Health and movement science Stage 6 (Year 11)

Teaching a collaborative investigation – immediate physiological responses to aerobic training

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

# Overview

This collaborative investigation is intended to be completed in Year 11 as part of Focus area 2– The body and mind in motion. The following collaborative investigation is provided as a guide using the syllabus content which models the process of investigation.

Teachers are advised that:

* this is not the only way a collaborative investigation could be completed
* the research question identified is not the only example suitable for this content
* adaptations will be required to suit the context of each school, including access to resources, equipment, number of classes, and number of students.

**Duration:** ten hours have been allocated to this collaborative investigation. This learning sequence is not designed to count towards the 20 indicative hours for collaborative investigation.

## Prior learning

A sound understanding of the following syllabus content will assist students to undertake this collaborative investigation:

* the principles of conducting an investigation
* methods to collect, present and analyse data
* how to present and analyse data
* the difference between aerobic and anaerobic training for individuals and group sports

**Including:**

* aerobic training
* anaerobic training
* differentiated training programs
* contemporary methods of training
* application of the Frequency, Intensity, Time and Type (FITT) principle to an aerobic training program
* the immediate physiological responses to training

**Including:**

* heart rate
* ventilation rate
* stroke volume
* cardiac output
* lactate levels.

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

## Purpose

This learning program enables the application of the 10 steps of the collaborative investigation process to further develop student knowledge and understanding of physiological responses in relation to aerobic training.

Figure 1 – collaborative investigation 10-step process

The 10-step process of a collaborative investigation. 

Step 1 reads ‘Forming a group’. 

Step 2 reads 'Identifying areas of interest’. 

Step 3 reads 'Collecting, analysing and recording secondary data’. 

Step 4 reads 'Developing a research question’. 

Step 5 reads ‘Selecting research methods’. 

Step 6 reads 'Creating methodologies to collect data’. 

Step 7 reads 'Applying research methods to collect data’. 

Step 8 reads 'Interpreting and analysing research to determine findings’. 

Step 9 reads 'Drawing conclusions from the research’. 

Step 10 reads 'Presenting findings to the class or a panel of experts’.

Students will deepen their understanding of this content, alongside applying the principles of research. This content has been pre-determined through the Health and Movement Science 11–12 Syllabus.

As a part of the investigation process the following research question has been created.

How do the various methods of aerobic training impact the physiological responses of an individual?

Each group will be responsible for one aerobic training method. Students will work in collaborative groups to determine and share findings to answer the research question. Figure 2 shows the process to be undertaken by students.

Figure 2 – collaborative investigation process to be undertaken in the sequence

A collaborative investigation process to be undertaken in the sequence. Text at the top reads: How do the various methods of aerobic training impact the physiological responses of an individual? 
There are 4 groups under the text with each group in an individual box.
Group 1 - Continuous, Group 2 - Aerobic interval, Group 3 - Fartlek, Group 4 - Circuit. Each group contains an arrow that points to a box underneath that reads: Combine groups findings to answer the question: How do the various methods of aerobic training impact the physiological responses of an individual. 

Where students have not previously engaged in learning associated with the principles of conducting an investigation, access the Teaching the principles of conducting an investigation learning sequence, which can be accessed on the [Planning, programming and assessing PDHPE 11–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/pdhpe/planning-programming-and-assessing-pdhpe-k-12/planning-programming-and-assessing-pdhpe-11-12) curriculum webpage.

Students will be provided with opportunities to manage their own learning while collaborating with others.

Access the department’s [collaboration support materials](https://education.nsw.gov.au/teaching-and-learning/curriculum/pdhpe/planning-programming-and-assessing-pdhpe-k-12/planning-programming-and-assessing-pdhpe-11-12#Health0) to learn more about teaching and assessing collaboration.

* Collaboration in our classrooms
* The collaborative investigation process
* Support – a framework for assessing collaboration

Collaboration involves:

* positive interactions with others to solve problems, reach agreements and work towards outcomes or goals
* equal contribution by group members to plan and complete the tasks as part of the investigation
* building and sharing perspectives for deeper understanding of concepts.

Meaningful collaboration as part of the Health and Movement Science 11–12 Syllabus and the process of collaborative investigation can promote the building of peer relationships and foster positive peer interactions. By involving students in different discussions, it enables them to understand different perspectives, and to give and receive feedback. Through collaboration, students not only become more skilled at working with their peers, but also working with other adults. Collaboration can occur online and offline.

Through this collaborative investigation learning program, students will:

* apply the principles of conducting an investigation
* demonstrate strategies to positively interact with others
* work together to formulate a research question
* develop methods to collect data
* present and analyse data
* apply collaborative skills and strategies to build shared understanding of movement concepts
* draw conclusions on the physiological responses of different types of aerobic training
* present findings.

A range of resources are available to support the process of investigation and collaboration. These can be accessed on the [Planning, programming and assessing PDHPE 11–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/pdhpe/planning-programming-and-assessing-pdhpe-k-12/planning-programming-and-assessing-pdhpe-11-12) curriculum webpage.

# Syllabus

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

## Outcomes

A student:

* Collaboration: demonstrates strategies to positively interact with others to develop an understanding of health and movement concepts **HM-11-05**
* Analysis: analyses the relationships and implications of health and movement concepts   
  **HM-11-06**
* Communication: communicates health and movement concepts to audiences and contexts, using a variety of modes **HM-11-07**
* Research: analyses a range of sources to make conclusions about health and movement concepts **HM-11-10**

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

## Content

**Focus area 2**

What factors influence movement and performance?

* Investigate the physiological responses in relation to aerobic training

**Including:**

* creating a research question
* selecting a method to collect data (**Example(s):**

Observation.

Survey.

Interview.)

* discussing the ethical considerations of the methods chosen
* discussing the validity, reliability and credibility of data collection
* presenting findings and drawing conclusions
* identifying further research questions that could be explored

# Applying the collaborative investigation process

In this section, students will apply the steps of the collaborative investigation process. This will prepare students ahead of conducting their own collaborative investigation in the preliminary year.

Opportunities for student collaboration have been embedded in the activities as a guide. Teachers determine the most suitable teaching strategies to deliver this content. Opportunities for reflection and adjustments can be made depending on student interest.

## Step 1 – forming a group

The purpose of this step is for group members to become oriented with each other and to establish group norms, boundaries, processes and expectations.

As a class, discuss group contracts or agreements.

* What are they?
* Why would a group use a contract?
* What are the benefits?
* What are some components of a group contract? What might it include?

A group contract is an agreement developed by a group to create the most effective environment or conditions for all members to operate or work in. A group contract can bring people together and ensure everyone fully understands what is expected and accepted as a member of the team. It should be created immediately upon formation of the group.

All members should come to consensus when developing the contract and need to agree to all terms of the contract. As collaboration develops throughout the course of the collaborative investigation, students might want to revise the contract to reflect more accurately what the collaboration looks like or to re-evaluate some decisions that could be negatively influencing the group’s collaboration as they work towards their goals.

In small groups, allocate one aspect of a group contract from the list below. Groups discuss and record responses for their heading. What might this aspect look like? What should a group discuss and consider?

### Aspects of agreement

* Group goals
* Decision making
* Conflict resolution
* Communication
* Attendance
* Sharing work
* Agreed roles and responsibilities

Use the [Resource 1 – group-forming activities.](#_Resource:_G_–) Choose a range of group forming activities to encourage students to introduce themselves, communicate effectively and feel confident interacting with others.

As a class, use the [Resource 2 – sample group contract](#_Resource:__S–). Ask each group to share their discussions and record these into the sample group contract for use later.

Groups can be formed:

* at the beginning of the investigation process to allow groups to collaboratively discuss expectations, areas of interest and roles and responsibilities
* after students have individually identified their areas of interests, as such, groups can be formed based on area of interest
* after collecting and analysing secondary data to support building knowledge and understanding
* based on prior learning activities, strengths, weaknesses and abilities
* centred around the preferred method of training.

### Accountability

* In pairs, discuss the term ‘accountability’. What is it? How do we make each person accountable when we work collaboratively or in groups?
* Share ideas as a class and create a list of what strategies could be used in a future collaborative task.

Accountability is a practice that will contribute to success in collaboration. Accountability grows a sense of ownership for tasks, roles, goals and outcomes across a group.

A range of strategies can be put in place to increase accountability within groups during a collaborative investigation.

Table 1 – overview of sample strategies, activities and resources to increase accountability among students

|  |  |
| --- | --- |
| Strategy description | Suggested activity |
| Use a group contract.  Understand clearly what the group is to do.  Support students to be accountable for themselves.  Support students to have discussions with team members about roles. | Create a [group contract](#_Resource:_Sample_group).  Refer to the group contract during group dysfunction.  [Resource 3 – sample roles and responsibilities table for group contract](#_Resource:_Designing_a). |
| Use a tracking system.  Monitor group goals and individual responsibilities. | Create a tracking sheet:   * [Resource 4 – sample tracking sheet group](#_Resource:_Sample_tracking) * [Resource 5 – sample tracking sheet individual](#_Resource:_Sample_tracking_1)   Use the tracking sheet to record and monitor tasks, roles and completions. |
| Keep a logbook.  A personal journal which records contributions to the work of the group. | Develop a logbook. |
| Engage in review and feedback.  Regularly review work to maintain consistency and performance expectations.  All done at regular, pre-determined time periods throughout the collaborative investigation. | Use [Resource 6 – giving and receiving feedback](#_Resource_6_–) to engage in:   * peer feedback * self-feedback * teacher feedback. |
| Students and teachers communicate frequently. | Schedule regular check-ins. |

**Formative assessment opportunity**: outcome (HM-11-05) checkpoint – use a logbook, or alternate method of self or peer assessment to encourage students to reflect on their collaboration. Access the HMS logbook teacher guide and the HMS logbook student guide on the [Planning, programming and assessing PDHPE 11–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/pdhpe/planning-programming-and-assessing-pdhpe-k-12/planning-programming-and-assessing-pdhpe-11-12) webpage for more support.

In addition, collect a group contract created and signed by group members as documented evidence of the group’s collaborative work and process.

**Points for check in have been identified throughout this collaborative investigation using the above pink box.**

Access the [Collaboration in our classrooms](https://education.nsw.gov.au/teaching-and-learning/curriculum/pdhpe/planning-programming-and-assessing-pdhpe-k-12/planning-programming-and-assessing-pdhpe-11-12) resource for suggestions, strategies and examples to increase accountability of group members during the collaborative investigation process.

## Step 2 – identifying areas of interest

The purpose of this step is for group members to review the syllabus content and identify areas of interest across the Focus area content which they would be interested in investigating further. Collectively, the group shares ideas and narrows down to a group-based area of interest.

To develop an investigation, a major step is to identify a specific area of interest, ponder some relevant questions or describe a possible problem in relation to this area of interest.

Doing this individually, allows students to consider their strengths, their goals, areas of vocation or future careers or study which match the syllabus content. The topic should be narrow enough to investigate or research within the relevant context, but also broad enough to have practical or theoretical merit.

Explain to students that when they do their own collaborative investigation, they must link the group research question to a concept taught in Health for individuals and communities or The body and mind in motion in Year 11. Therefore, they will identify an area of interest relevant to them and the syllabus content.

For this learning program, the areas of interest are pre-determined by the section of syllabus content being studied – aerobic training methods. The various types of aerobic training are the variables.

A variable is a factor that can be changed, maintained or measured through an investigation, for example, time, distance, intensity, amount, temperature, type of behaviour, age of participants, type of training, location, person, place, thing or phenomenon that you are trying to measure in some way. Some factors can be easily measured, some will need qualifications to measure, and others will need more resources and equipment to measure. The number of variables creates areas to provide comparisons or to identify relationships between ideas.

In their groups, students brainstorm further opportunities for investigation in relation to this content. Examples of brainstorming questions have been provided below.

* What is the response of the body when exercising?
* Why do I need to know the physiological responses to aerobic training?
* How can I support my body through training?
* How can I improve my performance in my sport?

In their groups, students use a table to discuss and record the strengths, weaknesses and considerations for the area of interest, an example has been included below.

Table 2 – examples of strengths, weaknesses and considerations for the area of interest

|  |  |  |
| --- | --- | --- |
| Strengths | Weaknesses | Considerations |
| The content around physiological responses relies on accessing reliable and valid secondary data and data that uses a set scientific method of data collection, that has already been tested for reliability and validity. | Ethical safety considerations of collecting student heart rate or ventilation rate data. Uncertainty as to whether the sample group can safely participate in aerobic training. There might be a need for parent or carer consent. | It’s important to ensure that the sample athlete is exercising safely, and that the equipment used to measure heart rate and ventilation rate is functioning properly. Accessible resources such as heart rate monitors on watches and accessing links to data collection apps such as Samsung Health, MyFitnessPal or Apple Health. |

## Step 3 – collecting, analysing and recording secondary data

The purpose of this step is for group members to identify and review secondary sources to further refine their area of interest for investigation. Collaboratively reviewing, recording and discussing information from secondary sources will build a shared understanding of the existing findings and gaps, before moving into creating a group research question or selecting methods for collecting primary data.

In groups, create a shared document or way of storing and referencing sources of secondary data to ensure integrity.

As a class, share ideas on how to share and store work so that everyone can access it.

* Discuss the term ‘integrity’. How does this term relate to secondary data and sources?

Students should have completed the NSW Education Standards Authority (NESA) [HSC: All My Own Work program](https://educationstandards.nsw.edu.au/wps/portal/nesa/11-12/hsc/hsc-all-my-own-work). This provides foundational understanding of plagiarism, referencing and crediting the work of others.

In their groups, students identify reliable and credible sources of primary and secondary data relevant to their investigation issue or focus.

Collecting, analysing and recording secondary data as an early step of the overall process supports students to gain a deeper understanding of the area of interest. It can give clues for the next steps, decide if the area of interest has already been previously explored and support the development of a research question or hypothesis. Collaboratively reviewing, recording and discussing information from secondary sources will build a shared understanding of the existing findings and gaps, before moving into creating a group research question or identifying methods for collecting primary data.

When researching and recording reliable sources to return to, identify what data would be needed to answer a research question in the area of interest, give clues to identifying possible resources, gaps in the current research or methodologies and timeframes. There is no set method or process to researching an area of interest, however, establishing key words as a group will be important. Accessing the school library and the librarian or becoming a member of the [NSW State Library](https://www.sl.nsw.gov.au/research-and-collections/get-library-card) and using the eBook collection can support this.

Groups discuss and record some questions or considerations when deciding on the sources.

Some questions or considerations when deciding on the sources are in the table below.

Table 3 – considerations for accessing secondary sources of data

|  |  |
| --- | --- |
| Source | Questions or considerations |
| Print or electronic | * How credible is the author? * How current is the content? * Are they selling a product or an idea? * Who is the audience? * When was it written, published or last edited? * Is the intention of the information to entertain, inform, educate or perhaps sell an idea or product? |

In their groups, students discuss and allocate roles and responsibilities to access agreed secondary sources, for example, healthcare data, newspaper articles and images or information in a published report and collect secondary data.

Possible areas of research include:

1. reliable methods for collecting physiological responses
2. equipment needed to collect physiological responses.

Each student in the group should access 2 agreed secondary sources.

Students complete a [Plus, Minus, Interesting (PMI) chart](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/551) on both of their secondary sources and answer the questions that follow:

* What did you find in your research?
* What were some interesting things you found?
* Were there potential problems or gaps you found in the research that you could look at?
* What potential research questions could you create from exploring and gathering your research?
* What type of data, if any, is being presented in the 2 sources you found? Justify and provide examples, such as qualitative or quantitative data.
* Do the sources provide some suggestions or spark ideas for the types of data or collection methods your group could collect?

Information can be collated in the group’s agreed shared document. In this document, record the website or books using the HSC: All My Own Work – [Acknowledging Sources](https://educationstandards.nsw.edu.au/wps/portal/nesa/11-12/hsc/hsc-all-my-own-work/acknowledging-sources) guidelines.

Each student reports back to the group and shares their PMI chart to establish common themes, findings or gaps across the sources.

Students use [Resource 6 – giving and receiving feedback](#_Resource_6_–) to engage in peer feedback. Provide feedback to one member of the group about the sources they collected and their value for the overall collaborative investigation.

This research might spark further questions, give some data collection ideas and potentially allow groups to branch off in a different area or narrow focus of their investigation.

### Reflection

Students reflect on the process they undertook when collecting secondary data by answering the following questions.

* What were the benefits of this type of research? For example, a wide variety of credible research, quality of research, larger samples for data collection, ability to access experts in the field.
* What are the limitations of this type of research? For example, not finding what you wanted, narrowing your search, too much research, research had a different purpose, bias, location of the research, date of research.
* Is further secondary research required?

## Step 4 – developing a research question

The purpose of this step is for group members to negotiate their final topic or issues based on the review of secondary sources. They then develop a research question for investigation. Using an evaluative process, they interrogate their question to ensure it meets their investigation needs.

Explain to students that as part of a collaborative investigation, they are required to collaborate to design their research question. Collaboration is most effective and observable when all members of a group are working towards the group’s outcomes or goals. Like the setting of goals, the collaborative investigation is a research goal that your group will work towards.

Students use the [Resource 7 – designing a research question](#_Resource:_D_–) to unpack a research question and the characteristics of a strong research question.

**Differentiation**: some students might find answering a research question difficult as the answer is not defined. The pathway to answer the question will rely on students’ ability to identify themes in the data or set predetermined themes to help with the analysis. This can be especially difficult when the data is qualitative in nature and broad responses are given. A research question allows for a wide range of outcomes, meaning resources such as time and analytical skills are essential.

Using a research hypothesis will follow the same research or investigation process, however, to answer the hypothesis, students are seeking to either prove or disprove the statement, therefore, the pathway to analyse the data is simplified. It therefore does not allow for a wide range of outcomes, simplifying the analysis and drawing conclusions steps of the investigation process.

A hypothesis can still allow for authentic collaboration.

**What is a research question?**

The research question is a question that the collaborative investigation sets out to answer. A research question:

* gives clear direction, focus and purpose to the investigation
* guides the path through the investigation, research and writing process
* can take the form of a hypothesis or question.

**What is a research hypothesis?**

The statement or a prediction the research study sets out to prove or disprove. Usually expressed as a precise and unambiguous statement that can be supported or refuted by investigation.

**Characteristics of strong research questions**

* Relevant to your chosen interest, collaborative investigation process and specific syllabus content.
* Is of interest to you or fills a gap that needs exploring.
* Answerable using primary data or creditable secondary sources, using qualitative and quantitative data.
* Focused on a specific population, age or characteristic.
* Multiple variables in the question to help promote authentic collaboration.
* Allows all group members to make authentic contributions.
* Enough time and resources to conduct research and to answer the question.
* Allows you to access the data you require to answer the question.
* Specific and well-defined concepts – words within the question are clear and have a specific meaning.
* Focus on delving deeper and narrower rather than broader.
* Can be measurable by collecting data or asking questions.

### RAFTER model

One way to formulate and evaluate a research question or hypothesis is to use the Relevant, Answerable, Focused, Timed, Ethical, Resourced (RAFTER) model.

A ‘rafter’ is a series of structural pieces used to support and frame a roof. We can look to use the RAFTER model to help support and frame a research question. This model will assist in making a research question more specific allowing a clear direction to be taken.

This provides an authentic collaboration opportunity as the basis for this discussion will be based on the students’ previous secondary data readings.

Explain to students that when completing the process, the question might change as considerations are made as part of the RAFTER model.

Students should use their secondary data findings to contribute to the discussions and collaborate with their group to build shared understanding and work towards a group goal.

This process will take time and spark many discussions. As a result, students might find themselves:

* going back and forth through the steps of the RAFTER model
* exploring some secondary research to check possibilities
* searching data collection options.

In groups, brainstorm all the possible questions for this content.

A number of potential questions have been identified below. One has been taken and applied to the RAFTER model.

* Does a change in the intensity impact the physiological response in aerobic training?
* What impact does altitude training have on the physiological response in aerobic training?
* How do the various methods of aerobic training impact the physiological responses of an individual?
* Does the larger the muscle group used impact physiological response in aerobic training?
* Does the type of exercise impact physiological responses in aerobic training?
* Will 30 minutes of continuous aerobic cycling training enable the participant to sustain a higher heart rate compared to continuous running training?

As a class, use [Resource 8 – the RAFTER model](#_Resource:_T_–) to improve the following question. A model example has been done for reference.

How do the various methods of aerobic training impact the physiological responses of an individual?

Table 4 – the RAFTER model applied to a research question – a modelled example

|  |  |  |  |
| --- | --- | --- | --- |
| Part of model | Definition | Considerations | Amendments |
| R – relevant | Relevant to an area of syllabus content  Relevant to your chosen interest  Relevant to the collaborative investigation process | Is there a direct link to the Health and Movement Science 11–12 Syllabus content?  Does this question link to specific content from Focus area 1 or Focus area 2?  Has the group selected something linked to content that sparks their interests?  Does the question allow for genuine collaboration in the group and input from each group member? | Directly links to Focus area 2 syllabus content.  Pre-learning that supports this collaborative investigation:   * Compare the difference between aerobic and anaerobic training for individual and groups sports AND investigate the immediate physiological responses to training. * Design an aerobic or anaerobic training program based on the FITT principle. |
| A – answerable | Answerable by collecting quantitative and/or qualitative data in a valid and reliable way  Answerable by reading credible secondary sources on the topic | Can this research question be measured and answered?  Do the variables in the question allow for data collection and analysis in a valid and reliable way?  Can primary and secondary data (qualitative or quantitative) used to answer this question be accessed and collected?  Does the question need to be narrowed further to make it easier to collect data?  Is this research question going to accurately test or measure what it is intended to test or measure (validity)?  Would a group get similar results if they repeated the process under the same conditions (reliability?) | Primary data can be collected on heart rate (HR) and ventilation rate (VR) responses to the various methods of aerobic training.  Validity and reliability are ensured through collection based on established protocols.  Reliability – to ensure reliability the same test subject needs to be used in each of the training methods. The test subject must remain the same due to their base line data, such as fitness levels.  Testing must take place over a short period of time to reduce the impact of the training on improved performance and efficiency of the body. Consider same time and same conditions.  Conditions (temperature, humidity, wind) will impact on results.  Secondary data tells us that we cannot validly test cardiac (CO) output or stroke volume (SV) due to lack of resource availability.  Research suggests that the Garmin watch can be used to reliably measure lactate levels (LL) during a lactate threshold test. However, this will rely on availability of resources at the school.  How do the various methods of aerobic training impact the physiological responses of an individual?   * The control variable is the various methods of aerobic training and we are seeking to collect data on how the body responds – HR, VR and LL to these various methods. * The various aerobic training methods that will be tested are: continuous, fartlek, aerobic (long) interval and circuit.   Using the aerobic training methods as the variable, each individual assigned to the training method will contribute a part of the answer to the full research question therefore promoting collaboration. |
| F – focused | Focused on a particular population, age or characteristic  Focused on specific concepts rather than general or broad areas | Is the research question or focus specific, for example, age, gender or characteristic?  Does the question have a variable?  Do the variables in the question promote focus and specificity?  Are terms within the questions focused with a clear meaning?  Do the variables in the question allow for data collection and analysis in a collaborative way within the group? | The types of aerobic training could be specified.  The sample we have access to are the students in the classroom, which means we could specify to students in Year 11 at [X] High School.  The research question can be kept broad as ‘individual’ because we are keeping the same test subject for each method of training. Being specific will not impact the reliability of the results. Reliability of these results is not subject to the location of students nor will the subjects values impact results. This is not qualitative data collection where bias due to location, shared relationships or values can impact. Reliability of the quantitative data in this research question relates to the calculation of the heart rate and ventilation rate and the quality of the lactate threshold measurement device.  We can identify those physiological responses as just those that are collected reliably through primary methodologies or keep it as all physiological responses and use a combination of primary and secondary data collection methods. This will increase the reliability but not impact too largely on time needed to collect the data. |
| T – timed | Time to complete the data collection and research required  Time frames and periods align to complete research | Is there enough time to collaboratively conduct the research required to answer the question?  Does the research require a specific time frame or period, for example, sporting season, start of school year, holiday period?  Is the data and resources accessible within the allocated time frame?  Does the question need to be narrowed further or changed if the required time and resources to answer the question are difficult to access? | There is time to collect the data. Data can be collected across one week in each of the allocated class periods.  Subjects will need to ensure availability for each of the training methods.  Greater reliability would occur if testing occurred indoors at the same testing time and with the same temperature conditions. This will depend on resources.  Does the school have access to heart rate monitors?  Will students rely on their own devices? Will different devices impact the results?  Will students be able to access the devices for lactate threshold for reliable collection of data? |
| E – ethical | Nature of the research focus requires further consideration around ethical behaviours, for example, informed consent, integrity, privacy and respect | Does the research question or focus have components of sensitivity, for example, the content, the focus group, the application of the process?  Are there aspects of safety which need to be considered and planned for before finalising the research question?  How will informed consent from participants be collected? Will this impact completion of the research in the time frame?  Could the way the group conducts their research and reports on their findings be questioned? | What is the role of pre-screening here?  Parent consent along with informed consent is needed.  Students who can safely exercise aerobically for 20 minutes.  Privacy of the data. The data collected should be de-identified. The same method of identification should be used across all training methods to ensure that the comparison of data across training methods is accurate. This is ensuring honesty of the results – integrity.  Using heart rate monitors. If placing under t-shirts, the subject should be responsible for placement and initial testing of the device. This is respectful to the test subject to remove unwanted touching and ensure privacy.  When the weather could impact the results, due to extreme conditions or safety, testing should be cancelled. This will ensure that the data collected is true and accurate, therefore has integrity.  Roles should be allocated such as subject test, recorder. These are to be kept consistent to ensure the process is the same and therefore reliable. Ensuring integrity of the data, breath counting should be completed by more than one person.  Equipment should be tested for reliability. Testing prior to each use is important. This means that the data collected can be trusted.  Cleaning the equipment is important for hygiene. This is respectful to the test subjects.  Process cards need to be established and communicated to all involved and each person should understand and be able to execute their role.  Heart rate and ventilation rate timing needs to be consistent across all methods to ensure reliability. Where changes in data drastically occur, students will need to account for that. If the process and roles are kept the same, then this removes process bias and could relate to subject bias. Knowing that it more likely relates to subject bias will save time.  Where secondary data is collected, students will reference and acknowledge sources through a bibliography and reference list. Any content directly quoted will be acknowledged and quotation marks used.  AI will not be used as a secondary data collection method. |
| R – resourced | Required resources available and accessible to answer the question | Is the type and number of resources needed to collect and analyse primary and secondary data to answer the question accessible?  Is all required specialist equipment or software accessible to complete the research and answer the question?  Can reliable and credible primary and secondary sources be accessed to answer this question? | Correct number of heart rate monitors for test samples.  Equipment for aerobic circuit training and circuit cards:   * stop watches * process cards * lactate level devices.   Recording method or spreadsheet established.  Leadership to ensure process on the day is clear and communicated.  Time needed and subjects to test equipment on the morning of testing.  Time needed and people to clean equipment.  Time to practise the collection of data. |

At the completion of the RAFTER model, the following are more refined examples of the original research question to be used by the class.

**Research question**: how do the various methods of aerobic training impact the physiological responses of an individual?

**Hypothesis**: regardless of the method of aerobic training the physiological responses of an individual will be similar.

**Formative assessment opportunity**: outcome (HM-11-05) checkpoint – use a logbook, or alternate method of self or peer assessment to encourage students to reflect on their collaboration. Access the HMS logbook teacher guide and the HMS logbook student guide on the [Planning, programming and assessing PDHPE 11–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/pdhpe/planning-programming-and-assessing-pdhpe-k-12/planning-programming-and-assessing-pdhpe-11-12) webpage for more support.

## Step 5 – selecting research methods

The purpose of this step is for group members to identify and select the most suitable research methods for their investigation and their question.

Students watch the video [Research Design: Choosing your Data Collection Methods | Scribbr (5:16)](https://www.youtube.com/watch?v=q17s84ADGfA&list=RDLVq17s84ADGfA). Complete a [PMI chart](https://app.pre.education.nsw.gov.au/learning-tools-selector/LearningActivity/Card/551) for each of the following data collection methods.

* Interviews
* Questionnaires
* Experiments
* Observations
* Focus groups
* Literature reviews

In groups, students consider the data collection methods.

For further information on data collection methods, please see the Investigation and research support booklet which you can find on the [Planning, programming and assessing PDHPE 11–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/pdhpe/planning-programming-and-assessing-pdhpe-k-12/planning-programming-and-assessing-pdhpe-11-12) webpage.

As a class, identify the variables within the research question and the type of data students need to collect to answer the question.

* Variables – various methods of aerobic training
* Type of data needed – physiological responses

Form groups, if not already formed, and assign each group a variable. In this case allocate or allow student groups to select an aerobic training method.

### Aerobic training methods

* Continuous
* Aerobic interval
* Fartlek
* Circuit

Groups should:

* research ways and create the process of collecting the heart rate and ventilation rates (where possible the lactate levels) of a sample group in the most reliable and valid way
* apply knowledge of research methods to discuss the positives and negatives of using different primary methods to collect the data. Consider
* Is the methodology straightforward?
* Will it help you to collect the data you want?
* Do you know why the methodology is the right one to use?
* Do you know how to do it?
* discuss accessing primary and secondary sources of data.

Refer to secondary sources if needed to clarify steps. Add any new sources to the reference list.

## Step 6 – creating methodologies to collect data

The purpose of this step is for group members to develop their plan for conducting the investigation. Groups will establish, create and test the processes, tools and methods to ensure reliability, validity and credibility.

In their groups, students collaboratively develop the plan for conducting the research. The [Resource 9 – sample training methods process cards](#_Resource_–_Sample) can be used as a guide. Each card outlines the testing protocols or process for testing heart rate and ventilation rate during one of the types of aerobic training, as well as the validity considerations for each test.

Suggestions include:

* determining who and how many participants are needed and how they will avoid bias and ensure a representative sample
* establishing a process and system to record including a way to de-identify the sample group, share results and data between group members
* creating a step-by-step process for testing heart rate and ventilation rate during
* continuous aerobic training
* circuit aerobic training
* fartlek aerobic training
* aerobic interval training
* discussing and recording
* ethical considerations for each research method and how the group will apply each throughout the investigation, for example, informed consent, integrity, privacy and respect
* any safety considerations or risks to be managed in conducting the research
* how the group will ensure reliability, validity and credibility of their research and data
* the suitability and accessibility of equipment for heart rate and ventilation rate measurement within each aerobic training protocol or process, considering the validity and reliability of each method, for example, Borg rating of perceived exertion scale, heart rate monitor, smart watches, pulse check and counting beats or breaths per minute, spirometer
* the timing of the testing.

### Considerations

* Equipment list
* Sample athlete consent and pre-screening
* The number of roles people have to adopt
* The exact space or environment needed (if using an outdoor space) and how to measure it
* How and when the heart rate and ventilation rate will be measured
* How the data will be recorded, ensuring privacy for the sample athlete
* How the recorded data will be shared
* Safety considerations, such as how the sample athlete group will be kept safe while completing the testing, weather considerations, recovery for the sample athletes, capability of the athletes
* Contingency plans if an athlete injures themselves before, during or in between testing
* Contingency plans for testing equipment, for example, if the equipment stops working
* Timing – when all sample athletes will be available, when assessment tasks are, other events or factors which might impact participation

**Formative assessment opportunity**: outcome (HM-11-05) checkpoint – use a logbook, or alternate method of self or peer assessment to encourage students to reflect on their collaboration. Access the HMS logbook teacher guide and the HMS logbook student guide on the [Planning, programming and assessing PDHPE 11–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/pdhpe/planning-programming-and-assessing-pdhpe-k-12/planning-programming-and-assessing-pdhpe-11-12) webpage for more support.

Additionally, collect their plan for research as evidence of the collaborative group work.

Collecting primary sources of data include collecting data from individuals and groups. It is the researcher’s responsibility to ensure that these groups feel a level of comfort and safety, resulting in them offering truthful responses or full commitment physically to experiments or observations. This ensures that the data collected is reliable.

This activity provides another authentic opportunity for collaboration. Within their groups students should demonstrate some of the following collaboration markers:

* apply their own strengths to participate in the group
* actively listen to understand others
* tailor explanations for different group members
* discuss difference of opinion or perspective
* come to an agreement where opinions differ, or conflict arises
* negotiate the most effective approach to completing the task for the greater good of the group
* make quality and relevant contributions
* perform responsibilities assigned by the collective group
* access assistance or feedback where required.

For further information on research data collection methods and ethical considerations please see the Investigation and research support booklet which you can find on the [Planning, programming and assessing PDHPE 11–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/pdhpe/planning-programming-and-assessing-pdhpe-k-12/planning-programming-and-assessing-pdhpe-11-12) webpage.

Use the following questions in the table below as a guide.

Table 5 – considerations and questions for accessing primary data ethically

|  |  |
| --- | --- |
| Source | Questions and considerations |
| Individuals and groups | * What data do I need to collect to answer the research question or hypothesis? * How will I collect that data? * What types of questions or observations will I use to collect that data? * Who is the target sample group and how will I access them? * What time of day, or what conditions are needed to make sure the data collected is not impacted? * How will the sample group know they can trust the process of data collection? * How will the sample group know I will keep their data confidential? * What types of communication is needed for the sample group to feel safe to give honest responses? * What instructions will need to be given when collecting the data? * How will I store the data to increase participant confidence in the process? * What if the data I collect is not what is expected? |

## Step 7 – applying research methods to collect data

The purpose of this step is for group members to apply their processes, tools and methods to collect data, and ensure reliability, validity and credibility.

Access the Investigation and research support booklet which you can find on the [Planning, programming and assessing PDHPE 11–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/pdhpe/planning-programming-and-assessing-pdhpe-k-12/planning-programming-and-assessing-pdhpe-11-12) webpage, for more information on collecting, analysing and presenting data.

Students carry out the following testing procedures clearly and methodically.

Variations to the testing procedures can impact the results, rendering them unusable.

* Allocate roles and responsibilities to access and collect primary data in their group.
* Identify, source and test resources for testing and recording.
* Organise access to the target or population group where possible or use members of the class as a test.
* Seek informed consent from research participants where required.
* Implement the research methods to collect and record data.
* Use an established process and system to record and share results and data between group members.

## Step 8 – interpreting and analysing research to determine findings

The purpose of this step is for group members to simplify, decode and extract meaning from the data they have collected. This involves presenting data in a variety of ways to enable group members to interpret the data, identify trends and construct meanings to draw conclusions. As students share findings as a group, they should analyse and discuss any primary data findings in relation to their research question and secondary data findings.

Access the Investigation and research support booklet which you can find on the [Planning, programming and assessing PDHPE 11–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/pdhpe/planning-programming-and-assessing-pdhpe-k-12/planning-programming-and-assessing-pdhpe-11-12) webpage, for more information on collecting, analysing and presenting data.

It can be complicated to extract useful content from raw data. The purpose of this step is for group members to simplify, decode and extract meaning from the data they have collected. This involves presenting data in a variety of ways, such as tables, charts, graphs, maps, pictographs or be transcribed to enable group members to interpret the data to identify trends, construct meanings and draw conclusions.

As students share findings as a group, they should analyse and have discussions in relation to their research question and secondary data findings.

The following activities will support students in understanding the best possible ways to present their groups’ data. The graphs and table examples used in the following activities are a guide and not specific findings found as part of the research question modelled throughout.

As a class, review the variety of ways data can be presented. Identify whether the mode of presentation works best for quantitative data, qualitative data or both.

Once students have collected and presented their data findings, they will need to be able to form a point of view by interpreting, speculating, critiquing, analysing and constructing meanings that allow conclusions to be drawn.

At this point, usually more than one method has been used to collect data, each method bringing a certain element, so when combined together the researcher has a clear picture of the research as a whole and the correct conclusions can be drawn.

**Quantitative analysis** is focused on combining information across a group or multiple groups of people, factors, things or themes and using this to draw out wider trends.

Before analysing the results, students must interpret the data.

Analysis and interpretation of **qualitative data** coming from open-ended questionnaires, interviews, observations or focus groups requires judgement and care, to identify key themes and ‘decode’ meaning in what people have said. Analysis of qualitative data should identify the main themes (in students’ own words) and illustrate these with quotes (in the words of respondents or observed facts). The analysis should also identify ‘outlier’ positions – perspectives that are equally valid and important, but less common.

The nature of qualitative data is that it is time consuming to gather and interpret. It can also be overwhelming for the researcher to make sense of. Working with a large volume of qualitative data might require ‘coding’. Coding is a useful strategy when working with a large volume of qualitative data.

The first step is to create some categories. Start by reading the first few pages of comments and identifying consistent themes.

When coding open-ended responses in a spreadsheet, start with each comment in its own row. Each theme then gets its own column. Ensure there is an ‘other’ column.

For each comment, put a ‘1’ in each of the columns where that theme is identified.

If there is a need to clarify, expand or split a theme during coding, pause at that point to check comments that had previously been tagged in that theme and reapply the new code-frame.

At the end, review the comments coded ‘other’ and ensure that they are genuine outliers.

Once qualitative data has been coded, the data should behave like a multiple response quantitative question, allowing greater comparison and additional analysis to be undertaken. The coding and identifying themes in qualitative data will support stronger links to the quantitative data.

As a group, students divide up the data and present their findings in graphs or tables.

Students use graphs and tables to present complex data in easy-to-understand information.

Graphs and tables are the most effective way to illustrate trends or comparisons observed in a large amount of data.

Create a naming system, such as Athlete A – method A, Athlete A – method B and so on, for all data for each sample athlete.

Ask students to demonstrate their understanding of the purpose for presenting the primary data collected and what they want the reader to take from the data.

Discuss ways to present the data to demonstrate a comparison of heart rates across each athlete sample for each aerobic training method.

Discuss ways to present the data to demonstrate a comparison of ventilation rates across each athlete sample for each aerobic training method.

Interpret the data using the following prompts.

* Identify any trends in the data.
* Were these results expected?
* Are there any outlying results? Can these be accounted for?
* Compare these primary results to secondary sources of information.
* Highlight how the primary results reflect, differ from or extend on current knowledge of the areas of interest, issues and focuses.
* Research, collate and record the secondary sources for the physiological responses that could not be tested with primary data.
* Share these results collaboratively so individual students have all the information, either through primary data or secondary data to answer the research question.

**Formative assessment opportunity**: outcome (HM-11-05) checkpoint – use a logbook, or alternate method of self or peer assessment to encourage students to reflect on their collaboration. Access the HMS logbook teacher guide and the HMS logbook student guide on the [Planning, programming and assessing PDHPE 11–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/pdhpe/planning-programming-and-assessing-pdhpe-k-12/planning-programming-and-assessing-pdhpe-11-12) webpage for more support.

## Step 9 – drawing conclusions from the research

The purpose of this step is for group members to answer their research questions by drawing conclusions from the research findings.

Following the interpretation of the data, the group should be asking ‘why’. Answer this by identifying one of the trends, patterns or relationships to:

* identify possible reasons for the trend, pattern or relationship found
* make inferences and predictions from graphs and justify.

The reasons, inferences and predictions need an evidence base and is the result of deep reading and understanding the topic. This can support, clarify or use qualitative data or secondary data. The qualitative or secondary data might even challenge the quantitative data.

Consider the following questions:

* Are the results similar or consistent with other studies or knowledge about this topic?
* What evidence from secondary data do they have to support or challenge the findings?
* Do the results reflect, differ or extend on the area of interest, issue or focus?
* What conclusions can be drawn from these results?

As a group, students:

* Draw conclusions from their findings to answer the research question**.** Draw a conclusion which shows the reader how the pieces of research fit together and work to support the research question and leaves the audience with the sense that a valid argument has been presented and supported by relevant research.
* Identify, share and discuss any relationships across the findings and compare to secondary data.
* Discuss and develop arguments and justifications for the data and findings.

Analysing and writing the discussion section of a research project can be challenging for students. The following sentence starters might support and help summarise their key findings, give interpretations, describe the relationships of their question, problem statement or hypothesis, discuss implications, acknowledge limitations and provide recommendations for further research questions.

* The graph shows …
* The results indicate …
* Based on the patterns in the data, we can see that …
* A trend that exists in the data is …
* The study demonstrates a correlation between …
* The data suggests that …
* In line with the hypothesis …
* Contrary to the hypothesis …
* The results disagree with Author (YEAR) who suggests that …
* The data shows a clearer understanding of …
* These results do not fit with the hypothesis …
* These results build on existing research which suggests that …
* Due to the sample size, results might …
* Due to the lack of data on [X], the results cannot confirm …
* Due to the way the data was collected …
* The reliability of this data is impacted by …
* Further research into [X] would …
* Further research questions that could be explored are …

## Step 10 – presenting findings to the class or a panel of experts

The purpose of this step is for students to present what they have concluded and found through their investigation. This could be presented individually or as a group.

There are several ways to present the findings of research. Some examples might include a written report, oral presentation, video, podcast, multimodal text such as an infographic and an explanation.

Students are encouraged to negotiate with group members a presentation mode of choice, ensuring that the chosen mode includes:

* a summary of the research question and methodologies undertaken
* findings and conclusions of the research with supporting evidence
* suggestions of further opportunities for research
* acknowledgement of sources.

Suitable experts could be:

* university exercise scientists
* a personal trainer in the local community
* the head teacher of PDHPE
* a local running coach.

**Formative assessment opportunity**: outcome (HM-11-05) checkpoint – use a logbook, or alternate method of self or peer assessment to encourage students to reflect on their collaboration. Access the HMS logbook teacher guide and the HMS logbook student guide on the [Planning, programming and assessing PDHPE 11–12](https://education.nsw.gov.au/teaching-and-learning/curriculum/pdhpe/planning-programming-and-assessing-pdhpe-k-12/planning-programming-and-assessing-pdhpe-11-12) webpage for more support.

## Resource 1 – group-forming activities

**Two truths and a lie**

Each person must make 3 statements about themselves, one of which isn’t true.

For example: I have 2 brothers, I was born in Australia, I have a motorcycle.

Allow the group some time to think of their statements and write them down if they need.

Once one person makes their statements, the rest of the group must guess, or vote on, which statement is the lie.

**Tangled chain or knots**

Students huddle in a group of 5 to 6 in the middle of the room and join each hand with someone across the circle. Once everyone has joined hands, their task is to untangle themselves.

**Remember everything**

In groups of 6 to 8, students partner up. Each person must find out 3 things about that partner. After a minute, everyone in the group of 6 to 8 reports back to the group about the person that they got to know.

Each person finds a new partner and discovers 3 new things about that person. After a minute, everyone in the group of 6 to 8 reports back to the group about the person that they got to know.

Then, maybe get a couple of students in the group to try to remember all 6 facts about both students they’ve interacted with.

You can keep going with a third or fourth round. Get people to try to report all the facts back without making a mistake.

This activity has been adapted from [Youth Group Games](https://youthgroupgames.com.au/) from [Remember Everything](https://youthgroupgames.com.au/games/remember-everything/).

## Resource 2 – sample group contract

Use the headings and the questions below to create a group contract or agreement for a collaborative investigation.

These agreements should also reflect the expectations of the classroom and school community.

**Note:** teachers can delete the sample questions to supply a blank table for students to complete.

Table 6 – sample group agreement

|  |  |
| --- | --- |
| Aspect of agreement | Group details and sample questions |
| Group | Insert members names and contact details. |
| Group goals | What are some specific, measurable, achievable, realistic and timely (SMART) goals for the collaborative investigation? List them below. |
| Decision making | How will the group make decisions? For example, consensus, majority rules. |
| Conflict resolution | How will the group deal with conflict? For example, talk it out, bring in a facilitator. |
| Communication | How will the group communicate? For example, respectful conversations, sharing of time to speak, active listening, group check-ins, text, email. |
| Attendance | What is the policy for people who are absent?  How many days can a person miss before there are consequences? |
| Sharing work | How will the group get work to one another? |
| Agreed roles and responsibilities | Identify the roles a collaborative investigation requires.  List below what their responsibilities will be.  Identify what the consequences will be if a group member can’t finish a deliverable on time. |
| Agreement | Signature of group members and date. |

## Resource 3 – sample roles and responsibilities table for group contract

Use the table to list the roles, responsibilities and students allocated for tasks.

Table 7 – sample roles and responsibilities table for a group contract

|  |  |  |
| --- | --- | --- |
| Role | Responsibility | Name |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

## Resource 4 – sample tracking sheet group

Use the sample tracking sheet to monitor work progress and completion.

Project name:

Group members:

Table 8 – sample collaborative investigation tracking sheet for group tasks

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Task | Who is responsible? | Due date | Status | Done |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

## Resource 5 – sample tracking sheet individual

Use the sample tracking sheets below to monitor work progress and completion.

Project name:

Group members:

Date:

### Goals

During this time, I had the following goals for project work:

Table 9 – sample collaborative investigation tracking sheet for goals and progress

|  |  |
| --- | --- |
| Goal | Details of progress |
|  |  |
|  |  |
|  |  |
|  |  |

### Tasks

During this time, I accomplished the following:

Table 10 – sample collaborative investigation tracking sheet for tasks and progress

|  |  |
| --- | --- |
| Task | Details of progress |
|  |  |
|  |  |
|  |  |
|  |  |

### Next steps

What I will do next:

Table 11 – sample collaborative investigation tracking sheet for next steps

|  |  |
| --- | --- |
| Step | Details |
|  |  |
|  |  |
|  |  |
|  |  |

Outline any concerns or questions you have.

## Resource 6 – giving and receiving feedback

Feedback helps us improve our future work and ourselves. It offers us an opportunity to see our work through others’ eyes, to help us recognise our achievement and see past our own blind spots.

Using the [The Tuning Protocol: A Framework for Personalized Professional development](https://www.edutopia.org/blog/tuning-protocol-framework-personalized-professional-development-jess-hughes) will promote effective feedback.

Effective feedback should be constructive. Asking questions to clarify and explore options could help to better understand the work. It involves detailed analysis and assessment with the aim of improving the work. It’s important to be open, honest and kind when providing feedback.

This feedback is provided by:

This feedback is provided for:

Table 12 – sample feedback form for peer assessment

|  |  |
| --- | --- |
| Feedback form | Comment |
| What I like about your work and why. |  |
| What I think could be better about your work and how. |  |
| Questions to make a difference. |  |

**Prompts for giving feedback**

* A strength of this work that I really like is ...
* The presenter has paid close attention to ...
* I think it will be helpful for teachers that the annotations ...
* I think it is worth considering ...
* I wonder if ...
* One way to improve this might be ...

When we seek feedback, we are sometimes looking for affirmation rather than information, which makes feedback hard to receive. Particularly if we have trouble separating the value of our work from how we value ourselves.

Receiving feedback is most effective when we can join our reviewers in looking at our work critically rather than defensively. When everyone involved can share honest viewpoints about the work, we can see the value in what has been done and potential for what could be done.

**Tips for receiving feedback**

* Remove the personal attachment and emotion from the feedback and the work. Consider that the work is what you did, not who you are.
* Recognise that the work is the best you could do with your time, knowledge and ability.
* Extract the useful information from the feedback, whatever form it might take.
* Focus on receiving feedback as suggestions for how you can do better in the future.

## Resource 7 – designing a research question

Developing a research question in a group will involve initial pre-research, negotiation and collaboration.

A research question:

* gives clear direction, focus and purpose to an investigation
* guides the path through the investigation, research and writing process
* can take the form of a problem statement, hypothesis, or question.

**Question:** asks whether a relationship exists between variables in a particular population. Including variables will promote authentic collaboration in the group. A variable is any condition that can vary or change in quantity (for example, dosage, intensity, level, amount, size) or quality (for example, type of training, health behaviour, initiative or strategy, age).

**Problem statement:** presents the idea, issue or situation that the researcher intends to examine in their study.

**Hypothesis:** a statement made to reflect the relationship between 2 variables and usually written as a prediction for the research study to prove or disprove. A good hypothesis puts the question into a form that can be observable and tested. For example: Young people are engaging more with technology when accessing health information rather than seeking help from a medical professional.

Review the sample research questions below. Identify the characteristics of a strong research question for a collaborative investigation.

**Examples of sample research questions**

* Does a change in the intensity impact the physiological response in aerobic training?
* What impact does altitude training have on the physiological response in aerobic training?
* How do the various methods of aerobic training impact the physiological responses of an individual?
* Does the larger the muscle group used impact physiological response in aerobic training?
* Does the type of exercise impact physiological responses in aerobic training?
* Will 30 minutes of continuous aerobic cycling training enable the participant to sustain a higher heart rate compared to continuous running training?

Pick 2 questions from the list provided above.

In pairs, discuss whether the selected questions are strong research questions and what changes you would make to improve the quality of the question.

## Resource 8 – the RAFTER model

Use the considerations provided for each part of the model below to develop, evaluate and change your research question.

Table 13 – the RAFTER model overview

|  |  |  |
| --- | --- | --- |
| Part of model | Definition | Considerations |
| R – relevant | Relevant to an area of syllabus content  Relevant to your chosen interest  Relevant to the collaborative investigation process | Is there a direct link to the Health and Movement Science 11–12 Syllabus content?  Does this question link to specific content from Focus area 1 or Focus area 2?  Has the group selected something linked to content that sparks their interests?  Does the question allow for genuine collaboration in the group and input from each group member? |
| A – answerable | Answerable by collecting quantitative and/or qualitative data in a valid and reliable way  Answerable by reading credible secondary sources on the topic | Can this research question be measured and answered?  Do the variables in the question allow for data collection and analysis in a valid and reliable way?  Can primary and secondary data (qualitative or quantitative) used to answer this question be accessed and collected?  Does the question need to be narrowed further to make it easier to collect data?  Do the variables in the question allow for data collection and analysis in a collaborative way within the group?  Is this research question going to accurately test or measure what it is intended to test or measure (validity)?  Would a group get similar results if they repeated the process under the same conditions (reliability)? |
| F – focused | Focused on a particular population, age or characteristic  Focused on specific concepts rather than general or broad areas | Is the research question or focus specific, for example, age, gender or characteristic?  Does your question have a variable?  Do the variables in the question promote focus and specificity?  Are terms within the question focused with a clear meaning? |
| T – timed | Time to complete the data collection and research required  Time frames and periods align to complete research | Is there enough time to collaboratively conduct the research required to answer the question?  Does the research require a specific time frame or period, for example, sporting season, start of school year, holiday period?  Is the data and resources accessible within the allocated time frame?  Does your question need to be narrowed further or changed if the required time and resources to answer the question are difficult to access? |
| E – ethical | Nature of the research focus requires further consideration around ethical behaviours, for example, informed consent, integrity, privacy and respect | Does the research question or focus have components of sensitivity, for example, the content, the focus group, the application of the process.  Are there aspects of safety which need to be considered and planned for before finalising the research question?  How will informed consent from participants be collected? Will this impact completion of the research in the time frame?  Could the way your group conducts their research and reports on their findings be questioned? |
| R – resourced | Required resources available and accessible to answer the question | Is the type and number of resources needed to collect and analyse primary and secondary data to answer the question accessible?  Is all required specialist equipment or software accessible to complete the research and answer the question?  Can reliable and credible primary and secondary sources be accessed to answer this question? |

## Resource 9 – sample training methods process cards

### Testing protocols

#### Resources or equipment

* Outdoor or indoor space and equipment, for example, oval, stationary bikes, treadmill
* Heart rate monitor device
* Spirometer to measure ventilation rate or a stopwatch for timing if counting your breathing rate

You can measure your breathing rate by counting the number of breaths you take over the course of one minute. To get an accurate measurement:

1. Sit down and try to relax.
2. Count the number of times your chest or abdomen rises over the course of one minute.
3. Record this number.

#### Prior to testing

* Sample athletes complete a pre-screening questionnaire and provide informed consent.
* Calculate sample athlete’s maximum heart rate. For example, maximum heart rate is 220 − age (years).
* Determine the appropriate exercise intensity. Aerobic training target heart rate is approximately 60 to 75% of maximum heart rate.

Maximum heart rate (MHR) can be calculated by using the following formula: MHR = 220 − age. Target heart rate (THR) zone can be calculated by 0.60 × MHR equals the lower end of the target heart rate zone. The upper end of the target heart rate zone is equal to 0.80 × MHR. For example, Sam is 18 years old. His MHR is 202 beats per minute (bpm). His THR zone is between 121 bpm and 161 bpm. Monitoring heart rate provides an objective measure of exercise intensity. In general, the higher your heart rate during physical activity, the higher the exercise intensity.

* Pre-test the heart rate monitor and practise using the spirometer or breath counting method. Ensure that each sample athlete is wearing the heart rate monitor correctly and that the device is functioning properly.
* Record the sample athlete’s resting heart rate and ventilation rate. This will provide information on their level of fitness.
* Prepare a data collection table to organise the data.
* Sample athletes complete a thorough warm-up before undertaking any of the practical experiences for each lesson.

#### Post testing

* Record each sample athlete’s heart rate and ventilation rate at one minute, 3 minutes and 5 minutes post exercise. This will provide additional information on level of fitness.
* Sample athletes complete a thorough cool-down to restore their body to pre-exercise state before undertaking any of the practical experiences for each lesson.

Table 14 – process and validity considerations for each aerobic training method

|  |  |  |
| --- | --- | --- |
| Aerobic training method | Process | Validity considerations |
| Continuous training method | **Testing**  Begin the continuous aerobic training activity for 20 minutes.   * Depending on the mode of exercise (for example, running, cycling, rowing), you might need to use a stationary bike or treadmill. * Encourage the sample athletes to maintain a consistent pace and effort for 20 minutes. This can be done using flat surface and consistent terrain for running or cycling protocols.   Monitor heart rate – use the heart rate monitor to measure the sample athlete’s heart rate. Record the heart rate at pre-determined time intervals, such as 2, 5, 8, 11, 15 and 20 minutes.  Monitor ventilation rate – use the spirometer or breath counting method to measure each sample athlete’s ventilation rate. Record the ventilation rate at pre-determined time intervals, such as 2, 5, 8, 11, 15 and 20 minutes.  Record data. | * **Counting breaths during aerobic exercise, is not the most accurate method.** * **The reason for this is that during exercise, the breathing pattern can become irregular, making it difficult to count breaths accurately.** * **Additionally, some sample athletes might breathe more shallowly or deeply than others, which can further affect the accuracy of this method.** * Using heart rate monitors. If placing under t-shirts, the sample athlete should be responsible for placement and initial testing of the device. This is respectful to remove unwanted touching and ensure privacy. * When the weather could impact the results, due to extreme conditions or safety, testing should be cancelled. This will ensure that the data collected is true and accurate, therefore has integrity. * Roles should be allocated such as subject tester and recorder; these roles are to be kept consistent to ensure the process is the same and therefore reliable, ensuring integrity of the data. Breath counting should be completed by more than one person (for integrity). * Equipment should be tested for reliability. Testing prior to each use is important. This means that the data collected can be trusted. * Cleaning the equipment is important for hygiene. This is respectful to the test subjects. * **Consider the impact on the recorded heart rate when stopping to test the ventilation rate.** |
| Fartlek training method | **Testing –** [Fartlek intervals](https://www.runningfastr.com/training/fartlek-training-sessions/)   * Begin running at a comfortable pace for a pre-determined distance or time (for example, 400 meters or 2 minutes). * Then, increase the intensity and pace of running to a faster pace (for example, sprinting or running at a fast tempo) for a pre-determined distance or time (for example, 100 meters or 30 seconds). * After completing the high-intensity interval, return to the comfortable pace for a pre-determined distance or time (for example, 200 meters or one minute) to recover. * Repeat this cycle of high-intensity intervals followed by periods of recovery for a total of 4 to6 intervals.   Monitor heart rate – use the heart rate monitor to measure the sample athlete’s heart rate. Record the heart rate at pre-determined time intervals, such as 2, 5, 8, 11, 15 and 20 minutes.  Monitor ventilation rate – use the spirometer or breath counting method to measure each sample athlete’s ventilation rate. Record the ventilation rate at pre-determined time intervals, such as 2, 5, 8, 11, 15 and 20 minutes.  Record data. | * **Counting breaths during aerobic exercise, is not the most accurate method.** * **The reason for this is that during exercise, the breathing pattern can become irregular, making it difficult to count breaths accurately.** * **Additionally, some sample athletes might breathe more shallowly or deeply than others, which can further affect the accuracy of this method.** * Using heart rate monitors. If placing under t-shirts, the sample athlete should be responsible for placement and initial testing of the device. This is respectful to remove unwanted touching and ensure privacy. * The duration and intensity of each interval can be adjusted based on the sample athlete fitness level. The whole 20-minute session must be completed. * Fartlek training can be done on various terrains such as hills, trails or even on a track. * Can be adapted to meet the needs of different runners. * If treadmills are available, pre-determined times and speeds are more accurate for each athlete. * When the weather could impact the results, due to extreme conditions or safety, testing should be cancelled. This will ensure that the data collected is true and accurate, therefore has integrity. * Roles should be allocated such as subject tester and recorder; these roles are to be kept consistent to ensure the process is the same and therefore reliable, ensuring integrity of the data. Breath counting should be completed by more than one person (for integrity). * Equipment should be tested for reliability. Testing prior to each use is important. This means that the data collected can be trusted. * Cleaning the equipment is important for hygiene. This is respectful to the test subjects. |
| Aerobic interval training method | **Testing –** Aerobic intervals  Cycle one – exercise for 30 seconds at 75 to 85% intensity, followed by 30 seconds at 25% intensity. Repeat 3 times.  One minute rest.  Repeat for 5 cycles followed by a one-minute rest each time. Record data.  Monitor heart rate – use the heart rate monitor to measure the sample athlete’s heart rate. Record the heart rate at pre-determined time intervals, such as 2, 5, 8, 11, 15 and 20 minutes.  Monitor ventilation rate – use the spirometer or breath counting method to measure each sample athlete’s ventilation rate. Record the ventilation rate at pre-determined time intervals, such as 2, 5, 8, 11, 15 and 20 minutes.  Record data. | * **Counting breaths during aerobic exercise, is not the most accurate method.** * **The reason for this is that during exercise, the breathing pattern can become irregular, making it difficult to count breaths accurately.** * **Additionally, some sample athletes might breathe more shallowly or deeply than others, which can further affect the accuracy of this method.** * Using heart rate monitors. If placing under t-shirts, the sample athlete should be responsible for placement and initial testing of the device. This is respectful to remove unwanted touching and ensure privacy. * The duration and intensity of each interval can be adjusted based on the **sample athlete’s** fitness level. The whole 20-minute session must be completed. * If treadmills are available, pre-determined times and speeds are more accurate for each athlete. * When the weather could impact the results, due to extreme conditions or safety, testing should be cancelled. This will ensure that the data collected is true and accurate, therefore has integrity. * Roles should be allocated such as subject tester and recorder; these roles are to be kept consistent to ensure the process is the same and therefore reliable, ensuring integrity of the data. Breath counting should be completed by more than one person (for integrity). * Equipment should be tested for reliability. Testing prior to each use is important. This means that the data collected can be trusted. * Cleaning the equipment is important for hygiene. This is respectful to the test subjects. |
| Circuit training method | **Testing**  This circuit can be done individually, or in a group, and it should take about 10 minutes to complete one rotation. Sample athletes should complete 2 rotations of the circuit.  Sample athletes should take a 15 to 30 second rest after each exercise (depending on fitness level) and a one-minute rest after each rotation of the circuit.  **Sample circuit**   * Squat jumps: 10 to 15 repetitions * Standard push-ups: 10 to 15 repetitions * Calf raises: 15 to 20 repetitions * Tricep bench dips: 10 to 15 repetitions * Star jumps: 10 to 15 repetitions * Abdominal crunches: 15 to 20 repetitions * Jump rope: 60 seconds * Mountain climbers: 10 to 15 repetitions * Lunges: 10 to 15 repetitions * Calf raises in squat: 15 to 20 repetitions * Burpees: 10 to 15 repetitions * Abdominal bicycles: 15 to 20 repetitions   Monitor heart rate – use the heart rate monitor to measure the sample athlete’s heart rate. Record the heart rate at pre-determined time intervals, such as 2, 5, 8, 11, 15 and 20 minutes.  Monitor ventilation rate – use the spirometer or breath counting method to measure each sample athlete’s ventilation rate. Record the ventilation rate at pre-determined time intervals, such as 2, 5, 8, 11, 15 and 20 minutes.  Record data. | * Using heart rate monitors. If placing under t-shirts, the sample athlete should be responsible for placement and initial testing of the device. This is respectful to remove unwanted touching and ensure privacy. * When the weather could impact the results, due to extreme conditions or safety, testing should be cancelled. This will ensure that the data collected is true and accurate, therefore has integrity. * Roles should be allocated such as subject tester and recorder; these roles are to be kept consistent to ensure the process is the same and therefore reliable, ensuring integrity of the data. Breath counting should be completed by more than one person (for integrity). * Equipment should be tested for reliability. Testing prior to each use is important. This means that the data collected can be trusted. * Cleaning the equipment is important for hygiene. This is respectful to the test subjects. |

# Further reading

CESE (Centre for Education Statistics and Evaluation) (2020a) [*What works best: 2020 update*](https://education.nsw.gov.au/about-us/educational-data/cese/publications/research-reports/what-works-best-2020-update), NSW Department of Education, accessed 24 August 2023.

CESE (Centre for Education Statistics and Evaluation) (2020b) [*What works best in practice*](https://education.nsw.gov.au/about-us/educational-data/cese/publications/practical-guides-for-educators-/what-works-best-in-practice), NSW Department of Education, accessed 24 August 2023.

Wiliam D (2013) ‘[Assessment: The bridge between teaching and learning](https://www.researchgate.net/publication/258423377_Assessment_The_bridge_between_teaching_and_learning)’, Voices from the Middle, 21(2):15–20, accessed 24 August 2023.

# Additional information

The information below can be used to support teachers when using this teaching resource for Health and movement science.

## Support and alignment

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

**Alignment to system priorities and/or needs:** [School Excellence Policy](https://education.nsw.gov.au/policy-library/policies/pd-2016-0468)

**Alignment to the School Excellence Framework:** this resource supports the [School Excellence Framework](https://education.nsw.gov.au/policy-library/policies/pd-2016-0468) elements of curriculum (curriculum provision) and effective classroom practice (lesson planning, explicit teaching).

**Alignment to Australian Professional Teaching Standards:** this resource supports teachers to address [Australian Professional Teaching Standards](https://educationstandards.nsw.edu.au/wps/portal/nesa/teacher-accreditation/meeting-requirements/the-standards/proficient-teacher) 3.2.2, 3.3.2.

**Consulted with:** Curriculum and Reform and subject matter experts

**NSW syllabus:** Health and Movement Science 11–12 Syllabus

**Syllabus outcomes:** HM-11-05, HM-11-06, HM-11-07, HM-11-10

**Author:** PDHPE Curriculum Team

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

**Resource:** Collaborative Investigation Learning program

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

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

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

Hughes J (2016) [*The Tuning Protocol: A Framework for Personalized Professional Development*](https://www.edutopia.org/blog/tuning-protocol-framework-personalized-professional-development-jess-hughes), Edutopia website, accessed 8 March 2024.

NESA (NSW Education Standards Authority) (2021) ‘[Proficient Teacher: Standard descriptors](https://educationstandards.nsw.edu.au/wps/portal/nesa/teacher-accreditation/meeting-requirements/the-standards/proficient-teacher)’, *The Standards*, NESA website, accessed 20 March 2024.

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