



# EMPIRIBOX

Primary School Science

Scientific skills  
- Evaluation  
Teacher Guide

## General guidance

This activity is designed to ascertain children's *Working Scientifically skills of evaluation*. The context of the activity is narrowed to a familiar topic of fitness and one therefore that all children will understand. It is not intended to test their knowledge but their progress in the acquisition of science skills. It may also be repeated at the end of a term or school year to assess their progress.

Is not intended to be conducted like a test. Ideally, children will work collaboratively at the activity to allow discussion and to support peer-teaching. Ideally, you will circulate around the groups of children during the activity to listen to their conversations and ask questions to probe their thinking and misconceptions. Circulating around the groups offers an opportunity to record assessment information during the activity. For example, noting that a child has said something that shows they have some understanding of an idea even though they might not be able to write it down.

Relevant LKS2 *Working Scientifically* objectives:

- Using results to [draw simple conclusions], make predictions for new values, suggest improvements and raise further questions;
- Using straightforward scientific evidence to answer questions or to support their findings.

Relevant UKS2 *Working Scientifically* objectives:

- Using test results to make predictions to set up further comparative and fair tests;
- Reporting and presenting [findings from enquiries, including conclusions, causal relationships and explanations of and] a degree of trust in results, in oral and written forms such as displays and other presentations;
- Identifying scientific evidence that has been used to support or refute ideas or arguments.

## 'Fair-Testing' Explained

The phrase 'fair testing' is often heard and found in primary schools and in primary curriculums. Science as a 'process' is undertaken using what is called the '**Scientific Method**'. In essence, this involves asking a question that can be investigated, forming a hypothesis, making a prediction and conducting an experiment following a carefully observed process and generating data that is 'Valid'

The data generated by an experiment or investigation may or may not match the prediction, however if it is 'Valid' it has to ensure **3 main criteria** are met and these are:

- ***Were all Independent (the change ones) variables controlled and only 1 variable changed?***
- ***Was the data obtained 'accurate' or close to the actual value being measured?***  
***and***
- ***Is the data 'repeatable'?***

If this is the case, then your data is '**Valid**'. It is essentially this that is implied when you hear the phrase 'fair-testing'.

## Investigating the effect of exercise

Children are shown an image of children taking part in exercise in school with an explanation of what heart rate is. They are also given a simple method that Grace, Maisie and Rory followed to collect data. You may choose to show the children how to measure heart rate by taking the pulse, which will help the children understand the context of the investigation. The children can then begin the evaluation task.

1a) In the first part of the activity, children evaluate the method that Grace, Maisie and Rory carried out to obtain data to answer their question, '*How does the amount of exercise we take affect our heart rate?*' In this case, the method is suitable to answer the question because Grace, Maisie and Rory take the heart rate at rest before the test starts, use the same person throughout, in the same room with the same conditions, ensure the pulse rate returns to normal between each exercise session etc.

*1 mark for acceptable answer*

1b) Use the same person throughout, in the same room with the same conditions, ensure the pulse rate returns to normal between each exercise session etc.

*2 marks for an acceptable answer*

Children are then provided with Grace, Maisie and Rory's predictions, and a table and graph of their results. Children are then required to compare Grace, Maisie and Rory's results with the predictions they made.

2a) Grace's prediction is fully refuted by the data as the heart rate (pulse) clearly increases as the amount of exercise undertaken increases.

*1 mark for an acceptable answer*

2b) Maisie and Rory both provide plausible predictions. Rory's prediction is the better prediction and is completely supported by the data, (the trend shows that the heart rate will increase to a maximum and then level out). Maisie's prediction is more specific but not

correct: the heart rate does increase with exercise, but it does not double when the exercise time is doubled. For example, with an exercise time of 1 minute the heart rate is 80 beats per minute but is only 92 beats per minute at 2 minutes. For Maisie's prediction to be fully correct, she should have said that the **increase** in pulse rate doubles.

*1 mark for an acceptable answer*

3a) The children are then prompted to use the table and graph of results to identify anomalies, explain them and suggest how to avoid them in the future. Most children will spot that the heart rate at one minute and thirty seconds is the same as that at one minute and is incorrect.

*1 mark for an acceptable answer*

3b) Possible reasons are that the timer was misread, the result was written down incorrectly, the calculation was incorrect, the pulse rate was miscounted, the person counting the pulse rate was distracted etc.

*2 marks for acceptable answers*

3c) To avoid such anomalies in future, Grace, Maisie and Rory should count carefully, ensure that there are no distractions, check their recording of data and check the working out in calculations.

*2 marks for acceptable answers*

4) The next part of the activity looks at the whole process. The investigation process is valid because:

- Grace, Maisie and Rory's method controls key variables and answers the question they asked;
- The data forms a curved line of best fit except for one point (exercise time of one minute and thirty seconds) and all points are near the line of best fit;
- The anomalous measurement can be explained by a simple mistake caused by counting incorrectly, mis-timing or recording the heart rate incorrectly etc.

*1 mark for one acceptable answer*

*2 marks for more than one reason*

5a) There are several other questions Grace, Maisie and Rory could investigate. For example:

- How does the type of exercise affect heart rate?
- How does exercise affect breathing rate?
- How does exercise affect body temperature?

*1 mark for an acceptable answer*

5b) The method Grace, Maisie and Rory follow to answer their new question will depend on the children's previous answer. However, it is important to check that their new method is valid. For example, it should provide an answer to their new question and should identify the key variables to change, measure and control.

*1 mark for some control measures*

*2 marks for all control measures*



# EMPIRIBOX

Primary School Science

Group/Name: .....

Class: .....

Marks	
Total	15

## Scientific skills – Evaluation

## Investigating the effect of exercise

Grace, Maisie and Rory are learning about the importance of exercise in keeping healthy.

They are going to investigate how their heart rate changes when they exercise. Heart rate is the number of times our heart beats in one minute.



This is Grace, Maisie and Rory's question:

'How does the amount of exercise we take affect our heart rate?'

Grace, Maisie and Rory's method.

1. One person will sit down and rest for one minute.
2. We will count the number of times we can feel their pulse in 15 seconds and multiply by 4 to get beats per minute. This is the pulse rate at 0 minutes. The measurement will be repeated.
3. The result will be recorded in the table.
4. The same person will then slow their breathing down by breathing in for 2 seconds, holding their breath for 2 seconds and breathing out for 2 seconds.
5. The same person will then exercise for 30 seconds and we will repeat steps 2-4.
6. We will repeat steps 2-5 for exercise periods of 1.0 minute, 1.5, 2.0, 2.0, 3.0 and 3.5 minutes. The person exercising will do the same type of exercise each time in the same room.
7. We will then plot a graph of the data.

1a) Read Grace, Maisie and Rory's method.

Will their method give results that answer their question?

 .....

because .....

.....



1 mark

1b) Read Grace, Maisie and Rory's method.

Describe **TWO** things they did to make their method fair (so they would collect valid data).

 1. ....

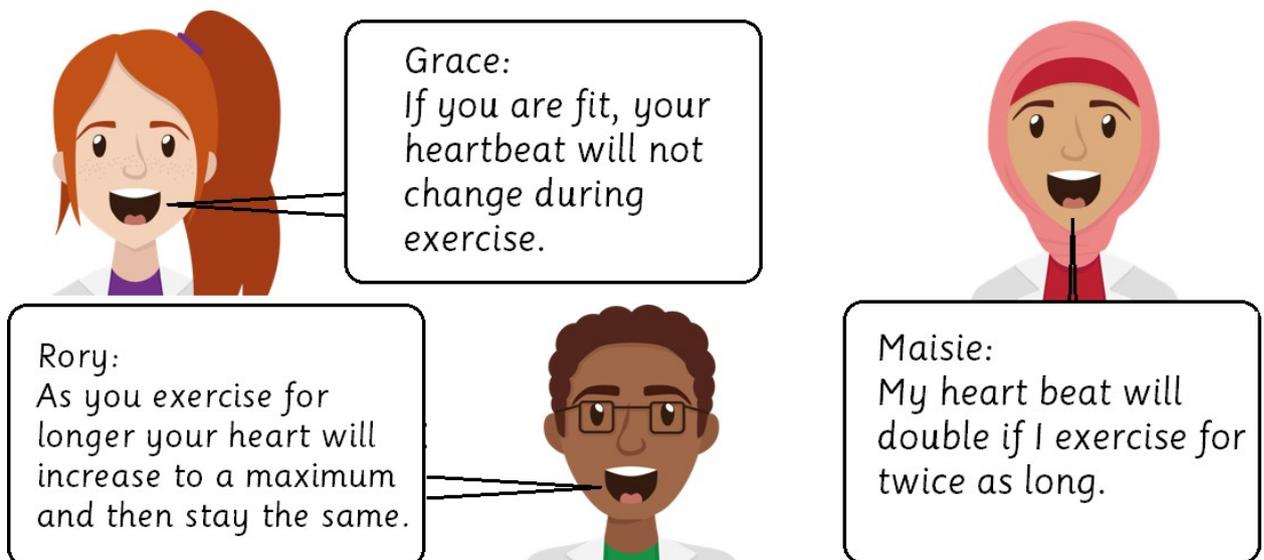
2. ....



2 marks

Grace, Maisie and Rory's predictions.

These are the predictions they made before they started their investigation.



Grace:  
If you are fit, your heartbeat will not change during exercise.

Rory:  
As you exercise for longer your heart will increase to a maximum and then stay the same.

Maisie:  
My heart beat will double if I exercise for twice as long.

Grace, Maisie and Rory's results table.

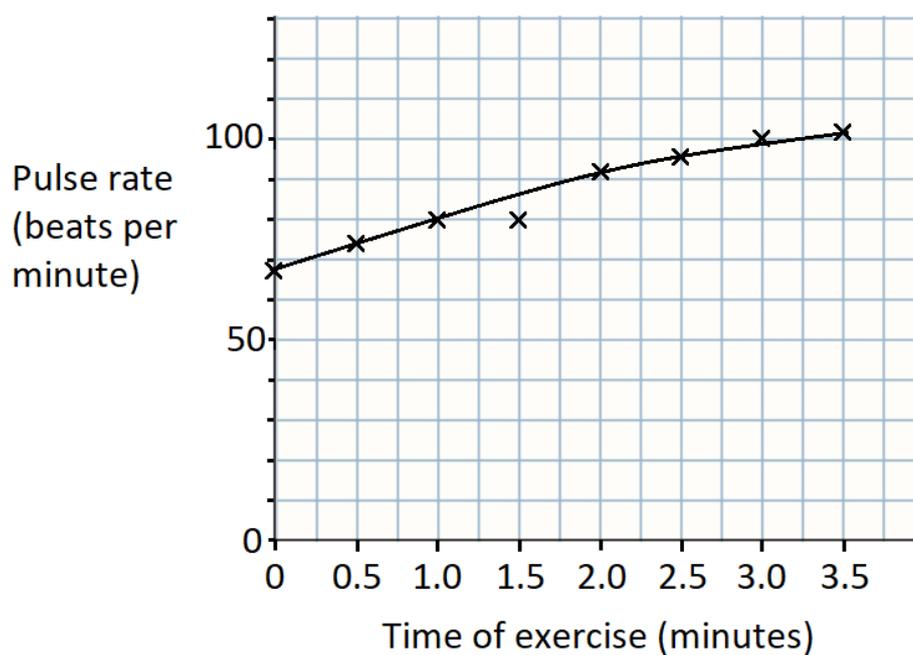
Grace, Maisie and Rory's calculated the mean beat value using:

$$\text{Mean value} = \frac{\text{Heart beat Try 1} + \text{Heartbeat Try 2}}{\text{Number of repeats}}$$

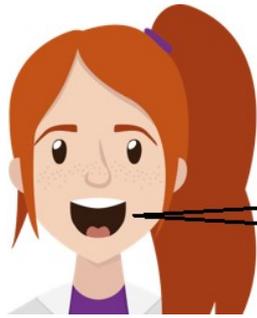
Time of exercise (minutes)	Beats in 15 seconds			Pulse rate (beats per minute)
	Try 1	Try 2	Mean	
0 (at rest)	17	17	17	68
0.5	18	19	18.5	74
1.0	20	20	20	80
1.5	19	21	20	80
2.0	24	22	23	92
2.5	24	24	24	96
3.0	25	25	25	100
3.5	26	25	25.5	102

Graph of Grace, Maisie and Rory's results.

## Investigating the effect of exercise



2a) Look at Grace's prediction.



Grace:  
If you are fit, your  
heartbeat will not  
change during  
exercise.

Do the results support Grace's prediction?

.....

because .....

.....

.....



1 mark

2b) Look at Maisie and Rory's predictions and their results.

Whose prediction is better?

 .....

because .....

.....

.....



1 mark

3a) Use the graph and table of results to identify any anomalous results.

 .....

.....



1 mark

3b) Describe **TWO** possible reasons for the anomalous results.

-  1. ....  
.....
2. ....  
.....

2 marks

3c) How could Grace, Maisie and Rory avoid getting any anomalous results?

-  1. ....  
.....
2. ....  
.....

2 marks

4) How valid is Grace, Maisie and Rory's investigation?

Evaluate their whole investigation process by drawing on your earlier answers.

-  .....
- .....
- .....
- .....

2 marks

5a) Write down another question about fitness that Grace, Maisie and Rory could investigate.

 .....

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1 mark

5b) What method could Grace, Maisie and Rory follow to answer their new question?

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2 marks