Primary Science & Technology *Bulletin*

Ideas and inspiration for teachers in Primary Schools and S1/S2

> SSERC support for Primary Science & Technology

> Evidence Based Education

> Snappy dragons - a beginner's guide to pneumatics and hydraulics

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SSERC support for Primary Science

As the new term starts we thought it might be a good time to remind everyone of the opportunities and services provided by SSERC. As a service shared by all Local Authorities in Scotland SSERC provides support for teachers and technicians in a variety of areas including the SSERC website, SSERC publications, Career Long Professional Learning (CLPL) opportunities and health and safety advice.

The primary section of the SSERC website www.sserc.org.uk is currently under development, with updated information on health and safety for primary science and technology activities due to become available in the next few weeks. More changes to the SSERC website are planned with additional resources becoming accessible soon. Some materials are available without logging in to the website but to access the full range of resources you will need to use your login details. If you don't currently have a valid user name and password then please contact us at STS@sserc.org.uk.

SSERC publications, including bulletins, are distributed to schools via each Local Authority and are also available on-line - with the most recent bulletins only available by logging in to the SSERC website using your username and password.

> "I found the whole course extremely useful. I loved trying out all the workshops and am looking forward to trying these out in my classroom, and sharing them with staff."

CLPL provision continues to be an important part of our work and we are pleased to offer exciting professional development opportunities for teachers in 2016/17. We have variety of courses on offer this session aimed at supporting primary teachers in the delivery of Science, Technology and STEM subjects. Courses take the form of single day events, residential courses and twilight CLPL sessions, the latter in the form of SSERC_Meets. SSERC_Meets enable SSERC to deliver high quality, interactive science and technology

> "Great fun getting to design and make a model just like the children do."

CLPL directly to teachers in school using our innovative "cookalong" format. Once registered on the course resource boxes are sent out to schools and staff join us as we guide participants through a series of activites in real time, offering help and support to those taking part.

& Technology 2016/17

Our residential courses - Supporting STEM and Primary Summer School are funded through an ENTHUSE award (administered through the National Stem Learning Centre) this means that the course costs, including resources, accommodation and meals, are received by the school on completion of the course. The "beginner's guide to pneumatics and hydraulics" article in this bulletin has been adapted from a workshop at the 2-part, 4-day Supporting STEM course, for more details access the link [1].

Comments from delegates on last year's course can be found throughout this article.

More information and booking forms for our courses can be found on the SSERC website or you can fill out an application form on one of our flyers.

SSERC also provides health and safety advice to teachers and technicians so if you have queries about any aspect of science and technology in school please check out the website, phone us on 01383 626070 or get in touch via STS@sserc.org.uk.

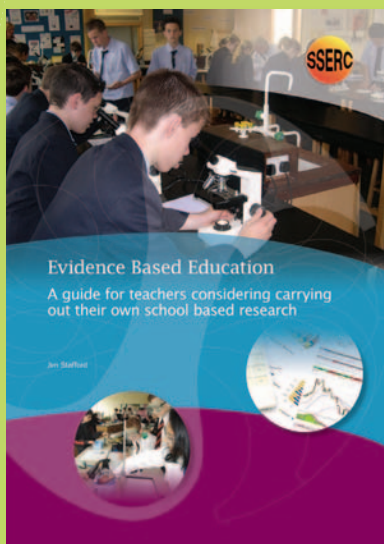
> "Thank you again, I have really enjoyed my time at SSERC, and am going away motivated and enthusiastic about the next part of my STEM journey."

Reference

[1] http://www.sserc.org.uk/index.php/primary-cpd47-2/3884-supporting-stem (accessed on 4th August 2016).

Evidence Based Education

Decision making in education should be based on sound research evidence and should be the concern of every teacher. This new publication written by Jim Stafford describes the main methods for collecting evidence on which to base decisions.



Learning how research works is important so that teachers become research literate, enabling them both to carry out their own research into what is effective and to be critical consumers of the research findings of others. Educational initiatives that are not supported by evidence should be challenged and the research that is required to demonstrate their effectiveness should be identified.

This document provides advice on designing your own research and analysing results. The challenges of getting evidence based practice accepted to become part of everyday practice in education are considered.

In his foreword to Evidence Based Education, Ken Muir (Chief Executive of The General Teaching Council for Scotland) makes the following observation:

Evidence Based Education ...reminds us that all education research should have a purpose and provide evidence for teachers taking decisions that will lead to improvement in practice and/or outcomes for learners.

Snappy dragons - a beginner's

- **A pneumatic system – a system where a gas in a confined space is used to do work.**
- **A hydraulic system – a system where a liquid in a confined space is used to do work.**

To investigate a pneumatic system take 2 syringes of the same size (in this case 20 ml). Make sure that the plunger is fully depressed in one syringe and that the other is open to its maximum marked level, and attach to the ends of a length of plastic tubing (see Figure 1a). Now press the plunger in half way down in the first syringe. What do you notice? How far has the other syringe "opened?" (Figure 1b). Did you observe any delay in this happening?

Figure 2a *- Keep the end of the tubing under the water while filling the system.*

Figure 2b *- Expel the air from the syringe before re-attaching.*

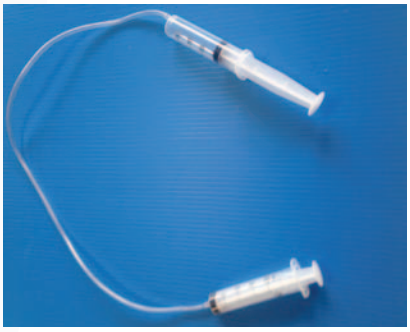


Figure 1a *- One syringe filled with air.*

Repeat, but make a hydraulic system i.e. this time fill the system with water in the following way. Attach a 'closed' syringe (i.e. with plunger fully depressed) to one end of the plastic tubing. Put the other end of the tubing in water (see Figure 2a) and draw up water until the syringe is full to beyond the 20 ml mark. Keeping the tubing under the water, attach the nozzle of the second syringe ('closed') to the other end of the tubing. With the whole system still under the water, remove the first syringe and expel any air that may have entered the system (see Figure 2b). To do this, angle the whole syringe until the air bubble is directly below the syringe nozzle then gently depress the plunger to push out the air. Ensure that the volume of water in the syringe is now 20 ml before re-attaching to the tubing (under the water).

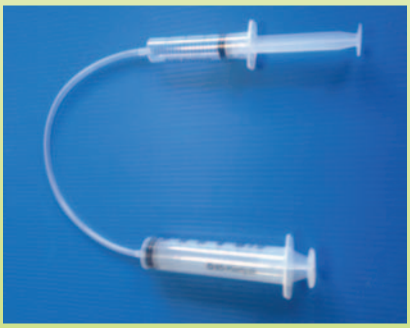


Figure 3a *- Syringes of different sizes, one containing air.*

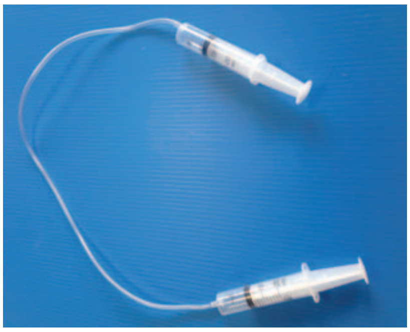


Figure 1b *- Air in both syringes.*

Is there any difference when compared to the pneumatic system?

Careful observation might lead you to notice 2 differences: (i) in the pneumatic system there is a slight time delay as the air in the syringe is compressed before it is squeezed through the system and (ii) the hydraulic system may feel smoother.

What happens when the syringes are not the same size? We'll do these investigations using the pneumatic system (less potential for mess!). See Figures 3a and 3b.

In this case note that the *distance* the plunger in the large syringe moves out is significantly less than the *distance* the small one moves in. The constant volume of air in the system with two syringes of different diameters allows us to reduce or multiply the distance

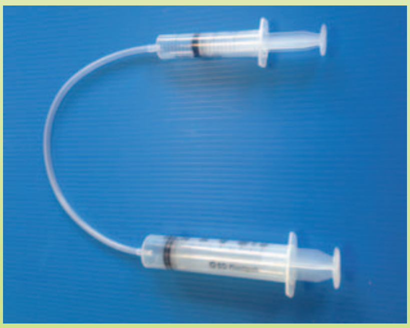


Figure 3b *- Air in both syringes.*

Figure 4 - Equipment to make a snappy dragon.

the plunger moves. In the real world this will multiply or reduce the force exerted. This ability to change the force exerted is what makes pneumatic and hydraulic systems so useful. Pneumatics and hydraulics are mechanical systems that enable a force to be multiplied or reduced using compressed gases and liquids.

We can use this knowledge to make moving models in the classroom...

Snappy dragon

The easiest of these models to make is a snappy dragon which uses air in a balloon and plastic bottle to provide the pneumatic system.

You will need a cardboard egg box (see Note 1), a large plastic bottle, 2 balloons, a length of plastic tubing, 2 small elastic bands and string. For decoration of the finished model we also use polystyrene balls for eyes and paper/card for teeth (Figure 4).

Note 1 *- From a health and safety point of view it is acceptable to use empty egg boxes for this activity. You must ensure however, that the egg boxes are clean. Discard any that have evidence of broken eggs, feathers or faeces.*

Egg boxes which hinge at the short side work best for this model. However, if you don't have this type of box see Note 2.

Cut the neck off one of the balloons (Figure 5) and use one of the elastic bands to secure the neck to the end of the tubing (Figure 6). Secure the other end of the balloon over the neck of the bottle (Figure 7). You may wish to use sticky tape or an extra elastic band to secure the balloon.

Carefully, pierce a hole in the top of the egg box near the hinge and feed the loose end of the tube through this, from outside to inside the box (Figure 8). Use the remaining elastic band to attach

Figure 5 - Cut the neck from a balloon.

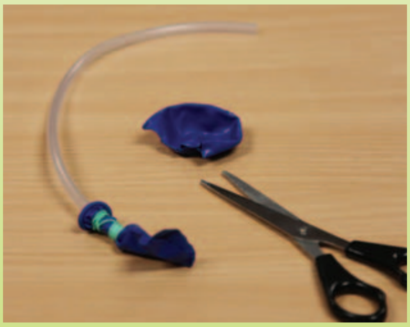


Figure 6 - Attach to the end of the tubing.

Figure 7 - Stretch over the end of the bottle.

Figure 8 *- Pierce hole and feed tube through from outside box.*

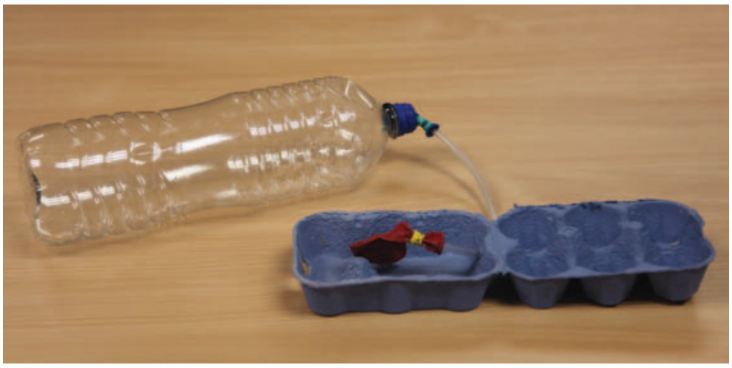


Figure 9 *- Attach other balloon to end of tube (which is inside box).*

the other balloon to the end of the tube, inside the box (Figure 9). It's a good idea to inflate this balloon a couple of time prior to use. Press on the bottle to make sure that the balloon inflates (Figure 10).

Pierce 2 holes on each side of the dragon's "head" (one in the lower half of the egg carton and one in the upper half of the egg carton) as shown in figures 11 and 12.

In this case we used a pencil to make the holes. Tie loops of string through these holes (Figure 13) to prevent the dragon's jaws from opening too far (Figure 14).

Your dragon is now complete and can be decorated (Figure 15).

Note 2 *- Egg boxes with side hinges can easily be "converted" to rear hinged for this activity. Separate the two halves of the box and create a hinge by using the technique shown in Figures 11 to 13. See Figure 16.*

Video instructions for 2 other, more complex, models (see Figures 17 and 18) that use syringes can be viewed via our website by following the link [1].

Pneumatic systems are used almost everywhere in the modern world.

- Dentists use pneumatics to operate drills and reposition their chairs.
- Carpenters use pneumatics to power air hammers.
- Trucks and buses use pneumatic brakes.
- NASA use pneumatics to control the operation of satellite launch vehicles.

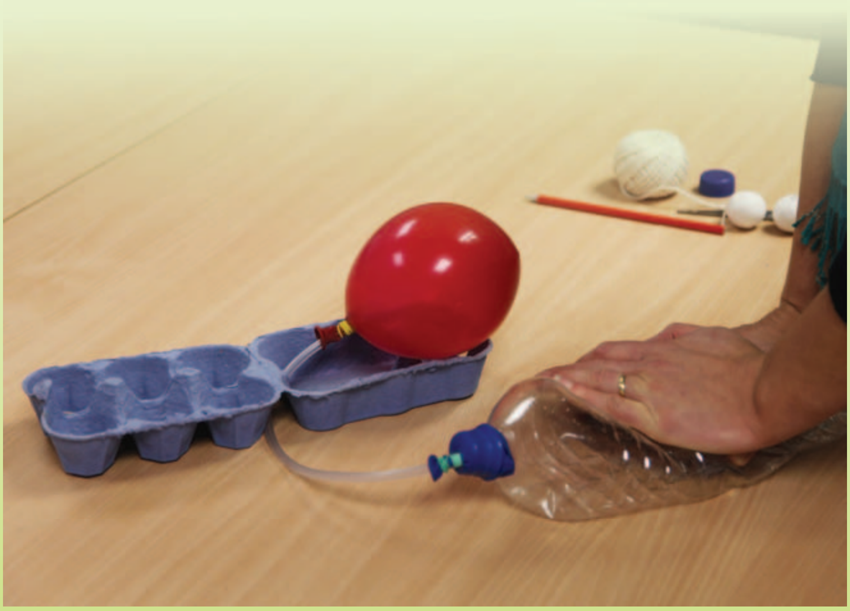


Figure 10 *- Test that the balloon inflates by squeezing the bottle.*

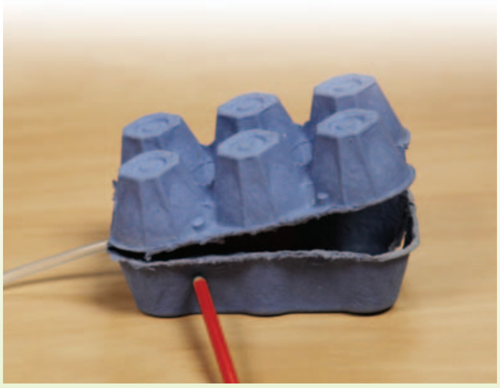


Figure 11 *- Pierce a hole in each side of the box near the hinge.*

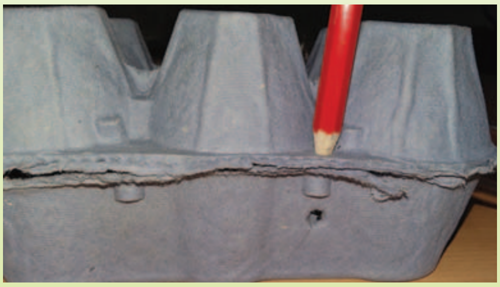


Figure 12 *- Pierce 2 holes in the top of the box in line with the ones just made in the side.*

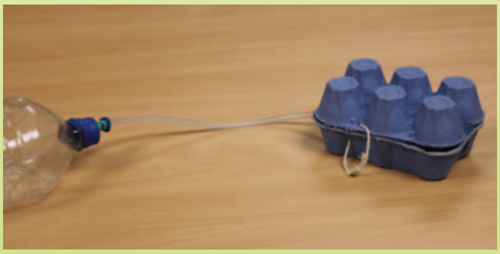


Figure 13 *- Put string through these holes to stop the jaws opening too far.*

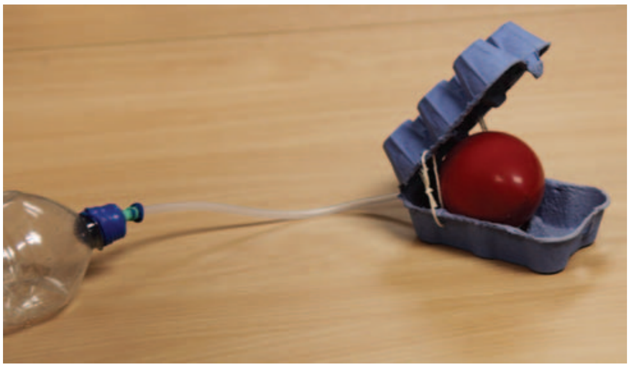


Figure 14 *- Hinged jaws won't open too far.*

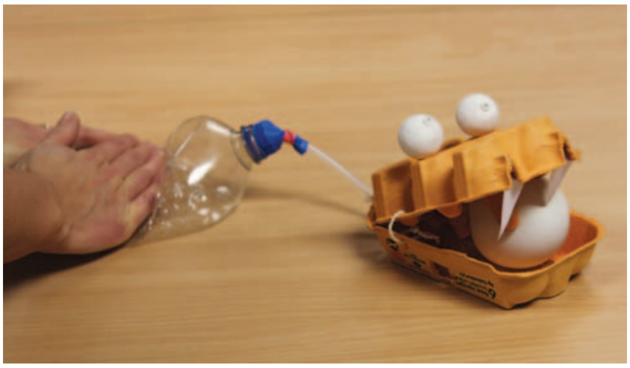


Figure 15 *- Decorated snappy dragon.*

Figure 16 *- Side hinged egg box converted to an end hinged box.*

- Other applications include jackhammers, the cylinder delivery systems used by some banks and various launchers and guns designed to propel objects.

Pneumatics is not an "old fashioned" technology. There are several high-tech applications of pneumatics that have a place in our technological future:

- pneumatic artificial muscles [2] (PAMs) are inflatable rubber tubes surrounded by a wire mesh. When inflated they contract and then elongate when deflated (see Figure 19). They are currently being used to power robotic arms and legs.
- a French automobile has been developed that runs on compressed air (Figure 20). Electricity is used overnight to compress air into an onboard cylinder and the car runs all day with no fuel and no polluting emissions.

Experiences and Outcomes

Within real and imaginary settings, I am developing my practical skills as I select and work with a range of materials, tools and software - *TCH 0-12a*.

I explore materials, tools and software to discover what they can do and how I can use them to help solve problems and construct 3D objects which may have moving parts - *TCH 1-12a*.

By applying my knowledge and skills of science and mathematics, I can engineer 3D objects which demonstrate strengthening, energy transfer and movement - *TCH 2-12a*.

By exploring current news items of technological interest, I have raised questions on the issues and can share my thoughts - *TCH 1-01c*.

I can investigate how an everyday product has changed over time to gain an awareness of the link between scientific and technological developments - *TCH 2-01b*.

Through discovery and imagination, I can develop and use problem-solving strategies to construct models - *TCH 1-14a/ TCH 2-14a*.

Having evaluated my work, I can adapt and improve, where appropriate, through trial and error or by using feedback - *TCH 1-14b / TCH 2-14b*.

Figure 17 *- Burger bun monster.*

Figure 18 *- Pop-up.*

Figure 19 - View an animation of a pneumatic artificial muscle [3].

Figure 20 - This car runs on compressed air [4].

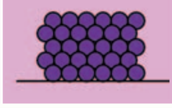
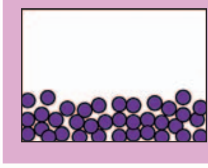
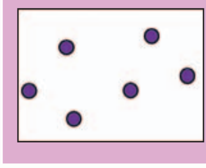
	Solid	Liquid	Gas
Volume	Fixed	Fixed	Takes volume of container
Shape	Fixed	Takes shape of container	Takes shape of container
Flow	N/A	Flows easily from one container to another	Flows easily from one container to another
Compressibility	Can't easily be compressed	Can't easily be compressed	Can be compressed
Particles	Tightly packed together 	Space between particles so they can move around each other 	A lot of space between particles so they can move freely 

Table 1 - The properties of solids, liquids and gases.

STEM links

"Engineering by its very nature is interdisciplinary, using skills and knowledge from different disciplines to solve problems" [5]. As STEM becomes a greater focus in the classroom there is a need to find explicit connections with the Experiences and Outcomes in science, technology and/or maths which can be further developed to provide learners with opportunities to undertake engineering challenges.

A good starting point for hydraulics and pneumatics is looking at the properties exhibited by different states of matter in science.

Typically learners would explore the properties of solids, liquids and gases in order to arrive at a table that may look like Table 1.

Through exploring properties and sources of materials, I can choose appropriate materials to solve practical challenges - *SCN 1-15a.*

The important facts, in this context, are that gases and liquids flow and that gases can be compressed.

We obtained our syringes from Scientific and Chemical [6] and our 3 mm plastic tubing from Mindsets [7]. Ensure that the tubing you purchase is a snug fit on the ends of the syringes used.

References

[1] http://www.sserc.org.uk/index.php/primary-publications/primary-bulletins/4076-pb-75-videos (accessed on 4th August 2016).

[2] http://softroboticstoolkit.com/book/pneumatic-artificial-muscles (accessed on 4th August 2016).

[3] https://en.wikipedia.org/wiki/Pneumatic_artificial_muscles (accessed on 4th August 2016).

[4] http://renewablekinabalu.blogspot.co.uk/2012/10/a-car-powered-by-compressed-air.html (accessed on 4th August 2016).

[5] http://www.educationscotland.gov.uk/stemcentral/about/interdisciplinary/index.asp (accessed on 4th August 2016).

[6] http://primary.scichem.com/Catalogue/Search search for plastic syringes - 5 ml, 10 ml, 20 ml and 50 ml are available (accessed on 4th August 2016).

[7] http://www.mindsetsonline.co.uk/Catalogue/CatalogueSearch search for 3 mm PVC tubing (accessed on 4th August 2016).

The SSERC Bulletin is published by SSERC • 2 Pitreavie Court • South Pitreavie Business Park • Dunfermline KY11 8UU
Managing Editor Fred Young • **Telephone** 01383 626 070 • **Fax** 01383 842 793 • **E-mail** sts@sserc.org.uk • **Website** www.sserc.org.uk