Moyston Primary School Evaluation of Fire and Brimstone workshop. Years 4-6

Date: 23 May 2022
Venue: Moyston Primary School
FLEET members: Jason Major, Ivan Herrera

Overview

This report is an evaluation of a workshop run for approximately 20 years 4-6 students from Moyston Primary School.

Objectives

- To create awareness and understanding about the process of science
- To have participants understand the basics of electricity, conductors, insulators and the structure of the atom
- To think critically about how we (society) use electrical energy
- An understanding of the features and functions of circuits

The workshop was divided into two 45-minute sessions: the first explored the structure of the atom; the second session got students to apply their understanding of the atom and its role in electricity to build circuits. Students drew their perception of an atom at the beginning of the first session then again at the end of that session. The drawings formed the core part of the pre- and post-evaluation of the workshop.

Key findings

- A definitive shift in student understanding/learning about atoms
- Greater student understanding about the features and functions of circuits
- Student enjoyment and engagement with the activities and FLEET presenters:

  "…doing work with Jason and Ivan has inspired me through electricity. Thank you."

  "I absolutely loved doing the graphite circuit and LED activity."

Method

Session 1

The session started with the home science activity, Electrified steel wool. This was demonstrated by a FLEET member. Students were first asked whether wood can burn. A FLEET member placed a 9V battery onto a wooden ruler (and nothing happened). Students were then asked if steel could burn. A FLEET member then placed a 9V battery onto steel wool (and it caught fire). A discussion happened with students to try determine what was happening. A FLEET member explained that what had happened was that we created a circuit and electricity was conducted through the steel. It was explained that steel is a good conductor of electricity and wood is not. The question of why the steel wool caught fire was left until the end of the session.

Students were asked to think about how electricity has changed the world and how they would feel if we did not have electricity. The students were asked to draw their perception of an atom. Following a more in-depth examination of the structure of the atom, students constructed a model atom based on their selection of an element from the periodic table. They constructed that atom from lollies based on the Build an atom activity from the FLEET schools resource. They then drew another model of the atom based on their new understanding. The two drawings of the atom formed the core part of the pre- and post-evaluation of the workshop. This session included and introduction to FLEET research and its objective to develop low energy electronics.

Session 2

Students revisited the structure of the atom and specifically the role of electron in generating electrical current. Following a brief overview of the structure of a circuit and concepts such as the flow of charge and resistance (where the example of the burning steel wool was discussed again) students constructed graphite circuits using a 9V battery, pencils and LEDs. The activity is based on the graphite circuit activity from the FLEET Schools resource and found here (Activity 10).

Students competed against each other to see who could make the longest circuit and still have their LED light up. Students were asked to observe what happened to the brightness of the LED the further they moved it from the battery. They were asked to consider what was happening with the electrons in the circuits. The discussion about resistance was connected back to FLEET's research into developing materials that conducted electricity without resistance.

Results

FLEET conducted a pre-and post-evaluation exercise to gauge students understanding of the atom at the beginning and end of the workshop. Students used pencils and crayons to draw and describe what they thought an atom was. The pre- and post-drawings and descriptions were compared to help understand the impact of the workshop relative to the objectives. Time constraints meant we could not do the same pre- and post-evaluation activity for circuits. This section first examines the outcomes of the pre- and post-evaluation activities, followed by the outcomes of the model atom building, what students learned about atoms, other student comments about the workshop and observations from the circuit building activity.

Pre-evaluation: Drawing of atom

Student drawings resembled random dots, lines and scribbles to make up a nondescript blob and, with the exception of one drawing, no distinct nucleus or electrons. The few descriptions associated with some of the drawings talked about atoms being really tiny and too small to see, though two students noted that human and living things are made up from them. See Figures 1-4.

Blobby and dotty atoms

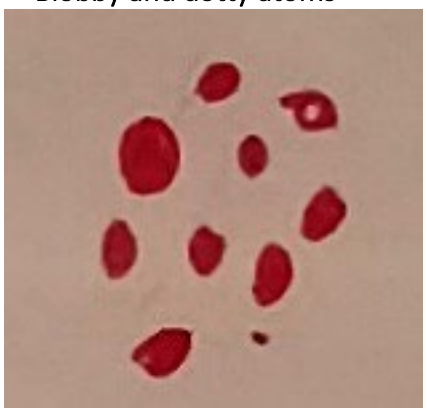

Figure 1 Moyston Primary students pre-evaluation drawing of an atom

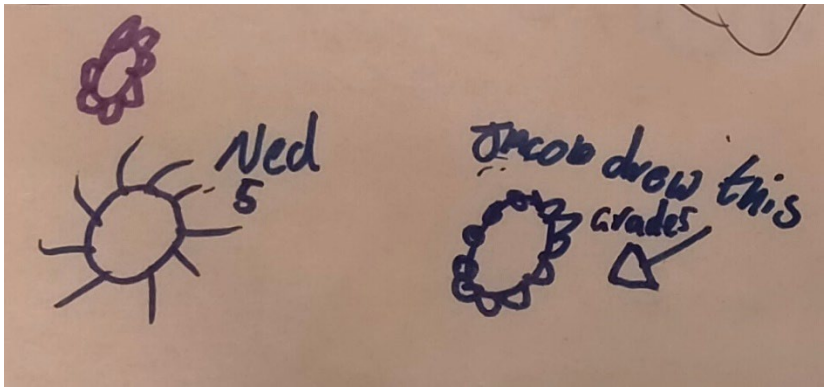

Figure 2. Figure 1 Moyston Primary students pre-evaluation drawing of an atom

Some students wrote descriptions next to their drawing, for example, [Atoms are] a small electrolyte that makes up all living objects. See Figure 3

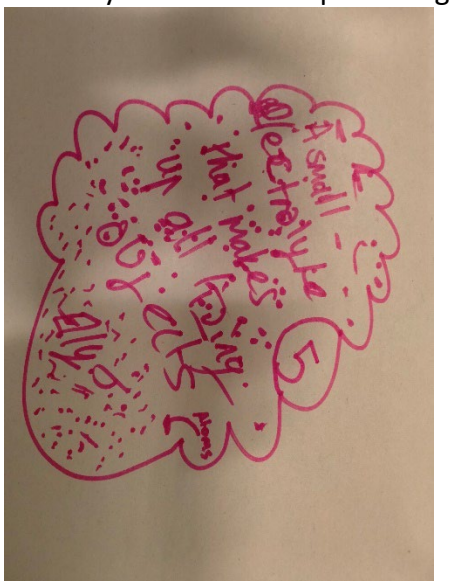

Figure 3. Figure 1 Moyston Primary students pre-evaluation drawing of an atom

A couple of drawings had a potential nucleus such as the drawing below, but the predominant understanding is they are tiny particles that are too small to see. See Figure 4

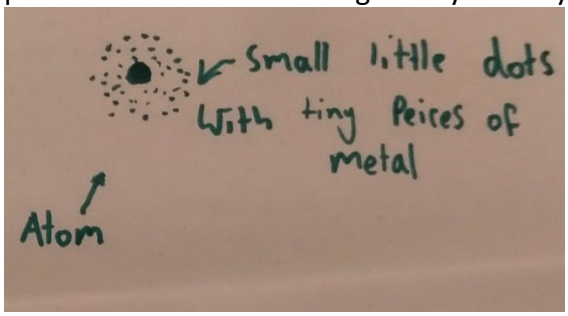

Figure 4. Figure 1 Moyston Primary students pre-evaluation drawing of an atom

Hint of electrons

Only one drawing in the pre-evaluation came close to the nuclear model. This was by a Year 6 student whose drawing indicated they understood that atoms had a nucleus and electrons positioned around it. See Figure 5.

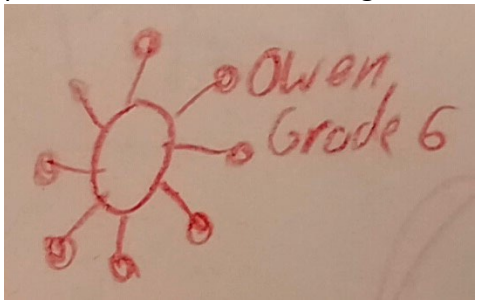

Figure 5. Figure 1 Moyston Primary students pre-evaluation drawing of an atom. This one is getting closer to the classic model with a nucleus and electrons.

Post-evaluation: Drawing of an atom

Nearly all the students described and drew a relatively correct model of the atom that had a nucleus surrounded by electrons. About half the students included protons and neutrons in the nucleus and electrons depicted as having a negative charge. Some students even described their recollection that there is a lot of space between the nucleus and the electrons.

Just the nucleus

About half the students depicted the atom with a nucleus and electrons positioned around the outside. While they describe the atom as a particle, their drawings suggest they now understand that it is made up of smaller particles such as electrons. See Figure 6.

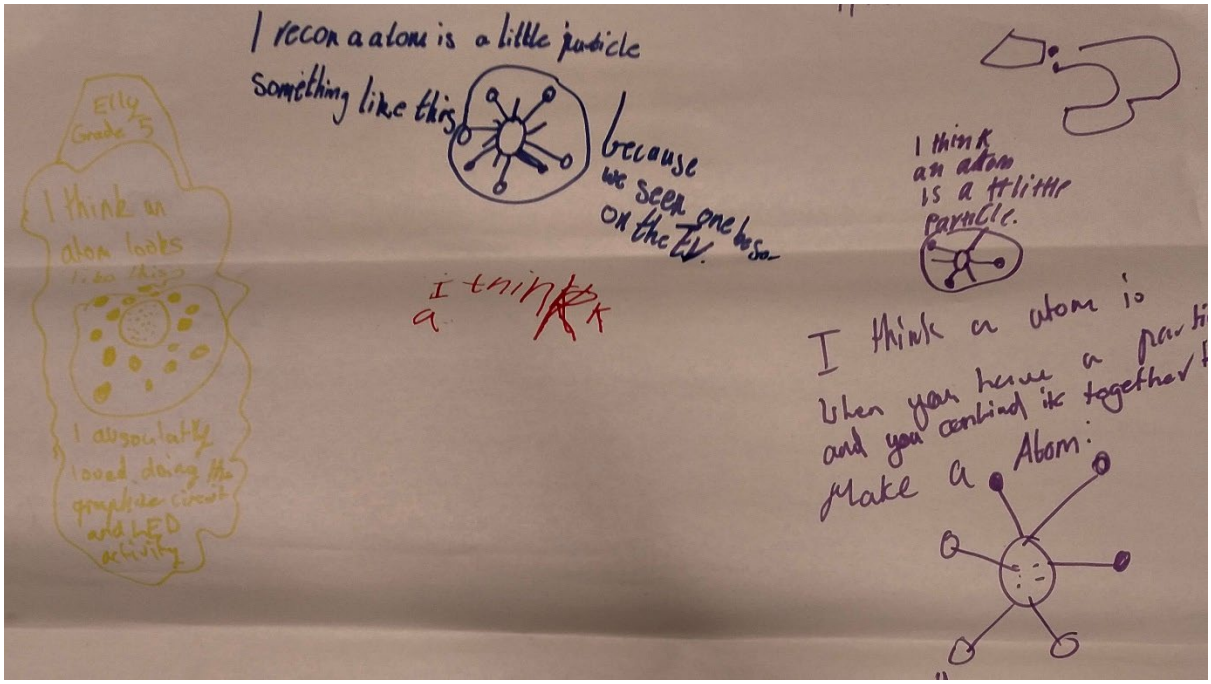

Figure 6. Moyston Primary School students post-evaluation drawing of an atom

Correct model

The other half of the students draw atomic models that included the protons and neutrons in the nucleus. They also designated a negative charge for the electron. See Figures 7(a)-(c).

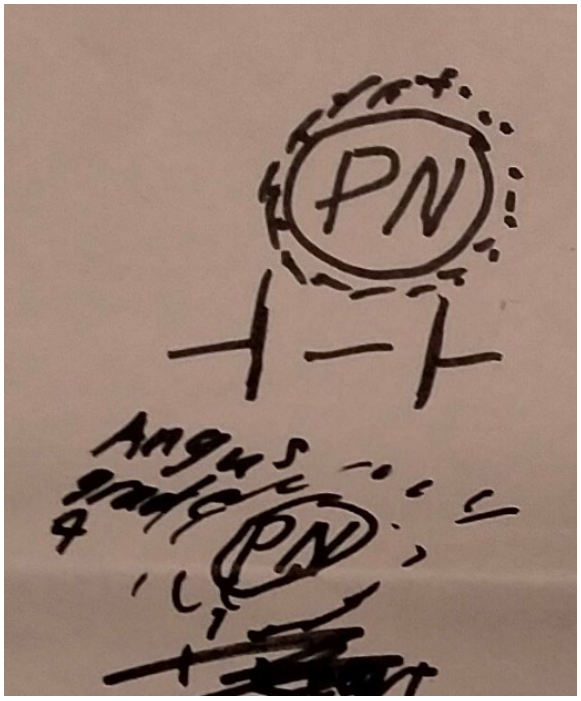

Figure 7(a) Correct atom models drawn by Moyston Primary students in the post-evaluation activity.

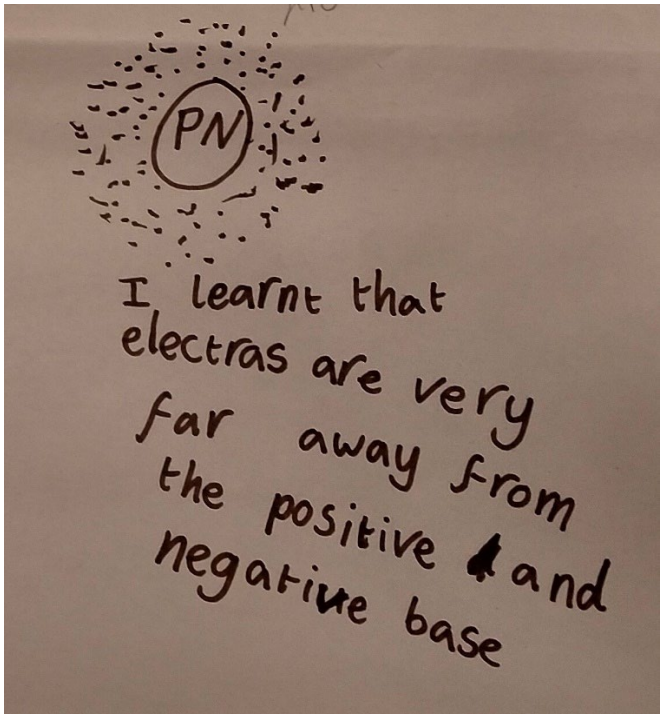

Figure 7(b) Correct atom models drawn by Moyston Primary students in the post-evaluation activity.

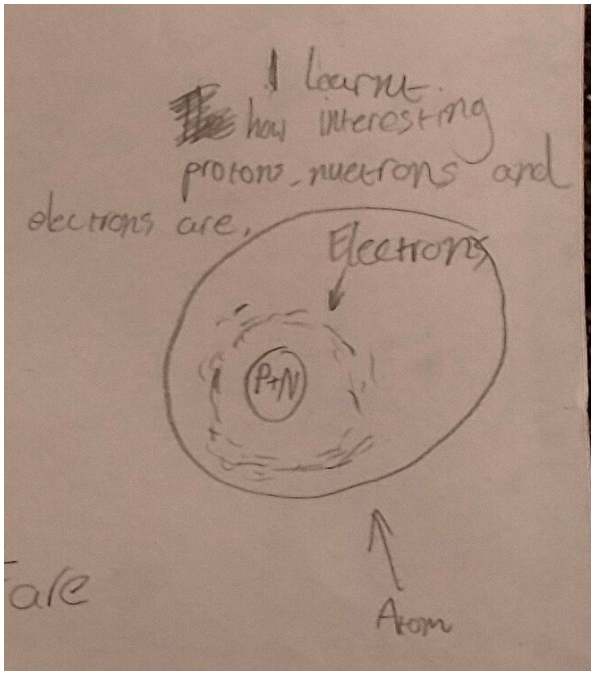

Figure 7(c). Correct atom models drawn by Moyston Primary students in the post-evaluation activity.

Atom lolly models

Students selected an element from the periodic table between hydrogen and carbon. Nearly all students constructed a model that was sufficiently close to what was required. I suspect there were some artistic constraints to getting a more anatomically correct model. At the start of the exercise some students started to build a more linear (kebab) model. This was

noticed and following a quick reiteration of the atom's structure it led to nearly all models being the correct one.

Clumpy atom

One student pair got it mostly right. See Figure 8. It is unlikely that electrons would be this close to each other, but we probably did not emphasize enough that because electrons have the same charge they will repel each other. Otherwise, the students got the correct number of protons and neutrons in a nucleus and the correct number of electrons surrounding the nucleus.

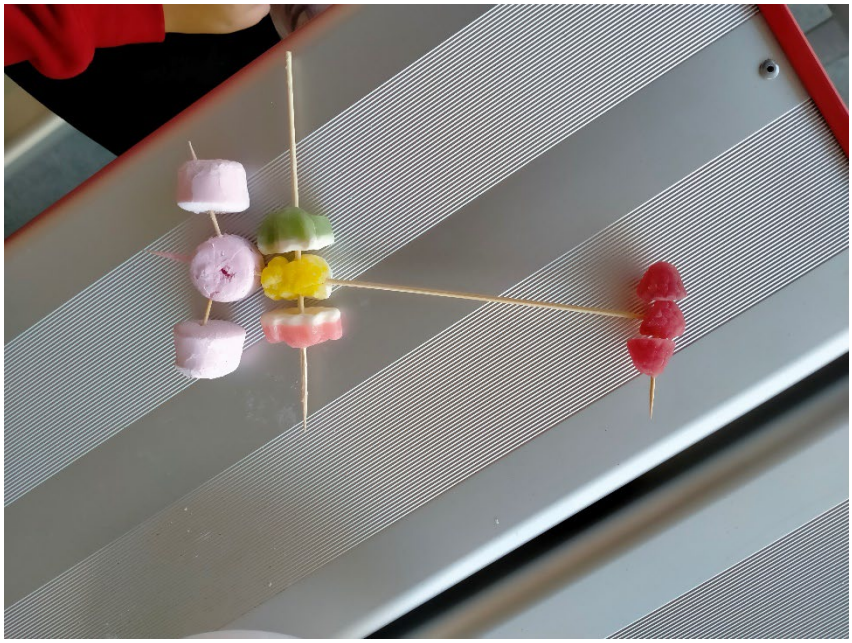

Figure 8. Moyston Primary School students' atom model that was almost correct. The probability of electrons being this close is remote.

The correct model

Nearly all students created an atomic model that we considered correct given the information and direction from us. Such models were made up the correct number of protons and neutrons in a nucleus with the correct number of electrons surrounding the nucleus at some distance. See Figure 9.

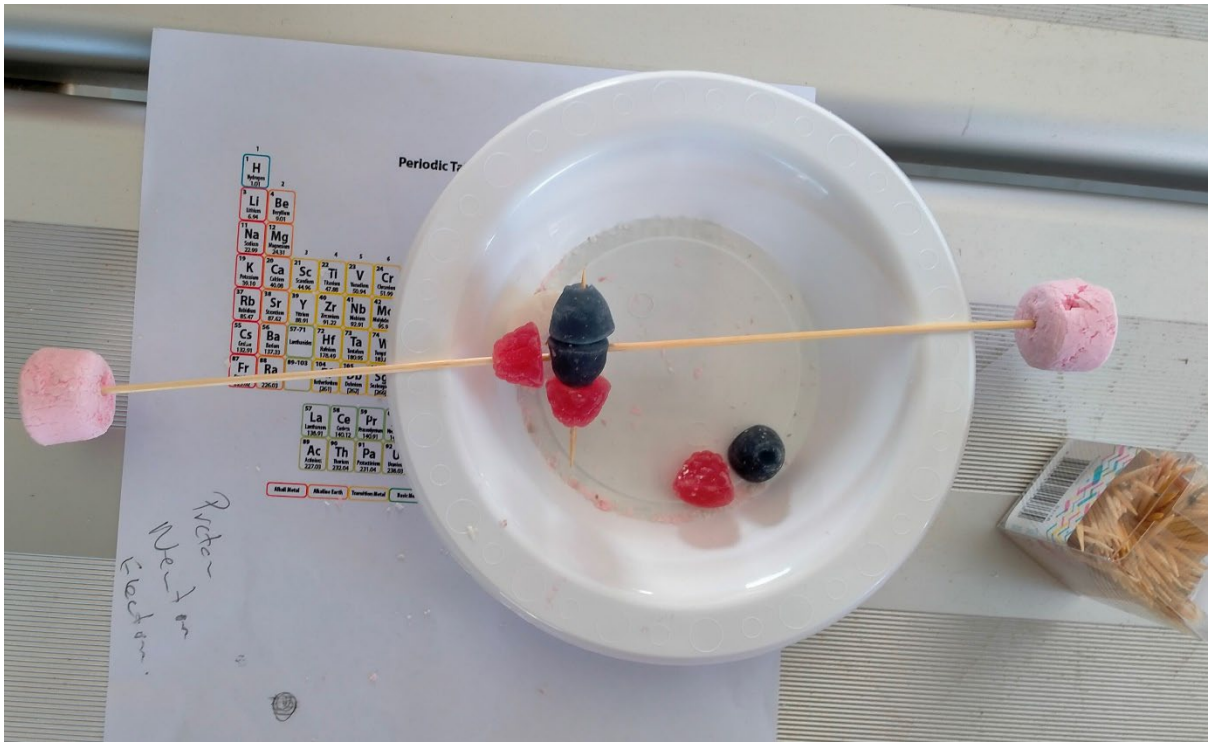

Figure 9. Moyston Primary School students' correct atom model. This one is Helium.

A lot of the students' drawings in the post-evaluation were accompanied by comments. These and some broadly associated themes are included in Table 1 below. These comments support the post-evaluation drawings that the workshop facilitated students' learning about atoms.

Table 1. Students' post-evaluation comments describing what they learned about atoms and their descriptive themes.

Student post-evaluation comments	**Themes**
I learnt how interesting protons, neutrons and electrons are	Solid: Atoms are described as distinct particles: protons, neutrons and electrons and that there are particles with a positive charge and electrons with a negative charge.
I learnt that electrons are very far away from the positive and negative base	
An atom is like a tiny circle. I learnt what and electron and proton are.	
I learnt what protons are	
I think an atom is when you have a particle and you combined it together to make an atom	Mostly: Atoms are still particles, no articulation of protons, neutrons and electrons but a drawing with a nucleus and electrons around it
I think an atom is so small	
I reckon an atom is a little particle	

I learnt what is an atom and we even did experiments with lollies	

What students learned about atoms

Students' learning about atoms can be grouped into the following conceptualizations:

- Learning about the shape/structure of an atom
- Conceptualizing the size of atoms
- Considering/understanding of the components of an atom
- Contextualizing atoms and their place/role in the periodic table
- Linking atoms with charged particles

As noted, time did not allow us to specifically evaluate the circuit building and how students connected the structure of atom to electricity and circuits, but observations and the few comments below suggest they enjoyed the experience of building the circuits. All student groups managed to get their graphite circuits to work, some exceptionally well with one circuit reaching almost one metre before the LED would not work.

Other student comments about the workshop

The following comments were written on the post-evaluation butchers paper:

> *"…doing work with Jason and Ivan has inspired me through electricity. Thank you"*
>
> *"I enjoyed today's lesson. We appreciated you coming today to see us"*
>
> *"I absolutely loved doing the graphite circuit and LED activity"*

Impact

Students initial conception of an atom varied between a nondescript blob and dots that often had no distinct components. The one exception from a Year 6 student was a drawing that depicted a potential nucleus with surrounded by electrons. Following an examination of the atom and the construction of the atom model, nearly all the students constructed a reasonably accurate drawing of the atom. Alongside student comments from Table 1, this suggests that students' conceptualization of atoms shifted from a simple explanation of atoms as tiny particles that are in living things to particles made up of protons, neutrons in a nucleus surrounded by electrons.

While there was definitive shift in understanding/learning about atoms among all the students, that understanding and learning was variable. The range of year levels (year 4-6) was a likely explanation for this. For example, the year 5/6 students had already done a short session on circuits.

The observed student enthusiasm in the circuit building activity and their post-evaluation comments suggest that they at least enjoyed the experience.

As noted we did not conduct pre- and post-evaluation of student learning about circuits, but our observation that all students successfully constructed a graphite circuit and that they

appeared to grasp the concept of resistance to help explain the LED becoming increasingly dim the further they moved away from the battery suggests the workshop affected how they understood the features and functions of circuits.

It is unclear whether the workshop had an effect on students' awareness about the process of science or if they thought critically about how society uses electrical energy. Time constraints meant we were unable to evaluate this effectively.

FLEET reflection

There is scope to adjust the content of this workshop in the given timeframe to include more effective evaluation of aspects such as critical thinking about the energy consumption of digital technologies and their understanding of circuits. The diverse age groups and therefore initial understanding meant we had to adapt aspects of the workshop to accommodate and re-explain some concepts for the younger year levels. This took up some of the time that could have been used for evaluation and student reflection. Minor amendments to the structure of the workshop can solve this.