Teaching Resource :
Top tips for your investigations
1. BETTER MEASUREMENTS
Guidance for Teachers...

ESB SCIENCE BLAST DELIVERED BY THE RDS

"Better Measurements" is one of **four interactive resources** designed to explain some of the simple strategies employed by real scientists whilst investigating. They represent good scientific habits which primary school children are able to learn. Exploring these will enhance critical thinking skills and give a major boost to your ESB Science Blast Investigations. Each resource can be used independently of each other. It's important to select the ones that are likely to be relevant to an investigation that you have in mind, and ideally they would be introduced to your class as an early part of the planning process.

Each resource consists of two parts:

1. **An animated video** that explains through examples. Each video contains points where it can be paused to allow for class discussion and problem solving.
2. **A small group discussion exercise**. Learning is reinforced by challenging students to apply the new strategies in different contexts. Descriptions and questions are summarized on our ready to print discussion cards.

The "Better Measurements" resource introduces **two tips** for making more accurate measurements. We've called these strategies:

"Think BIG to measure small" & "Measure, think, REPEAT !"

The thinking behind these strategies.

1 **"Think Big to Measure Small":** Scientists accept that no measurement can be perfectly accurate but there are certain approaches they can use to minimize any 'errors'. Inaccuracy can be introduced by the limitations of the equipment being used AND/OR by our human abilities to use it. Scientists often to refer to these as "random errors". In your ESB Science Blast investigations students may have to measure distances, weights or times that are small and so we would like them to understand that they can reduce the significance of these kinds of errors by finding clever ways to make the measurement of a small thing...BIGGER. This way the errors make a smaller contribution to your overall measurement. So instead of measuring the mass of a single bean, why not measure 10 and divide by 10. Or better still, measure 100 and divide by 100 (this is example developed in the video). The bigger you make your measurement the less significant any little mistakes become. When you try to measure the time it takes for a pendulum to swing just **once** you risk getting a poor result. Trying to start and stop a timer perfectly at the beginning and the end of **one** single swing is not easy. Start and stopping the clock involves judgement and action and will lead to small mistakes. All of this can be diluted with the strategy of timing 50 swings and dividing down to get the time of one swing. It's a subtle point but is very important in improving the accuracy of scientific measurement. Not every measurement can be treated in this way. Do this when it makes sense to do so.

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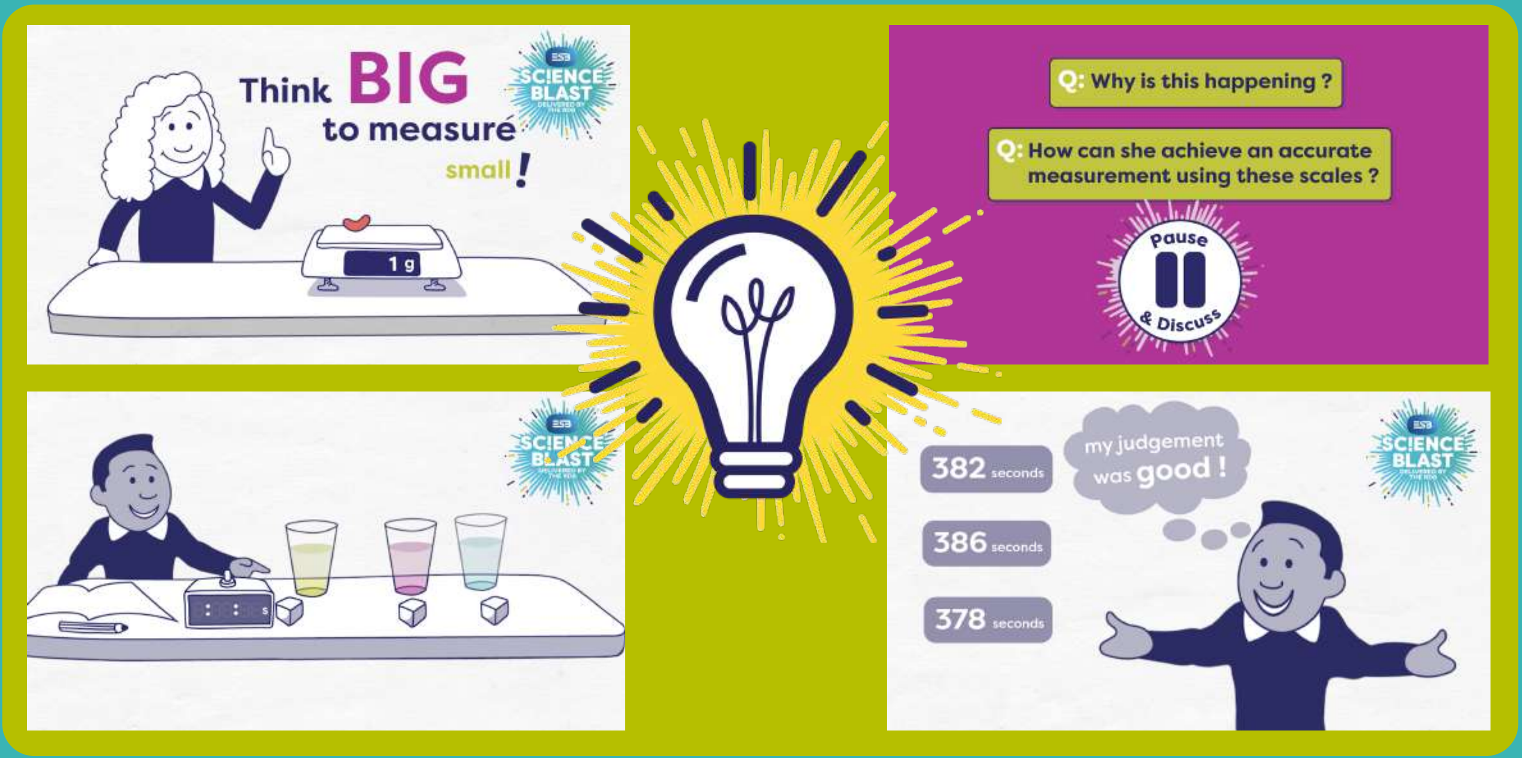
"Measure, think, repeat": Scientists and Engineers are always wary of the quality of their measurements and always look to repeat their experiments if that is possible. They do this for two main reasons. Firstly they accept that inaccuracy in measurements are inevitable. If they repeat many times they can calculate an average measurement which will give a truer result. Repeating also gives them an indication of how accurate they can claim their measurement to be (i.e an indication of the size of their 'random error'). If their results differ widely then then this adds more information to their research. How many times should an experiment be repeated? There are no clear rules about this. The more the better, but scientist also have to be practical and so does your class. General three times is a good minimum but the more uncertain you think the measurement might be the more times it is wise to repeat it. In encouraging your students to repeat their measurements common sense has to be applied; you cannot really do repeats on one off events (like how long the sunset lasted) or ask someone to remeasure the length of their copy book 3 times with their ruler. This strategy should only be applied when the need arises and it makes sense to do so. Hopefully, through this resource your students will be better able to recognise those moments.

Using the Animated Video:

The video is designed to explain the two strategies in an engaging way, using plausible examples.

There **are two pause points** in the 'Better Measurement' video for you to open up discussion and challenge students to come up with their own solutions before the video explains further.

It is important to emphasise that the aim is to engage students and encourage critical thinking. It is not important that they only come up with the "correct" solution. They may actually come up with some other strategies that could also help in this particular situation. Encourage that kind of thinking.



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Using the Learning Reinforcement Cards:

This resource comes with **4 printable cards**. Each card describes an aspect of a possible scientific investigation that would benefit from the use of one of these two strategies. Ideally your class would be divided into small groups and they could discuss each scenario and the questions posed. If time allows their conclusions could be reported as part of a whole class discussion. Again the emphasis is on engagement. There are no definitive answers. Each card is broadly aiming for the following....

Measurement 1: The times measured are going to be quite short. It may not be practical to drop the helicopters from a bigger height but it is easy and practical to improve accuracy by **repeating the measurement** and **calculate an average result**. If the 5 repeated measurements (for each type of helicopter) are very similar then that would give greater **confidence** that the overall result are quite accurate.

Measurement 2: The tiny mistakes made whilst stopping and starting the clock will be much less significant if **the time for 20 full swings** is measured, and then divided by 20. Measuring 30 **or more** swings would increase the accuracy even further.

Measurement 3: A scientist would aim to **repeat** the experiment (for each side of the coin) several times and calculate an average number of drops of water. They will have a whole set of results for each side and they can also use the variation in that information to decide whether there really is any significant difference between them.

Measurement 4: This one could really start some debates about the nitty gritty of how to make this measurement. Some may point out that when someone starts walking the first few strides may be smaller and may need be ignored. We are aiming for a realisation that each stride might vary a little bit from the other so it is best to measure an average stride. They would need to create a set up (there are lots of options) where they **make a measurement of many strides** and then divide this large measurement down to get the length of one typical stride. How many strides they measure will depend on what is practical in the space you have. The more the better!