a base of fitness.

## Planning a training program

- Step 1: Review research articles and other forms of secondary data relevant to training for the physical activity.
- Step 2: Decide and state the purpose of the program, as everything in the program needs to work towards that purpose.
- Step 3: Conduct a game analysis by collecting relevant primary data or details of performance. Game analysis may assess skills, decision-making and/or fitness.
- Step 4: select a battery of suitable fitness tests, based on the results of the game analysis, the time available for testing, and access to equipment and facilities.
- Step 5: Select suitable, relevant training methods that will develop the fitness components that the games analysis has shown to be essential.
- Step 6: Plan the length of the program. A typical program is 6 weeks in duration, with a minimum of 3 sessions per week.
- Step 7: Periodise training sessions, planning the number of sessions and the content (i.e. exercise type, volume, duration and intensity) for each session.
- Step 8: Timetable training sessions by combining the sessions for each training method into a total training grid.

## Features of an effective training session

- To gain maximum benefit, all training sessions should involve a warm-up, a conditioning phase and a cool-down period.
- The warm-up should include exercises that prepare the muscles to be used and activate the energy system required. It should last approximately 10–30 minutes.
- The four components of a quality warm-up are summarised in the RAMP protocol: raise, activate and mobilise, prepare.
- During the conditioning phase, specific fitness components are developed using appropriate training methods and following proven training principles.
- The cool-down begins the recovery process and returns the body to homeostasis. Its purpose is to allow energy stores to be replenished, muscles to relax and your heart rate to decrease.
- The cool-down should take 20–40 minutes and is structured in three parts: active recovery, stretching and refuelling.

## Evaluating training programs

- Step 1: Review the purpose of the program. Did the program suit the special needs of the individual or team for which it was designed?
- Step 2: Review the game analysis. Shortcomings of the game analysis may be highlighted by the post-test results or the individual's feelings about their performance.
- Step 3: Review test selection. Consider the order, number and specificity of the tests, and whether they need adjustment.
- Step 4: Review training methods. Consider training diary or journal entries, subjective performance assessments and post-test results.
- Step 5: Review training sessions and timetable. For the most part, this step should focus on whether the timetable was appropriate for the athlete's needs.
- Step 6: Review training principles. Any evaluation must consider how well the training principles were built into the training program.

# SAMPLE RESPONSES

## Chapter 1

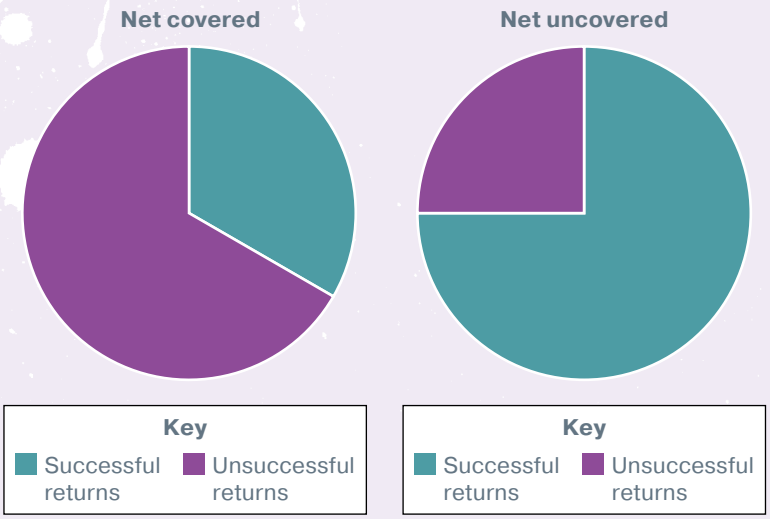
### Limiting perception

**Physical activity:** Volleyball
**Task constraint:** Receiving a volleyball serve with without the presence of key information

**Data recording**
The teams used their combined data to create a table of results.

| Team | Net covered | | Net uncovered | |
|---|---|---|---|---|
| | Successful returns | Unsuccessful | Successful returns | Unsuccessful |
| A | 4 | 8 | 9 | 3 |
| B | 3 | 9 | 8 | 4 |

Team A went further and created graphs of their results to help with their analysis.




In addition, the members of Team B shared some of their personal reflections on the activity.

- **Student 1:** 'That was impossible! If I can't see the ball coming, I don't know where to set myself for the return.'
- **Student 2:** 'I'm still getting the hang of volleyball, so this made it really difficult for me.'
- **Student 3:** 'Even when we did manage to return the serve, it usually went wild. That might be because we couldn't prepare to get the angle right – we'd hit it, but in the wrong direction.'
- **Student 4:** 'I managed to return two serves successfully towards the end of the set with the covered net.'

### Tasks

Student 4 from Team B provided the following responses to the tasks.

1 When the net was covered, we only successfully returned 25% of the serves. When it was uncovered, we successfully returned 67% of the serves. Covering the net clearly had a major effect on our team's performance.
2 When the net was covered, the only information that I could coordinate my movement with was the flight of the ball. It was only when I saw the ball clear the net that I started to move into position to return the serve.
3 When the net was uncovered, I could coordinate my movement with the movement of the server. When I saw the server contact the ball, I started to move into position to return the serve.
4 When my perception was limited, my ability to return the serve was poor. This was because coordinating my movement with the flight of the ball did not allow me enough time to accurately predict where it would land in the court. When I could see the serving action of my opponent, I was able to use perceptual cues such as their ball toss to anticipate the ball flight. This allowed me enough time to get into the correct position to return the serve.

# Chapter 2

## Investigating the constraints-led approach

**Physical activity:** Basketball
**Task constraint:** If the player with the ball is tagged, they lose possession

### Data recording

One student observed the game, capturing digital footage of play. They recorded their observations in a table.

| Observed on-the-ball and off the ball tactical behaviour | |
|---|---|
| Attack | Defence |
| • Teammates provided forward, backward and lateral passing options to the ball carrier<br>• Player in possession selected and executed appropriate passes to players who were under less pressure<br>• Quick transitions from defence to attack | • Defenders pressured the ball carrier to regain possession<br>• Defenders defended the space away from the ball |

### Tasks

Another student who played in the modified game provided the following responses to the tasks.

1 Evaluate the modified game.
   - **a** The environment is manipulated through the task constraint that if the player with the ball is tagged, they lose possession.
   - **b** The environment is representative as key elements from the performance environment are included, such as teammates, opponents, a game context and referee. These elements made the environment variable and unpredictable.
   - **c** The inclusion of two floating players on the attacking team simplified the environment for that team. This simplified environment matched the ability level of the players, as shown by their ability to overcome the problem of the defensive pressure.
   - **d** Players developed tactical awareness implicitly. For example, without being told, players moved into space to support the ball carrier.

2 We expected defenders to pressure the ball carrier. However, we did not expect defenders to defend the space away from the ball. We also did not expect the quick transitions from defence to attack.

3 The task constraint presented the tactical problem of the ball carrier being placed under defensive pressure. This resulted in the emergence of the solution; the ball carriers' teammates moved into space to provide a passing option for the ball carrier. Having teammates open in space is an affordance for the action of a pass.

4 The constraints-led approach was effective in developing my personal tactical awareness. When I participated in the modified game, I looked at the position of my opponents and teammates before receiving the ball. Then, when in possession, I could choose and carry out a successful pass to an unmarked teammate.

# Chapter 3

## Improving technique using practice

**Physical activity:** Touch football
**Drill:** Three-person rucking pattern

### Data recording

After participating in the isolated drill, a student completed the table.

| | | | | |
|---|---|---|---|---|
| **1 How much did the practice environment look like the actual game, that is, how representative was it?** For example, did it include key physical elements such as opponents and teammates, player movements, passing movements, line markings, goals? | | | | |
| 1<br>nothing like the game | 2<br>very little like the game | 3<br>somewhat like the game | 4<br>mostly like the game | 5<br>identical to the actual competitive game |
| **2 How variable was the practice environment?** For example, did it use a variety of game conditions, movement patterns, opponents and teammates? | | | | |
| 1<br>very repetitive | 2<br>very little variety | 3<br>some variety | 4<br>mostly variable | 5<br>highly variable |
| **3 How well did the practice task complexity match the technical ability of the players?** | | | | |
| 1<br>far too simple or far too complex | 2<br>poorly matched | 3<br>matched to some extent | 4<br>closely matched | 5<br>perfectly matched |

### Tasks

The same student provided these responses to the tasks.

1 The 'three-person rucking drill' is not a suitable practice environment for developing a rucking technique. This is because rucking is practised in a simple, non-representative, predictable and repetitive environment, which is not very similar to the complex, unpredictable and variable touch football performance environment.

The drill environment is too simple and predictable because it does not include the key elements that are present in a game of touch football, such as moving defenders, a referee and a game context. Without these elements, a player cannot learn to coordinate their movements in response to what they perceive (perception–action coupling), or learn to detect affordances for action, such as a 'lazy' defender.

The drill environment does not allow a player to learn to read the play and make decisions associated with rucking, as would happen in a game. The drill is also very repetitive and predictable, unlike a real game, as players run over the same distance in the same direction, to the same order of markers, and use the same rucking technique.

2 Our group developed a tactical strategy, which we called 'Tryline express', that will more effectively develop rucking technique that will transfer to a real game.

| **Tryline express** | |
|---|---|
| Game constraints explanation | Organisation |
| **Rules**<br>• Normal touch football rules apply.<br>• External focus instruction: 'the attacking team must make as much ground upfield as possible in 10 seconds'.<br>• Each team takes turns.<br>• Team A starts from their try line and attempts the task; Team B defends.<br>• Mark the distance attained.<br>• Swap over, and have Team B start from the same position.<br>• The team that makes the most ground, wins.<br>• If ball is dropped, the team's turn is forfeited.<br>• Repeat three attempts each team<br>• **Must use a referee** to ensure that defenders retreat 5 m | Unlimited length x 7 m wide<br><br>3 vs 3 with referee<br><br>**Equipment:**<br>Touch footballs<br>Sets of coloured bibs<br>Markers |

The modified environment is more representative as it includes the key elements that are present in a game of touch football, such as moving defenders, a referee and a game context. This environment creates variability due to the unpredictable movements of attackers and defenders. The use of external focus instructions facilitates the implicit learning of a variety of rucking techniques.

This unpredictability and variability makes the task more complex, thus better matching player's technical ability. However, it is not as complex as the full game, because of the task constraints of a reduced number of players and the field dimensions. Also, the technique of rucking is carried out in combination with reading the play and decision-making, as would occur in a game.

**3** We tried out the Tryline express strategy and I recorded our responses.

| | | | | |
|---|---|---|---|---|
| **1 How much did the practice environment look like the actual game, that is, how representative was it?** For example, did it include key physical elements such as opponents and teammates, player movements, passing movements, line markings, goals? | | | | |
| 1<br>nothing like the game | 2<br>very little like the game | 3<br>somewhat like the game | 4<br>mostly like the game | 5<br>identical to the actual competitive game |
| **2 How variable was the practice environment?** For example, did it use a variety of game conditions, movement patterns, opponents and teammates? | | | | |
| 1<br>very repetitive | 2<br>very little variety | 3<br>some variety | 4<br>mostly variable | 5<br>highly variable |
| **3 How well did the practice task complexity match the technical ability of the players?** | | | | |
| 1<br>far too simple or far too complex | 2<br>poorly matched | 3<br>matched to some extent | 4<br>closely matched | 5<br>perfectly matched |

**4** The data confirms the suitability of the modified practice environment for developing a transferable rucking technique. The modified practice environment was assessed as being mostly like the game and variable most of the time.

The presence of key elements of the performance environment, such as defenders, allowed players to learn to coordinate their actions in response to what they perceived, and to read the play and detect affordances for action.

To optimise learning and transfer, it is important that the task complexity matches the technical ability level of the players (Amezdroz *et al.*, 2019). The complexity of the modified game was suitable, because it closely matched the technical ability level of the players.

**5** If a player improves their rucking technique, it could allow them the opportunity to learn tactics or movement strategies associated with touch football. For example, the ability to ruck effectively would allow a player the opportunity to learn the movement strategy of exploiting space by attacking a disorganised or retreating defence.

# Chapter 5

## Designing ethical games

**Physical activity:** Volleyball
**Purpose:** Design an ethics strategy for a modified game

### Setup

As part of the planning session, the participants in this class addressed the organising principles. They selected a small-sided game of volleyball, played on a badminton court, using an extended-height net.

| | |
|---|---|
| How will you ensure that the game is fair and doesn't allow participants to take unfair advantage of any of the rules? | The group discussed writing simple rules that were fair to all participants. We decided to develop a simple code of conduct to guide our actions during the game. We also discussed whether the game needed an umpire to oversee the rules. We eventually reached agreement that, given a code of conduct was guiding our behaviour during the game, we needed an umpire oversee this code and give consequences for breaches of the rules, if necessary. |
| How will you ensure that players participate within the spirit of the game? | The code of conduct helped to describe the spirit of the game. Any breaches of the code require the offending player to be excluded for a period. This means that a team might have to play with one player less than the opposition, but we agreed that this was appropriate, to actively discourage any breach of the code of conduct. |
| How will you ensure that participants are treated with dignity and consideration, throughout the process of planning, devising and implementing the game? | We were very clear during our first discussions that each member of the group should be encouraged to contribute to the planning process. We appointed one person to watch over the discussion and encourage everyone to contribute. |
| How will you ensure that participants will take responsibility for their own actions? | This question led to some discussion about the meaning of the term 'responsibility'. We agreed that participants should be bound by the code of conduct and playing rules. We also agreed that each player should be responsible for their own ethical actions. It was also agreed that players have a responsibility to their team, as well as to the game itself, if the game was to fulfil the requirements of the task given to us. |
| How will you encourage healthy and safe procedures, preventing and reporting dangerous behaviour, while demonstrating concern for others? | We reached a broad understanding of the term 'safety' in our discussion. We strongly supported the idea that players should feel safe, free from harassment, injury and discrimination. If we could establish this environment during participation in the game, we would essentially be demonstrating concern for others. |

### Data recording

The group designed a GPAI as a data-gathering tool to observe group responses during the planning phase of the task. Each occurrence of appropriate (A) or inappropriate (IA) behaviour related to fairness, respect, responsibility and safety was noted during the planning discussion.

| | Fairness | | Respect | | Responsibility | | Safety | |
|---|---|---|---|---|---|---|---|---|
| Behaviour | A | IA | A | IA | A | IA | A | IA |
| Occurrence | 𝍸 | \| | \|\|\| | \|\|\|\| | \|\|\| | \|\|\| | \|\|\| | \| |

The group designed a similar GPAI as a data-gathering tool to observe single participants during game play. This was collated following the implementation of the game, through review of video capture.

Each occurrence of appropriate or inappropriate behaviour related to fairness, respect, responsibility and safety was noted in the small-sided game.

| | Fairness | | Respect | | Responsibility | | Safety | |
|---|---|---|---|---|---|---|---|---|
| Behaviour | A | IA | A | IA | A | IA | A | IA |
| Player: Glenn A | \|\|\| | \| | \|\|\| | \|\| | \|\|\|\| | \| | \| | \|\| |
| Rating | Very effective | | Moderately effective | | Very effective | | Less effective | |

**Tasks**

The members of the team completed a journal in two stages. The first half was completed before the game, following the planning session, while the second half was completed after the game was played.

In this student's response, the shaded section of the journal was the first part completed.

| | |
|---|---|
| How did participants reach agreement about how the game might be performed? | Once a person was appointed to moderate the discussion (Angie), we agreed quickly on the key points of the purpose and intent of the game. Patrick raised the issue of developing a code of conduct which we had discussed in class. Before appointing Angie as moderator and developing the code of conduct it was pretty chaotic! However, once these two things had happened our discussion was better guided. Everyone seemed to be on-board with the purpose of the task. |
| Predict the likely outcomes for participants. | I predict that this game will be successful in its aims. The group discussion during planning was very respectful, once the code of conduct idea was raised. Players should feel safe, respected and fairly treated in the game. |
| Comment on any challenges that came up during the game development. | This task really required me to evaluate my own conduct when I play sport. I'm naturally very competitive, so winning is important to me. However, I also consider myself a fair player, but this made me really think about others' safety and the responsibility I have for my own behaviour. It's more about respect for the team, my opposition and the game. This is really important. |

| | |
|---|---|
| Assess how these challenges were overcome. | During the discussion, Angie did a great job in referring us to the code of conduct, which we had all agreed on. That seemed to get us back on task, whenever we got sidetracked. It was very challenging for some of us who are more 'win-at-all-costs' types to understand others' viewpoints. It was also enlightening to hear other participants' opinions about how our behaviours made them feel. It got some of us really reflecting on our actions in games. |
| Discuss how the action of each participant affects:<br>• teammates?<br>• opposition players?<br>• spectators/ observers not playing the game? | • As a participant, knowing that my behaviour was being observed and recorded made me very aware of my actions. I was conscious of how I was acting right through the game. I believe that as a consequence, my teammates felt better supported by me, and we developed into a more unified team.<br>• Opposition players loved participating. There was lots of banter and friendly rivalry and the game was really enjoyable. It was played in the right spirit – still pretty competitive, though. It was a great game.<br>• Spectators seemed to enjoy the game, too. The rules were simple so the game was pretty easy to follow. There was lots of support for both teams. |
| Assess the success of the small-sided game in having participants follow the principles of fairness, respect, responsibility and safety. | The game was still competitive and strongly contested, but there was a sense of respect for the rules, our team and the opposition. There were a couple of minor infringements, when players seemed frustrated with their own performance (e.g. missing targets with passes, unforced errors) more than anything else.<br>The umpire decided that these were not breaches of rules or the code, so no consequences were applied. I agreed. |
| Justify your responses, using data from your journal and the video evidence of your group's participation in the game. | Looking at the data from observation and the GPAI, it can be concluded that the small-sided game was a success. All of the observed players achieved mostly effective ratings for fairness, respect and responsibility. The only result that was less than effective was the score for safety, where appropriate and inappropriate actions were the result of some unacceptable language. At first, this was dismissed by the players, but later in our debrief, we decided that the language was directed at one particular player and this impacted on their safety. The offending player later apologised, expressing frustration with their own behaviour.<br>It would be good to play the game for a longer period to see if these trends persist. |

# Chapter 6

## Sprint tests

**Physical activity:** Track
**Purpose:** Analyse energy use during a series of high-intensity sprints

### Setup

Students A and B are in Group 2. Student A will perform the 50 m sprints, while student B will record the data.

Student B records their responses to the group questions before the sprint tests.

| | |
|---|---|
| How will the contribution of the different energy systems change from the first to the last sprint? | In the first sprint, the runners should mainly get their energy from the ATP–PC system.<br>By the last sprint, the runners should mainly get their energy from the aerobic system. |
| How might the body respond differently if the athlete was a sprinter or an endurance athlete? | Sprinters would continue to get their energy from the anaerobic systems for longer, and their heart rates would recover further during recovery periods.<br>Endurance athletes may not reach the same intensities (speeds) but could sustain the efforts for longer; heart rates would not get as high and would recover faster. |
| How might the contribution of the energy systems differ with specific training and fitness? | Runners with lower fitness or more general training would exhaust their ATP–PC and lactic acid systems earlier, and their heart rates would stay high during recovery periods. |
| What might happen if you changed the recovery time (increased it or decreased it) or the distance sprinted (increased or decreased)? | Longer recovery periods would give runners time to clear blood lactate and resynthesise ATP and PC aerobically, allowing them to repeat and sustain the high-intensity efforts (work anaerobically using the ATP–PC system).<br>Longer distances would require runners to draw more heavily on the lactic acid system. You might see a higher heart rate during the recovery periods, as the body works hard aerobically to remove lactate and resynthesise ATP and PC.<br>If recovery was insufficient to remove lactate, intensity would have to be reduced for the athlete to be able to complete the repetitions, and the aerobic energy system would be the main system used. |

### Performance

Student A completes the eight sprints, while student B records their time and heart rate.

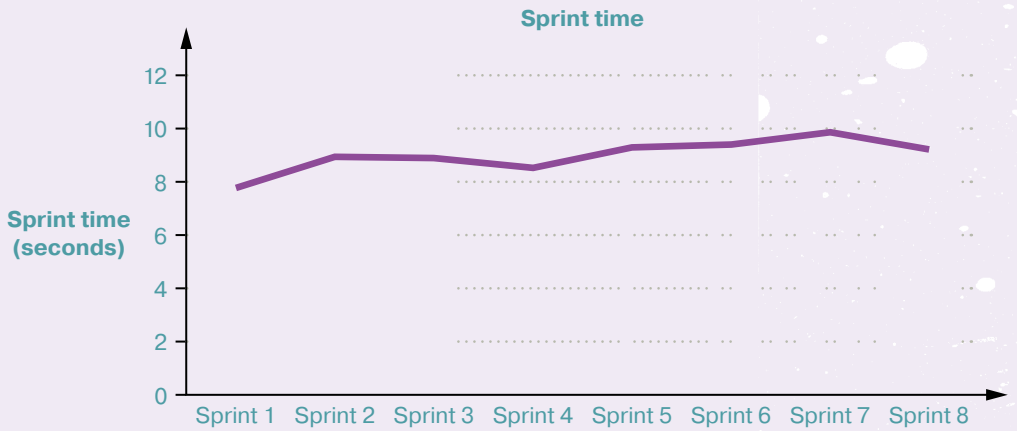
### Data recording

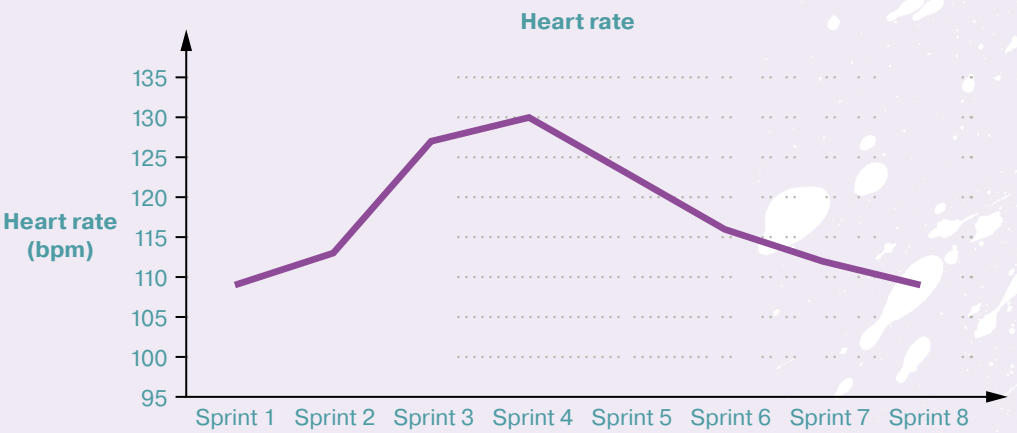
Student B completes the table with student A's results.

| Repetition | Time | Heart rate HR | Recovery HR at 1 min | Recovery HR at 3 min |
|---|---|---|---|---|
| 1 | 7.77 | 109 | 121 | 141 |
| 2 | 8.94 | 113 | | |
| 3 | 8.90 | 127 | | |
| 4 | 8.53 | 130 | | |
| 5 | 9.30 | 123 | | |
| 6 | 9.41 | 116 | | |
| 7 | 9.87 | 112 | | |
| 8 | 9.22 | 109 | | |

### Tasks

**1** Students A and B graph the results.



**2** As expected, the fastest time was recorded in the first sprint, when the athlete was rested. After this effort, the heart rate was still quite low, indicating that this high-intensity, short-duration activity (50 m in 7.77 seconds) used the ATP–PC system to supply the energy.

The gradual increase in time taken to complete each of the sprints correlates with an initial spike in heart rate over the first four sprints (109–130 bpm), followed by a slow, progressive reduction in heart rate during the last four sprints (123–109 bpm). Initially, there are sufficient ATP and PC stores in the muscles for them to work anaerobically, but this can only be kept up for a short period. With only 30 seconds of recovery between each effort, there is not enough time to fully restore supplies of ATP and PC in the muscles, so they cannot continue to rely on this system.

At the same time, we saw an increase in heart rate to help recovery aerobically, but when this could not occur quickly enough fatigue increased, as shown by the increase in sprint times. The decrease in intensity after sprint four matched the decrease in heart rate caused by an increased reliance on the aerobic system to complete the remaining four sprints. This proves the linear relationship between exercise intensity and heart rate.

**3** The heart rate increased post-exercise at the 1-minute mark (from 109 to 121 bpm), and again at the 3-minute mark (141 bpm), as the process of removing accumulated lactate and resynthesising ATP and PC heavily depended on the aerobic system. Heart rate stayed high to deliver the large amounts of oxygen required to aerobically provide the energy to resynthesise ATP and PC stores in the muscles and remove blood lactate.

**4** The main energy system involved in the sprint activity is the ATP–PC system, which provides energy for muscular contraction for short-duration, high-intensity activities. However, the limited recovery of only 30 seconds between each sprint meant that the lactic acid system and aerobic systems are also used.

Once exercise or activity exceeded 10 seconds with limited recovery, the anaerobic lactic acid system also provided energy for muscular contraction, resulting in the accumulation of blood lactate. In addition, the aerobic system is also very important, because full recovery between efforts is not possible in the duration of the recovery (30 seconds). This led to the decline in intensity (speed) after sprint 1 (7.77 to 8.94 seconds) and then significantly again after sprint 4 (8.53 to 9.30 seconds).

There was also a corresponding decrease in heart rate after sprint 4 (130 to 123 bpm) as the aerobic system assumed dominance; heart rates continued to further decrease and times increased (mostly) from sprints 5–8. The activity clearly became more and more aerobic with each successive effort, demonstrating the dynamic interplay between energy systems in relation to exercise intensity and duration.

# Chapter 7

## 12-minute run test

**Physical activity:** Volleyball

### Setup

Student A will perform the test, while student B will record the data.

### Data recording

Student B fills out a table with the run test data.

| Lap | Heart rate (bpm) | Activity | Total laps | Total metres |
|---|---|---|---|---|
| 1 | 140 | Fast jog | 11.81<br>Each lap = 237.8m | 2810 m<br><br><br>Average HR: 189 bpm<br>Max HR: 202 bpm<br>1st km = 4.22.33 min<br>2nd km = 4.13.68 min<br>0.81 km = 3.23.34 min |
| 2 | 155 | Fast jog | | |
| 3 | 167 | Fast jog | | |
| 4 | 172 | Fast jog | | |
| 5 | 180 | Fast jog | | |
| 6 | 186 | Fast jog | | |
| 7 | 190 | Fast jog | | |
| 8 | 193 | Fast jog | | |
| 9 | 195 | Fast jog | | |
| 10 | 197 | Fast jog | | |
| 11 | 199 | Fast jog | | |

### Tasks

Using the data, student A (16 years old and male) calculates his $VO_2$max rating as 51.51 mL/kg/min. His rating for both the fitness test and $VO_2$max are excellent for his age and gender. He writes the following responses.

**5** These results indicate I have an excellent ability to aerobically resynthesise ATP, remove carbon dioxide and clear blood lactate so that it does not accumulate to the point that I have to decrease intensity. This was evident through each lap as my heart rate continued to increase, from 140 bpm on the first lap to 199 bpm by the 11th lap. I passed the anaerobic threshold (85% of maximum heart rate, or 174 bpm) after lap 4, and the rest of the test was spent at maximal aerobic levels (heart rate average of 189 bpm and a maximum heart rate of 202 bpm – only 3 bpm off my maximum heart rate).

This was further proved when I completed the latter half of the test faster than the first. For example, I completed the first km in 4:22 minutes and the second in 4:13 minutes. This high level of aerobic fitness would be beneficial for any endurance sport such as marathon, triathlon or biathlon, as well as for team sports. My aerobic capacity would allow me to perform at high intensities and recover quickly during periods of low intensity.

**6** We're studying touch football, an intermittent game of varying intensities played over a long duration, so a high aerobic capacity is essential. To be effective, you have to repeat high-intensity efforts such as rucking the ball, chasing down the opposition or sprinting for the line or through a gap in defence. You often have to make these high-intensity efforts while running backwards, changing direction or controlling the ball (pass or catch).

While these high-intensity actions mean you are heavily using the anaerobic systems (ATP–PC and lactic acid), you also have the opportunity for recovery while the ball is on the other side of the field or during a substitution. During recovery, you use the aerobic system to resynthesise ATP and remove blood lactate. This means having a high aerobic capacity is advantageous, because if your body is able to deliver large amounts of oxygen you will have a faster recovery. A high aerobic capacity also means that you can work at high intensities for longer before feeling fatigue and having to stop or slow down, making you more effective on the field.

# Chapter 8

## Fitness analysis

### Physical activity: Netball

#### Setup

A team of students gather primary data about their netball performance, using video cameras and heart rate monitors.

#### Tasks

1 Student A conducts a personal fitness analysis of three roles played during a netball game – goal shooter (GS), goal keeper (GK) and centre (C).

| | Activity | GS | GK | C |
|---|---|---|---|---|
| Work times (seconds) | Shuffle | 1.6 | 1.9 | 1.6 |
| | Jog | 1.3 | 1.2 | 2.1 |
| | Run | 1.2 | 1.2 | 1.5 |
| | Sprint | 0.8 | 0.3 | 0.7 |
| | Total | 3.3 | 2.7 | 4.3 |
| Rest times (seconds) | Stand | 5.4 | 5.4 | 1.8 |
| | Walk | 6.0 | 5.6 | 5.2 |
| | Total | 11.4 | 11 | 7 |
| Work:rest ratio | | 1:4 | 1:4 | 1:1.62 |
| Intensity of movement (HR zones) | <75% | 7% | 6% | 1% |
| | 75–85% | 10% | 9% | 8% |
| | 85–95% | 33% | 35% | 30% |
| | >95% | 50% | 50% | 61% |
| Heart rate (bpm) | Average | 167 | 172 | 185 |
| | Maximum | 192 | 193 | 196 |
| Distance covered (m) | | 2575 | 2361 | 4049 |
| Specialised movement sequences (number) | Pass | 65 | 56 | 103 |
| | Catch | 95 | 34 | 115 |
| | Jump | 39 | 52 | 36 |
| | Guard | 86 | 135 | 59 |
| | Defend | 17 | 48 | 38 |
| | Shuffle | 155 | 116 | 304 |

**2** The main fitness components a player uses are aerobic capacity, speed, power and agility. Aerobic capacity is necessary for the player to last for the duration of the game and to help them with recovery of ATP and PC stores, and the removal of lactate, which result from the high-intensity efforts of sprinting, jumping, running and jogging. The anaerobic fitness components of speed, power and agility are also required to perform high-intensity efforts.

Netball is an intermittent activity of varying intensity. The aerobic energy system is used the most, but the anaerobic pathways also provide energy for the high-intensity efforts, as shown by the heart rates of players in the three positions. They spent between 83% and 91% of game time at heart rates above 85% of maximum (anaerobic threshold).

The goal keeper and shooter had work: rest (w:r) ratios of 1:4. The centre had much less recovery time between efforts, with a 1:1.62 w:r ratio. This is most likely due to the nature of the centre position, which requires the player to cover nearly all areas of the court, while the other two roles are restricted to one third of the court.

The specialised movement sequences identified during the game include pass and catch, jump, shuffle, guard and defend. These add to the anaerobic requirements of the game, as they are generally high-intensity and explosive. These sequences help players in all positions to set up attack, by using their speed to lead into space to receive a pass and evade the defence, jump to catch the pass and defend the next option.

**3** Secondary data revealed that elite netball players cover large distances during games; centre position covers the most distance, 7.9 km, while the goal keeper and goal shooter cover 4.2 km (Davidson & Trewartha, 2008). The analysis of primary data also revealed that the centre covered the most distance (4.049 km) and the goal keeper and shooter covered less (approx. 2.5 km and 2.3 km respectively). This is probably due to the elite team performing at a higher level, but reinforces the necessity to develop a netball player's aerobic capacity.

Another similarity in the data between elite teams and my data revealed a heavy reliance on the anaerobic systems, due to the high-intensity, short-duration activities (e.g. running, sprinting and jumping) performed by all players. This was shown by the percentage of time spent above 85% of maximum heart rate (MHR). Woolford and Angove (1991) have reported that centre players spend 96% of their time during a game working at intensities above 85% MHR, which is similar to our primary data, where the centre spent 91% of time at these intensities. Kennedy, Appelby and Piggott's research (2011) also supports this, with 85% of first-quarter players, across all positions, recording heart rates above 85% MHR. This highlights the point that netball is played at high intensities.

A difference in our primary data relates to w:r ratios. Our goal keeper and goal shooter recorded w:r ratios of 1:4, and the centre recorded 1:1.62. Secondary data from Fox, Spittle, Otago and Saunders (2013) revealed that across all positions, including the centre, a 1:5 w:r ratio was the most frequent. However, the next most frequent w:r ratio for the centre was 1:1 and 1:2, which is similar to the primary data we collected. This data suggests a heavy reliance on the anaerobic energy systems.

Thus, it can be concluded that there are many similarities between our primary data and data from the research on elite teams. Our primary data can be used to plan more effective training programs.

**4** The training method I selected is interval training, involving high-intensity activity of short duration. This training aims to improve the anaerobic systems, with a focus on speed, acceleration and agility. These are essential components of fitness for a netball player, and will enable me to be more effective in my centre position as well as helping me to develop the fitness to last for the duration of the game.

Fox and colleagues confirm this choice of training method, as they report that 'Netball players must ... be conditioned to perform short bouts of work at a high frequency during matches' (2013, p. 1594). Interval training achieves this, as I can design sessions that mimic the w:r ratios of the game.

As a centre, I also need a high aerobic capacity (Chandler, Gabbett & Pinder, 2014) to enable me to cover the distance required in the game and to be able to manage with only limited recovery from high-intensity efforts. Interval training allows me to combine aerobic and anaerobic training by varying the distances covered, the number of repetitions, the amount of recovery and the types of activity performed (which could incorporate agility work).

Davidson and Trewartha (2008) state that, 'based on the nature of the high-intensity activity carried out by the centre, [training] should primarily incorporate high-intensity running and sprinting'. Interval training is therefore the perfect choice of training method, because it can be specific to the requirements of netball, the energy systems and the components of fitness.

# Chapter 9

## Decision-making

**Physical activity:** Netball
**Purpose:** Develop and implement a GPAI

### Setup

A class of students assemble to play netball for 10 minutes.

The class decides that the critical elements to be observed are movement- and activity-based rather than skill-based; they include stand/walk, shuffle, jog, run/sprint, jump/leap and direction change.

As a class, they develop a GPAI to record their observations.

| Position | | | | |
|---|---|---|---|---|
| | **Frequency** | **Successful** | **Unsuccessful** | **Time** |
| Stand/walk | | | | |
| Shuffle | | | | |
| Jog | | | | |
| Run/sprint | | | | |
| Rebound | | | | |
| Pass | | | | |
| Catch | | | | |
| Shoot | | | | |
| Guard | | | | |
| Defend | | | | |
| Jump/leap | | | | |
| Baulk/fake | | | | |
| Lead/drive to space | | | | |

### Tasks

1 Student C from the class participates in the netball game and completes the GPAI based on her own experience of play and the observations of the data recorders.

| Position | Centre | | | |
|---|---|---|---|---|
| | Frequency | Successful | Unsuccessful | Time (total) |
| Stand/walk | 101 | | | 5:00 min |
| Shuffle | 85 | | | 2:25 min |
| Jog | 79 | | | 2:00 min |
| Run/sprint | 25 | | | 1:15 min |
| Rebound | 1 | | | - |
| Pass | 27 | 25 | 2 | - |
| Catch | 29 | 20 | 9 | - |
| Shoot | 0 | | | - |
| Guard | 15 | 5 | 10 | - |
| Defend | 10 | 3 | 7 | - |
| Jump/leap | 18 | | | - |
| Baulk/fake | 15 | 7 | 8 | - |
| Lead/drive to space | 18 | 10 | 8 | - |

**2** In attack I was effective on the ball; my passing accuracy was highly successful, with 27 passes made and 25 of those reaching the intended target. Also successful was my movement intensity, with most of the recorded time spent either shuffling, jogging or running and sprinting. This is due to the nature of the centre position. It requires you to set up attacks, defend against attacks when off-ball, and create and exploit space, with virtually unlimited court restrictions.

I was less successful in creating and exploiting space through baulks/fakes and leading to space, with almost half being unsuccessful, I need to do more work in this area as these are critical specialised movement sequences for this position. My defence also needs improvement, as there were more unsuccessful attempts in these critical elements than successful, and the centre player has to defend their opposition to limit possession.

**3** Based on the primary data gathered, I believe the positions I am most suited to are centre or wing attack. I have excellent passing and catching skills, and this is a critical movement sequence for these positions, as they both have to move the ball down the court to create attacking opportunities. My ability to operate at the higher intensities of shuffling, jogging, running and sprinting are also essential for the centre and wing attack positions.

However, I need to work on my guarding and defending to be more successful in these positions, especially the centre, which is both an attacking and defensive position, and is involved in on-ball and off-ball movement sequences. I would also like to work on the specialised movement sequences of leading and driving into space, as the data showed that these were successful only about half the time.

# GLOSSARY

**acidosis** lowering of the pH in any tissue, such as muscle cells or blood

**adenosine diphosphate (ADP)** chemical by-product of the breakdown of ATP for energy production

**adenosine triphosphate (ATP)** a complex chemical compound present in all living tissue, which provides energy to drive many processes in the body

**adipose tissue** connective tissues in the body containing deposits of fat

**aerobic capacity** the ability to persist in physical activities that rely heavily on oxygen for energy production

**aerobic** needs oxygen to take place

**affordance** information in the environment that presents or affords you with an opportunity to act or exploit

**agility** the ability to change position quickly while maintaining balance

**amino acids** organic compounds containing nitrogen, hydrogen and carbon

**anaerobic capacity** total amount of energy provided by the anaerobic energy systems

**anaerobic** taking place without oxygen

**analogy** a verbal representation of a task using a simple biomechanical metaphor to help explain a movement

**arterial blood** blood pumped from the heart that is high in oxygen

**battery** a group of similar items to be used together

**blood lactate** lactate that appears in the blood as a result of anaerobic metabolism

**capillary** very fine, branching blood vessels

**carbohydrate loading** a nutritional strategy to maximise muscle glycogen stores prior to endurance competition

**carbohydrates** chemical compounds consisting of carbon, hydrogen and oxygen atoms in specific arrangements

**cardiorespiratory** relating to the heart, lungs, blood vessels and blood

**cognitive psychology** a branch of psychology that proposes that behaviours of individuals result from their internal mental processes

**constraint** a boundary that shapes each learner's movement by limiting available options

**continuous training** physical training that involves activity without rest intervals

**cool-down** combination of activities done at reduced intensity to help the body return to pre-exercise state

**dexterity** the ability to perform a difficult action quickly and skilfully

**dilemma** a difficult or complex situation in which the way forward is not clear

**dynamic systems theory** a learning theory that sees the learner as a dynamic system made up of many body parts that interact with a task and the environment

**ecological model** a model of learning that describes how motor control systems interact with the environment

**ecological psychology** a branch of psychology that proposes that behaviours result from interactions between a person and their environment

**energy system** one of the body's methods of providing energy to muscles

**environmental constraints** any characteristics of the physical and social environment that can influence movement

**enzyme** proteins that function as catalysts, increasing the speed at which chemical reactions occur

**ethics** a system of principles and rules of conduct

**excess post-exercise oxygen consumption (EPOC)** increased rate of oxygen intake during recovery immediately following strenuous activity

**facilitate** make something easier or less difficult

**fair play** fairness, justice and respect in sports and games

**fatty acids** chains of molecules that are the building blocks of fat

**flexibility** the ability to perform large joint movements easily

**formal fair play** conforming to the rules of a game or physical activity

**game analysis** the recording and analysis of data about an individual's or team's performance in a game

**gamesmanship** gaining an advantage using questionable means, but without breaking any formal rules

**globalisation** organisations operating or influencing others on an international scale

**glucose** a simple sugar that is an important energy source in living organisms

**glycogen** the form in which energy from digested carbohydrates is stored in muscles and liver

**glycolysis** the reactions that convert glucose into lactate

**governance** management and oversight of an organisation or system

**homeostasis** the systems a living organism uses to keep the conditions inside it constant, despite changes in the conditions around it

**hypertrophy** the enlargement of an organ or tissue due to an increase in size of its cells

**individual learner constraints** any personal characteristics of the learner that can influence movement

**individuality** relating to a specific individual's needs

**informal fair play** displaying positive attitudes towards a game and those involved

**integrity** honesty and soundness of moral principle and character

**interval training** physical training made up of alternating periods of high- and low-intensity activity

**ion** an atom or molecule with a net electric charge due to the loss or gain of electrons

**joint capsule** the envelope of cartilage, ligaments and fluid surrounding each joint

**kilojoule (kJ)** unit of energy used to refer to the energy content of food or drink

**lactate threshold** the highest oxygen consumption or exercise intensity possible with a little increase in blood lactate concentration above resting levels

**lactate** a molecule that is the by-product of the anaerobic metabolism of glucose in muscle

**lactic acid** organic acid produced in muscle tissues during high-intensity exercise

**linear relationship** a straight-line relationship between two factors; when one increases, so does the other by a constant amount

**mitochondria** structures (organelles) within cells where oxygen and nutrients react and ATP is produced

**morals** personal actions and beliefs with respect to conduct

**movement strategies** a variety of approaches, tactics or strategies that help an individual or team successfully achieve a movement outcome or goal

**muscle fibres** long cells that make up the tissues of muscles

**muscular endurance** the ability of a muscle to sustain repeated contractions against resistance for an extended period

**myoglobin** iron- and oxygen-binding protein found in muscle tissue

**norms** society's accepted standards of behavior

**oxygen debt** during recovery from exercise, oxygen uptake that is in excess of the normal oxygen uptake in a rest period

**oxygen deficit** period during exercise when oxygen consumption is below that necessary to aerobically supply the ATP

**oxygen uptake** the ability to consume oxygen to produce energy

**peaking** being in the optimum state of readiness for competition

**perception–action coupling** the direct link between the process of interpreting or giving meaning to information from the environment and an action

**periodisation** process of dividing an annual plan into a series of training phases

**phosphocreatine** a compound that acts as a store of phosphate to facilitate energy for muscular contraction

**phosphorylation** biochemical process involving the addition of a phosphate group to an organic compound or molecule to form ATP

**plyometric** describing exercise that involves jumping and rebounding to increase muscle power

**power** the ability to exert maximal force in a short period of time

**prescribe** lay down rules, direct or dictate

**principle** fundamental truths that determine right and wrong

**principles of decision-making** the processes involved in the execution of a tactic or movement strategy

**principles of play** fundamental movement strategies used by individuals or teams to effectively adapt to any tactical situation in authentic performance environments

**principles of training** vital factors that must be included in a training program to achieve performance outcomes

**progressive overload** the gradual increase of stress placed on the body during training

**pulmonary** relating to the lungs

**pyruvate** a molecule produced by the breakdown of glucose

**rate limiters** factors that influence how an individual learns and potentially restricts their performance in a specific context

**resynthesise** to synthesise again

**saturated fat** type of fat in which the fatty acid chains have single chemical bonds

**specificity** how much an action belongs or relates uniquely to a particular activity

**stakeholder** someone who is affected by an issue

**strength** the force that a muscle can exert against resistance

**submaximal exercise** exercise at less than maximum intensity and/or duration

**tapering** reducing training before a major event to allow for complete recovery and optimal performance

**task constraints** boundaries applied to a game or activity that shape movement

**technical ability** the ability to execute a movement or technique

**unsaturated fats** type of fat in which the fatty acid chains have at least one double chemical bond

**valid** having a sound basis in fact

**value structure** how compatible your values are with each other

**value system** the relative priorities that you give to different values

**values** beliefs about what is important or desirable

**venous blood** blood flowing back into the heart that is low in oxygen

**$VO_2$max** volume of oxygen an individual can use to produce energy, measured in millilitres per kilogram per minute

**warm-up** combination of activities done at a low intensity to prepare the body for more vigorous exercise

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