Creating Science – Bob the Blob

One of my most favourite science concepts relates to why things float or sink. The explanation that they float because they have air in them is really quite unhelpful. So why do things float or sink?

#CreatingScienceBobTheBlob

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

- Earth and space science 2: Earth's resources, including water, are used in a variety of ways.
- Physical Sciences F: The way objects move depends on a variety of factors, including their size and shape.
- Physical sciences 4: Forces can be exerted by one object on another through direct contact or from a distance.

Science inquiry skills

- Science Inquiry Skills: Question and predict (explaining, communicating).

Science as a human endeavour

- Science as a Human Endeavour 5: Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena

Science vocabulary words

Tier 1 (Everyday words) – water, squeeze, click

Tier 3 (Specialised vocabulary)

- Pressure – the idea that something, such as water, is pushing in all directions all the time. (Water would even turn into a gas if the air wasn't holding it down as a liquid!)
- Prediction – a guess of **what** is going to happen.
- Theory – a 'testable explanation of how the world works'. A theory explains **why** you think a certain prediction will occur.

Warning

- Some water is involved. Be wary of slippery floors, or of splashing electronic devices such as pocketed smartphones.
    - Make sure students CLOSE their lid on their bottle BEFORE squeezing to see if Bob will 'swim' downwards.
- BOB IS AMPHIBIOUS, NOT AQUATIC - he will 'drown' if you leave him in there too long because the water will soak into the balloon. Take out when not in use and keep him dry.

Preparation

- A balloon. We find the long, modelling balloons such as what clowns use are the best for strength, durability, and lower permeability. Normal balloons require too much ballast.
- A large block of Blu Tack or plasticine.
- A small, clear, clean plastic bottle with a water tight lid.
- Clear cups and a water trough for testing Blobs.

And for the lesson;

- You need a large container, clear, strong and big enough for students to push a balloon into even though the container is already almost full of water.
- Other items for sinking and floating. You can have students attempt to find some of their own.

    - Two objects that weigh the same but are different sizes (such two identical cushions, but one of them can be scrunched up tightly with a piece of string, the other one is not scrunched, but has the same amount of string sitting neatly on top of it).

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 well suited to this age group, but they will need help calibrating Bob, and frequent reminders to keep him out when not in use.

Children at this age can have difficulty with focus. Avoid tangents if you're attempting to make a key point.

Middle:

Challenge students to calibrate Bob on their own as part of the learning process. The patience and precision of Calibrating are important and highly employable skills.

Teen:

At this age they can focus on gaining a deeper understanding of floating and sinking, especially with regards to Archimedes principals and the mathematics involved. Challenge them to calculate the volume of their own body (or hand). Do they think Archimedes had the technology to implement his test properly?

Learning Intent (student friendly)

'We are learning to' (WALT) – test our ideas, and to appreciate buoyancy.

What I already know

Find out what students already understand about the topic by:

- Asking them - why do things float? Why do some things sink?

Success criteria

'What I'm looking for' (WILF) – students who can successfully build and calibrate a Bob the Blob, and give explaining the science of buoyancy a genuine go. Can they demonstrate how to *feel* water pressure? Can they demonstrate that water pressure increases the deeper one goes? Can they use these ideas to explain that water is always trying to push things up and makes them lighter?

Student learning goals

Help students make a self-monitored learning goal for this lesson, such as 'find out why things float'.

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?

Engage

- ⇨ Make sure all students write down any questions they may have generated during this phase regarding the topic for today.

If possible, bring along two objects that weigh the same but are different sizes (such as a bottle of sand, and a bag of rice. Or even better, two exact pillows but one of them can be scrunched up tightly with a piece of string, the other one is not scrunched, but has the same amount of string tied neatly around it.)

- ⇨ Challenge students to determine which object is heaviest.

Then reveal to the students that be objects are (almost) the same weight. Ask them: what, then, is the difference between the two objects?

Students will be able to tell that while they weigh the same, one is more pressed up or squished together. This idea is called **density.**

Density is how 'squished up' an object is (to be technical, it is its weight divided by its volume). Black holes are the densest things there is, while the air isn't very dense. Dense does not mean heavy: A very small amount of a very dense object might still weigh less than a feather! Look online for a list of relative densities, it may surprise you what objects are more "squished together" than others!

Explore

- ⇨ Ask: What makes things float or sink.
  - Introduce several objects, and have students predict whether they will float or sink.
  - Have students discuss the results, and provide *explanations.*
- ⇨ Encourage and validate student explanations of this phenomenon. You may like to ask students to write or draw their explanation personally to avoid embarrassment to students unfamiliar with this material. Remember, 'I don't know' is a valid explanation in science – it is the beginning of learning new things!

Explain

Explain that the simple answer to why things float or sink is, quite simply, because they are **more *dense* than water** (See the activity #CreatingScienceDensityCylinders).

- ⇨ Test this claim with a few simple objects (for example, hot water is less dense than cold water, and salty water is more dense than pure water)

Ask: How can you make an object less dense? [Spread it out more.]

- ⇨ Demonstrate this using the block of plasticine. When it is dense (scrunched up into a ball), it will sink. However, if you change the shape of the glob into a bowl so that it still weighs the

same, but now has a much bigger area, it will float (provided no water gets in and makes your plasticine boat heavier!)

- ⇨ Most things, as they get cooler, shrink in size. But water has a special trick that it does from about 4 degrees (Celsius) – it actually gets more spaced out as the water molecules line up in organised patterns around each other! This means that ice is actually less dense than water, meaning it floats, which is just as well or the bottom of every ocean might be frozen!

What else will float or sink?

- Hot water floats on colder water. That is why when you wade knee deep into water, it may feel cool on your feet but warmer at your knees.
- Salty water sinks in fresh water. That is why a certain section of the Atlantic Ocean is not salty! Because the Amazon River flows out and right on top of it.
- Submarines use air chambers to rise and lower themselves in the water. Try sinking a bottle in a tub, and making it rise to the surface again by blowing air into it with a long hose. This is similar to how real submarines rise! (Except they usually carry their air compressed as a liquid rather than having long hoses reach up to the surface air.)

Elaborate

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

Build a Bob the Blob, see #CreatingScienceBobTheBlob, and perform the activity:

- Tell the students you're going to try and trick them, and that they need to figure out your trick.
- Introduce Bob and tell them there is something special about him – he is alive! (Make a funny face in younger year levels so they can tell you are joking).
- They will probably challenge you, so allow this as long as they can explain what is really happening (theory generation) and test their ideas by seeking evidence (experimentation, in a broad form).
- Tell Bob to move down, then surreptitiously squeeze the bottle. This will increase Bob's density (because his head is full of air), and make him denser than the surrounding water. Thus, he will appear to sink on your command.
- Have students attempt to disprove your explanation[1] with some of their own and, as best as possible, test their suggestions. When they prevail, congratulate them and ask,

[1] In the philosophy of science, extreme falsification is the acknowledgement that no point at which a theory is free from dispute. Maybe Bob IS alive, but deaf and blind, so responds to the squeeze as his cue to swim downwards. At some point there's no way to test these extreme ideas, and we have to make a moral and intellectual judgement regarding which theory is best. We usually look for theories that are logically **coherent**,

⇨ So why do you think squeezing the bottle make Bob go down? [See last page for an explanation that focuses on water pressure instead of density, giving a more detailed description of what is happening physically.]

Why do things float?

1. Water is pushing things up.

- Try holding a balloon under water. Can you feel the water trying to push the balloon back up?
- Try holding a **larger** balloon under water - can you feel the water pushing even harder to push the balloon back up?
- The larger things are, the more the water tries to push them back up.

But *why* does water push things up?

- This is where things get a little more technical.
- Water has pressure. Water particles are always moving, pushing in every direction all the time.
- The further down you go the more pressure the water has. This is because there is more water pressing down on it from above.
- This means any liquid or gas (in a gravity field), will push things up against the direction of gravity.

2. But gravity is pulling things down.

- You, me, water, Bob; it's all getting pulled towards the centre of the earth.
- But the water is pushing Bob up. So what's the deciding factor?
- When you squeeze the bottle, the air bubble in Bob's head shrinks. This makes him **smaller**. This makes the push up of the water less, and the water pressure is no longer enough to lift Bob up.
- When you let go of the bottle, the air bubble grows back up to normal size. This increases the push up of the water on Bob, and up he goes!

Pressure in a touch more detail

Try filling a bottle with water and one with air. Which one squashes the most when it is squeezed? This is because water does not compress much at all when squashed (a fact that started the science of Hydraulics). Water transfers pressure very well. Air is very squashy, has a lot of give in it, and absorbs pressure very well. Did you know that squashing air (and other liquids) heats them up, and un-squashing them cools them down (a fact that is the basis of the science of refrigeration)?

Will the bottle diver work with the lid off? Why / why not? (It's because of the pressure: instead of being transferred to the air bubble, the pressure pushes the water out of the bottle and all over the floor!)

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connected with other accepted theories, **simple**, are supported by **experiment**, and are accepted by the scientific community via **consensus**. See my upcoming book on the philosophy of science 'The book you should probably ignore'.

Do things float because they have air in them?

From the testing you should be able to help students *conclude* that air doesn't make things float, but since air isn't very dense it is useful for making other things less dense, thus they will float! There are loads of substances without *any air at all* that float: oil, alcohol, margarine, etc., etc!

Remember: AIR IS NOT THE REASON THINGS FLOAT!

Can we float right up to space?

From what we've learned, you might hopefully realise that:

- Things float because the thing that they're in is PUSHING THEM UP.

So once they leave that thing, there's no more push.

Remember: Helium balloons CANNOT float into space. They only float to the top of the atmosphere that is more dense than the balloon and the gasses inside it are.

Can air float on air?

Yup. A bubble of normal air will float on a cushion of carbon dioxide made by mixing a cup of vinegar and 1/3 cup of bicarb in a small glass fish tank. It takes quite a bit of skill to do it however!

Try not to breath in the carbon dioxide, it's the gas that tells our lungs to take a breath, so it's very tickly and just a little chokey – but at least you can know very clearly that it's there!

A dimly visible bubble of normal air floating on a tank ½ full of carbon dioxide, Made by mixing a cup of 2 cups of vinegar with 2/3 cup bicarb – or thereabouts.

Evaluate

- ⇨ Review with students what the felt they learnt from this lesson. Did they have any questions at the start that they feel were answered?

Success criteria

- ⇨ Review the Learning Intentions of this lesson with students. Was it 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 things float?
- What is water pressure?

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

- 'Air' isn't the reason things float – density is.
- Bob does not move because he's alive, he moves because we're squeezing the bottle.

Summative:

Help students consider ways they can communicate their new understanding to others, just as scientists need to do.

Can they make an oral or PowerPoint presentation of Bob the Blob?

Can they apply this understanding to a new environment, such as explaining why boats float?

So what?

Learning to see beyond the 'magic of science' can help you understand how the world really works, and makes it much harder to trick you in the future.

Creating science

Science understanding

The point of today's lesson was

- The reason things float or sink has to do with density (or in other words, weight and volume).
    - In even the prep year it can be seen and felt that a balloon's size will affect how strongly the water pushes it back out. Bigger balloons, more push!
- Advanced content outcome: the pressure gradient between the top and bottom of the tank (or indeed, the atmosphere) is what pushes objects upwards. The larger they are, the more the pressure gradient can lift them!

Science inquiry skills

- Test predictions regarding floating and sinking, and use that knowledge to develop a theory as to why Bob the Blob will float and sink.

Science as a human endeavour

- Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena
- To demonstrate that some explanations (i.e., things float because of the air in them) is insufficient and leads to inaccurate claims.

So what's heavier, a tonne of bricks, or a tonne of feathers?