Creating Science – Exploring Variables, Experimenting, and Rocket Balloons!

In science, we like to know why things happen, and that means exploring carefully.
#CreatingScienceRocketBalloons

Suggested Outcomes

(NOTE: This is by no means an exhaustive list of possible outcomes, neither is it intended that ONLY these outcomes can or should be met. Science is a deeply interrelated activity, and you may find cross curriculum links you can and should use.)

Science understanding

- Physical science 2 (4): A push or a pull affects how an object moves or changes shape.

Science inquiry skills

- In particular, SIS 3, questioning: With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge
- Science inquiry skills: Questioning and predicting, Planning and conducting, Processing and analysing data and information, Evaluating, Communicating.

Science as a human endeavour

- Science is a human endeavour Y5: Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena

Science vocabulary words

Tier 3 (Specialised vocabulary)

- Variable – a quality that can change; such as height or colour. In science, we like to know what effect variables have on each other.

Warning

- Balloons pop unexpectedly, eyewear should be worn, and children need to be warned. Do not overinflate a balloon.
- With sticky tape to be cut and balloons to be inflated, this activity involves mouths. Please make sure you employ all appropriate health and safety measures such as not sharing balloons and cutting sticky tape properly with scissors or a dispenser.
- You will want a balloon inflation plan. While children blowing up balloons is great for core muscle exercise - hand pumps are cleaner, easier and sometimes necessary for little children.
- Some space is needed. Do not attempt this in a crowded area.
- MAKE SURE all students run their ideas for variables and how to test them past a responsible adult first. Many variables are NOT safe to test.

Preparation

- Lots of string (strong enough to be used by your students, but thin enough to thread through a normal straw).
- Straws. Drinking straws are fine but thicker 'thickshake' straws can be easier for some.
- Balloons. Lots of balloons. Many shapes are welcome, bigger is often better but they still need to be inflated.
- Hand pumps for blowing up balloons if students require.
- Something to stick the balloons onto the straws, like sticky tape.

Notes

- This demonstration is set up for students to work in pairs; however, younger students may get more from the experience working as a class.
- Remember as with this and all science activities: try it out yourself first!
- http://www.youtube.com/watch?v=pIBreWmG34M has a great demonstration of how to set up the balloon rocket.

Suggestions for other year levels

As always, more material is presented here than can be used by the average class during the average lesson time. However, since the students' questions can and should guide student learning, more material is presented for your convenience. Remember, it is not uncommon for students to only remember those points which answered their personal questions.

Younger:

This activity is fun for this age group, but they will need assistance. They enjoy thinking very creatively regarding variables to try. Children at this age can have difficulty with focus. Avoid tangents if you're attempting to make a key point.

Middle:

This activity is well suited to this age group. Watch for children becoming a little too creative with variables and getting themselves in trouble.

Teen:

Students at this age should be able to accurately describe the action and reaction forces. Help them to investigate the kind of forces regular passenger jets or space rockets require.

Learning Intent

'We are learning to' (WALT) – Identify variables, and how to test them.

Success criteria

'What I'm looking for' (WILF) – students who can make their rocket complete its journey, and then who are able to define a variable and test its effect.

Student learning goals

Help students make a self-monitored learning goal for this lesson, such as, "What effect does the colour of the balloon have on the distance the rocket will fly."

Evidence of learning

How will you know when the learning goal is achieved? What EVIDENCE do you have that your students have met or exceeded the learning expectations?

- They set up a balloon rocket and it completes its journey
- They are able to describe a variable and its effect.

Engage

- Note the Learning Intention of this lesson for students.
- Make sure all students write down any questions they may have generated during this phase regarding the topic for today.

Set up the activity (from the book Creating Science at #CreatingScienceRocketBalloons) and announce that you are going to try and get the balloon to shoot along the string as far as it can go! Release the balloon with a ***loose*** string, and watch with 'disappointment' as it fails to move very far.

Ask: Can you think of what things it will take to make this balloon go all the way? What will I need to do?

Try out a few activities and see if the group can get the balloon to go.

Explore

Ask: What is an experiment?

Explain: We use the word 'experiment' in science an awful lot, but what does it mean? There are many very good answers, but the idea we like to use is that experiments are used *to create knowledge*. So if we already know what is going to happen, it's not really an experiment, it's an activity or demonstration.

So today we are going to do a ***real experiment***. The question (or aim) is; "How can we get this balloon rocket to travel all the way along this long string?"

What things will help make this balloon travel along the string? Let's brainstorm some ways – and you need to know that, in science, these ways are called 'variables'. Suggestions may include:

- The string has to be tight, but is the tighter the better?
- The kind of string - is nylon better than cotton?
- How long the straw is - is short better (less friction) or long (keeps it straight)
- Does the angle of launch matter?
- Does the colour of the balloon matter?
- Will something to keep the nozzle of the balloon from wobbling around improve performance?

Within each variable is the question 'why'? We answer the question *why* in science with a theory (which means 'explanation'). Every theory leads to more questions, and thus more experiments!

Language help

You may want to scaffold the structure of a scientific variable as such:

"We want to know what the effect of **<variable>** has on **<result>**"

For example:

"We want to know what the effect of **string smoothness** has on **balloon flight length.**"

Upper year levels: dependent, independent, and control variables.

The above language help is an excellent scaffold for more in depth discussions at higher levels, which make use of terms such as independent and dependent variable:

- The independent variable is the one we ourselves change, i.e., balloon colour or amount of air.
- The dependent variable is the result that comes from the chance in the independent variable, in this case, how far and fast the balloon makes it along the string.
- The control variables are all the other factors that we keep the same so that we can isolate the effect of the independent variable. There are often more control variables to be controlled than we can count, including string tension, balloon colour, and launch height.

For example, we would rephrase the above as "We want to know what the effect of string smoothness (independent variable) is on balloon flight length (dependent variable), while being careful to control all other factors such as string tension, balloon colour, and launch height."

Explain

So why does the balloon fly at all?

One explanation for why the balloon moves is that air is pushing all the time, though it may not feel like it! The air inside the balloon is pushing the balloon outwards, keeping its inflated shape. When you open the nozzle the air at one end rushes out, which means the air pushing on the front of the balloon (at the opposite end!) 'wins' and pushes the whole balloon along the string.

- Can students explain WHY each of their variables work? Ask them to generate a theory or three that answers the question of why this variable is important and helpful.

Elaborate

- Ask students if they can design new ways to test their explanations. Is it really sufficient? Can they think of further or better explanations, and the experiments needed to test them?

Remember:

- The string needs to be taut for this activity to work, or the balloon will get stuck.
- The straw needs to be long enough to help the balloon travel in a straight line.
- Stopping the nozzle from wobbling around helps. A narrow nozzle will lower acceleration but can keep up that acceleration for a longer amount of time, sometimes improving results.
- One of the most effective ways to get the balloon going a long distance is to actually put something inside, like a little sand or hole-punched paper bits. While you may think the extra weight slows the balloon down (it does) the extra weight also helps produce extra force on the front of the balloon, moving it further.

Extra challenges

Try out the multistage rocket.

Hold a competition to see whose balloon will go the furthest. What makes for a super effective balloon rocket?

Have a competition of <u>efficiency</u>. See who can develop a system that uses the least amount of air to make the balloon travel along a four meter string. This may result in valuable learning opportunities to discuss fuel efficiency and energy saving in modern society. (The most efficient solution to this problem was given to me by some clever grade 5 students at Westend state school. They didn't put any air in the balloon, and holding their end of the string high in the air allowed gravity to do *all* the work. Using natural means readily available, such as gravity, is a very efficient and often healthier way of doing things.)

Evaluate

- Help students to review what the felt they learnt from this lesson. Did they have any questions at the start that they feel were answered?
- Help students conclude what VARIABLES made their rocket move the best.

Success criteria

- Review the Learning Intentions of this lesson with students. Were they met?

At the end of each class, review the learning objective and see how we did. Ask:

- Did you achieve your learning goal?
- What did You learn?
- What worked to help you achieve it?
- What might you do better next time?
- (If needed) where can you go for extra help or information?

Assessment

Prior Learning:

Take time to focus on planned content material during the engage phase, for example;

- Why do we do experiments?
- How do scientists do experiments?
- What is a variable?

Be sure to watch out for the following common alternative conceptions:

- Rockets go left, by pushing air right. Often students can explain there's an equal and opposite force, and that the air is leaving the balloon, but they have no idea what is pushing the rocket itself. It is the air inside the balloon, pushing in all directions all the time, which is pushing the balloon.

Formative:

This is a fun activity just to watch, but some good science is happening all the time if you move among students, asking for what they're testing, what they think will happen, and why.

Summative:

Help students consider ways they can communicate their new understanding to others, just as scientists need to do. A project where students explain their experiment, including what variable they were testing, is a great idea for this activity. Again, any report or oral presentation need not focus at all on whether the rocket makes it to the end or not: that's more of a technology project. The science is still respectable if the activity didn't work and students can think of reasons *why*, and the kinds of things they will do next time to make it go.

Perhaps the best way to learn is to have students present an oral report where they teach others how to make the best balloon rocket they can.

So what?

When we do a scientific experiment, we need to clarify what variables are involved, and how they affect the results. This takes time, and creativity, and focus.

(Science is not just 'playing with toys' – it is playing with the purpose of finding the effects of variables).

Creating science

Science understanding

As students explored the motion and behaviour of rocket balloons, they experienced that;

- Physical science 2 (4): A push or a pull affects how an object moves or changes shape.

Science inquiry skills

By generating their own questions to explore, students could;

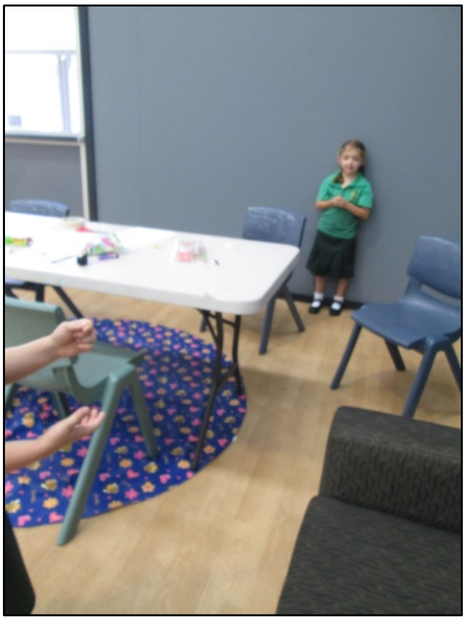
- In particular, SIS 3, questioning: With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge
- Science inquiry skills: Questioning and predicting, Planning and conducting, Processing and analysing data and information, Evaluating, Communicating.

Science as a human endeavour

By generating their own experiments to test their own predictions, students learnt that;

- Science is a human endeavour Y5: Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena

Tips from the Masters



Keep the string tight, and of a decent length. Great fun for scientists of all ages!

Appendix: Challenges

Find out how to make your rocket go the furthest? Can you invent a 2 stage rocket?

Find out how to make your rocket go exactly four meters!

Efficiency test: Can you make your rocket go the furthest with the least amount of air?

Appendix: Variables (primary)

Variable – a quality that can change; such as height or colour. In science we often want to know the effect certain variables have on our results.

For example:

“We want to know the effect **string smoothness** <AKA “variable”>

has on **balloon flight length** <AKA “results”>.”

Can you come up with your own scientific experiment? Fill in the following:

“We want to know the effect ___________________has on __________________”

<variable> <results>

Remember to keep EVERYTHING ELSE THE SAME – change only the variable you want to test. And remember to do your experiment multiple times, and to measure accurately, in order to get the best results!

The following table may be of some assistance.

Variable – condition 1:	Variable – condition 2:	Variable – condition 3:
Results 1:	Results 1:	Results 1:
Results 2:	Results 2:	Results 2:
Results 3:	Results 3:	Results 3:
Results 4:	Results 4:	Results 4:
Average (add results / 4):	Average :	Average :

Can you come up with two more variables to test?

Appendix: Variables (high school)

Variable – a quality that can change; such as height or colour. In science, we like to know what effect variables have on each other.

There are two main kinds of variables. **Independent Variables** are the ones we deliberately change in order to measure their effect on the results. The **Dependent Variables** are the things that change due to the changes in the dependent variable – they *are* the results. All other variables are carefully controlled - kept the same or cancelled out as best we can least they confuse our results.

For example:

"We want to know the effect **string smoothness** <independent variable>
has on balloon **flight length** <dependent variable>,
while controlling for **balloon weight, elasticity, and string tension & length** <control variables>."

Can you come up with your own variable to test? Fill in the following:

"We want to know the effect of ________________________________<independent variable>
has on ____<dependent variable>,
while carefully controlling for ____<control variables>"

Each variable is made up of things that vary, called 'conditions'. For example, the variable of string tension can be 1/ tight or 2/ loose. Remember to keep EVERYTHING ELSE THE SAME. And remember to do your experiment multiple times, and to measure accurately, in order to get the most scientific results! The following table may be of some assistance:

Experiment number	Variable – condition 1 results	Variable – condition 2 results
1		
2		
3		
4		
Average		

Can you come up with two more variables to test?

"We want to know what the effect of _____________________________<independent variable>
has on ____<dependent variable>,
while carefully controlling for ____<control variables>"