Monash City Council Library workshops

Workshops: Blast off: Look out below / Fire and brimstone: Playing with electricity

Date: 21 and 28 May (Mulgrave); 29 June (Clayton) 2022
Location: Clayton and Mulgrave Library (VIC)
FLEET members: Mulgrave: Jason Major, Dmitry Efimkin; Clayton: Jason Major, Caiden Parker

Overview

FLEET approached the Monash City Council libraries to seek their interest in hosting FLEET workshops for children. Clayton and Mulgrave libraries expressed interest and FLEET conducted two workshops at each library: Blast off: Look out below and Fire and brimstone: Playing with electricity. The Clayton library workshops were done during the school holidays and formed part of the library's holiday program. The Mulgrave workshops were conducted during the school term, but over two Saturdays. The format for the workshops was the same for each venue except where indicated in the Methods section. The workshops from the two venues are evaluated together here.

The objectives for both workshops were less about formal learning and more about providing a fun way to engage children with science and physics. I outline specific objectives below, but unlike workshops conducted with schools, I allocated less time to pre- and post-evaluation activities and more on letting the children play with the balloon rockets, catapults and circuits. There are limitations therefore on the conclusions that can be drawn about the impact of the workshop relative to the objectives outline below.

Participants: Children aged 7-11. All four sessions were fully booked (capped at 25), but between 18 and 24 turned up for each session. Note the age range of 7-11 was was the range advertised to the public as being suitable for participation, but this was changed to 8-11 for the Clayton workshop because, based on the attendance of two 7-year old children at the Mulgrave workshop, seven years was considered too young to comprehend the content and participate in the workshop in an effective way.

As noted the core objective for each workshop was for participants to have fun and be engaged with science. The basic description of each workshop and their more specific, sub-core objectives are outlined below.

Blast off: Look out below

This is a workshop on forces and energy. Participants learn about potential and kinetic energy and apply that knowledge to build balloon rockets and catapults.

Objectives

- To create awareness and understanding about the process of science
- For students to understand the basic concept of energy and conservation of energy
- For students to understand the difference between kinetic and potential energy and apply that to the activities of building balloon rockets and catapults
- For children to think critically about their own use of energy

Fire and brimstone. Playing with electricity

This workshop gets participants to investigate the structure of atoms, their role in generating electrical current and apply then that understanding to the construction of circuits.

Objectives

- To create awareness and understanding about the process of science
- To give participants a basic understanding of electricity, the structure of the atom and its role in electricity
- To think critically about how we (society) use electrical energy
- For participants to use their understanding of electricity to build a circuit

Method

Workshop: Blast off, Look out below

Before any activity, students were asked the question, What comes to mind when you think of or hear the word energy? We wrote students' answers on a white board (Clayton) or butchers paper (Mulgrave). The whiteboard was more effective because of our ability to have a more proactive and facilitated brainstorming of their thoughts. The participants repeated this exercise at the end of the workshop. This formed our pre-evaluation and post-evaluation data that was compared to help understand the workshop impact.

Ball drop

Following the pre-evaluation exercise, students were introduced to the difference between kinetic and potential energy, and the transfer of energy using the ball drop demonstration. The ball drop demonstration involves placing a tennis ball on top of a basketball and dropping the two from a height simultaneously.

Introducing FLEET

After the ball drop demonstration, we introduced FLEET's research and the motivation for their research, which was framed around the problem of the increasing energy consumption of digital technologies. A FLEET member facilitated a short discussion to examine how students value digital technology. The students were encouraged to think critically about how they use digital technology, its value to them, the implications of energy consumption of such technologies and the acceptability of potential solutions.

Hands-on activities

The workshop was divided into two hands-on activities: the balloon rockets and the catapults. Students were divided into two groups. Each group did one activity, then swapped and did the other.

Balloon Rockets

This activity is based on the FLEET home science activity found here: https://www.fleet.org.au/blog/balloon-rocket/

The basic setup is an inflated balloon attached to a straw that can run along a string when the inflated balloon is released. Participants had to consider where the potential and kinetic energy existed in the balloon rocket system before and after the release of the balloon. The participants were introduced to Newtons 2nd and 3rd laws asked to think about where they applied in the balloon rockets.

Participants used horizontal and vertical rockets (the string was horizontal between two chairs or attached to the floor and ceiling for the vertical rockets). Particiapnts competed to see who could make their rocket travel furthest along the horizonal string, then how high it could go up the vertical string. Student also added increasing amounts of weight to the vertical balloons and were asked to observe the effect of the weight and think about and explain what was happening.

Catapults

Participants used and modified the catapult that is described in the FLEET home science experiment found here - https://www.fleet.org.au/blog/catapult/

Working in teams of 2-3, participants had to apply the physics of potential elastic energy stored in the rubber bands and the icy pole stick, and the effect of different fulcrum points to do three tasks:

1. Participants had to adjust the fulcrum point of their catapult and observe the height and distance their catapult flung their projectile.
2. Participants modified their catapults to produce a desired effect (eg greater height or distance that the projectile could be flung). Participants had to come up with a prediction/hypothesis for what their modification would do, test that idea and observe the effect.
3. Participants used their modified catapults to play a game that involved flinging their projectile into bowls and cups that represented food and medical drop sites across a flooded river. Each bowl or cup was allocated a certain number of points. Some bowls/cups were called red cross volunteers and points were taken away for landing a projectile in these vessels.

Workshop: Fire and brimstone: Playing with electricity

A similar pre-and post-evaluation exercise to Blast off! Look out below occurred except that the question we asked the participants was, What comes to mind when you think of or hear the word electricity?

Participants were introduced to the basic structure of atoms using role play and diagrams on the whiteboards. Participants then made a model atom from lollies: three types to represent electron, protons and neutrons. Wooden skewers and tooth picks were used to hold the lollies together.

Participants received an introduction to circuits and the role of electrons in generating an electrical current then they got the chance to build circuits using the FLEET circuit kits. This included the graphite circuits using pencil, LEDs and a 9V battery.

Results

The pre-and post-responses for the Boom! Watch out below workshops at Mulgrave and Clayton were combined, as were the two workshops for Fire and brimstone – electricity, conductors, insulators from both libraries. The results for each workshop are examined below.

Boom! Watch out below

The participants' pre-evaluation responses to the question, What comes to mind when you think of energy were grouped under the following themes:

- Human energy: Participants used words to describe their perceived relationship between energy and the human body, for example, running, crazy and stamina.
- Energy forms: Participants listed different forms of energy such as kinetic, potential and electrical.
- Providing energy: Participants responded with things that provide energy such as the sun, lightning, or fuel.
- Tech using energy: Participants listed the names of devices/technologies that use energy such as iPads, TVs or transport.
- Word association – thesaurus: Students used words they perceived were similar to energy such as power and kaboom!

The post-evaluation responses suggest learning occurred relative to the concept of energy and its function. See Table 1 below for the breakdown of pre- and post-responses for the combined Boom! Watch out below workshops from Mulgrave and Clayton libraries. The post-responses were grouped under the following three themes:

- What is energy: Participants considered the forms of energy involved in their catapults or balloon rockets, how that energy was transformed, and that everything has energy. It was a deeper conceptualization of energy.
- Energy forms: This is similar to the pre-responses, but with fewer responses.
- Providing energy: As with pre-responses, but fewer responses in comparison.

There was a shift in perceptions and participants' conceptualization of energy from the what uses energy and produces energy, to what is energy and how we can use it to do stuff (work). There were no responses in these workshops to suggest participants had strong recollections or had thought critically about the implications of energy consumption of digital technologies, but this was expected in such an informal learning environment. Participants did, however, think deeply about how their catapults and balloon rockets were working in an effort to change the way they worked to achieve a desired effect (Bending the catapult lever gave it energy – potential energy; Air pressure in the balloon - in energy). Some participants gained a broader understanding of about the role of energy (Everything has energy). See Table 1 below for full outline of pre- and post-responses per theme.

Fire and brimstone – Playing with electricity

Four core themes emerged from the pre-evaluation responses: Implications of electricity, Word association – thesaurus, What generates electricity, and Tech powered by electricity. They are outlined in more detail below.

Pre-evaluation response themes

- Implications of electricity: Participants use words to describe what happens when electricity is present (electrocution, zapping)
- Word association – thesaurus: Participants used words that they perceived were similar to electricity (power, connection)
- What generates electricity: Participants described entities that generate electricity (Solar, Gas)

- Tech powered by electricity: Participants described the technologies that use electricity to work (Tesla, devices)

Post-evaluation response themes

There were three core themes to emerge from the post-evaluation data: Learning about electricity – Electricity does work; Learning about atoms; and Linking atoms to electricity. They are outlined in more detail below.

- Learning about electricity – Electricity does work: Participants described circuits and components of circuits (Graphite in circuits; Batteries attached to LEDs), and, to varied extents, how circuits worked (currents; I learned which is positive/negative)
- Learning about atoms: Participants used words such as protons, neutrons and electrons to describe what they learned about atoms, and that "you can make atoms".
- Linking atoms to electricity: Participants made the mental connection between atoms and electricity (Electrons get hot; Electrons light LEDs)

Similar to the Boom! Watch out below workshop, there was a shift in how participants conceptualized, in this case, electricity. Participants shifted from what electricity does or simple words associated with electricity, to what electricity is and how it works. Participants could apply some of these deeper conceptualizations to the circuits they were building (Electrons light LEDs, I learned which is positive and negative). See also Figure 1 below that shows an accurate circuit diagram indicating the participant could apply their understanding to build a functional circuit. See Table 1 below for full outline of pre- and post-responses per theme.

Table 1. pre- and post-evaluation responses for the workshops, Boom! Watch out below, and Fire and brimstone – electricity, conductors, insulators.

Session 1 – Blast off! Look out below. What comes to mind when you think of energy?	
Pre-evaluation	**Themes**
Hyperactive / strength / stamina / nervous system / human body	Human energy
Chemical / kinetic / acid/ fuel/ kilojoules / electricity / I think about forces like push and pull / heat, potential, electric / lightning / heat / lightning bolts, weather /	Energy forms
Emotional Damage (Gaming reference)	Tech using energy
Power / plug / Kaboom! /	Word association – thesaurus
Solar / fire/ battery – lemons / lunar / sun / water / wind / stars	Providing energy
Post-evaluation	**Themes**
Food / Nuclear / Solar	Providing energy

Kinetic / When I think of energy I think about kinetic energy	What is energy – deeper thinking
Bending catapult lever gave it energy – potential energy	
Transforming energy / Heat	
Balloons can be rockets – air in balloon	
Elastic energy in the catapult	
Air pressure in the balloon (in energy)	
Everything has energy	
Some types of energy are potential, kinetic and thermal. I learned about the way energy works	
When I made the (balloon rocket) the energy, I think, is wind power.	
Radiation / potential, kinetic / wheels / movement	Energy forms
Session 2 Fire and brimstone – electricity, conductors, insulators. What comes to mind when you think of electricity?	
Pre-evaluation	**Themes**
Electrocution / Zapping / Lightning	Implications of electricity
Power / Energy / Connection	Word association - Thesaurus
Solar / Gas powered	What generates electricity
Tesla / Spending time on devices / TV transmitters	Tech powered by electricity
Post-evaluation	**Themes**
Circuits / Batteries attached to LEDs / graphite in circuits / I learned which is + (positive) and – (negative) / graphite circuit / Technology-power, currents	Learning about making electricity. Electricity does work
Protons, Neutrons, Electrons / I learnt about atoms, electrons / Atoms, eg helium / electron, protons/ that you can make atoms	Learning about atoms
Electrons light LEDs / Electrons get hot / technology, particles, neutrons, protons, electrons, lightning /	Linking atoms to electricity

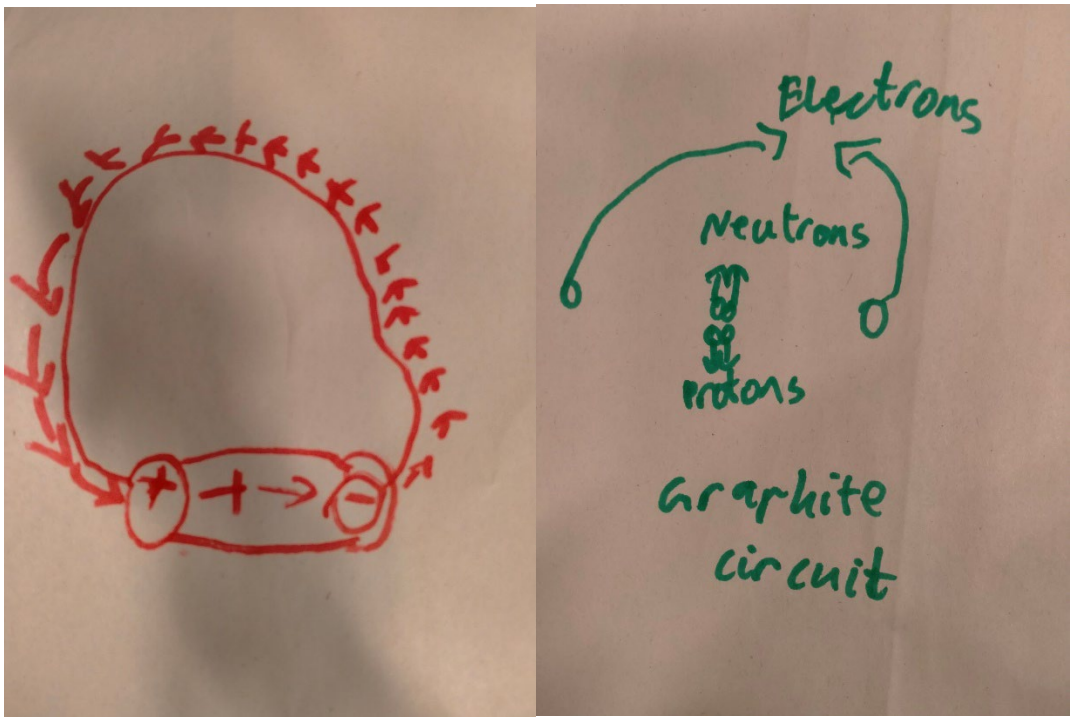

Figure 1 Post-evaluation drawings from the Fire and Brimstone workshop that indicates participant learning about atoms and circuits and the role of electrons in generating current. The left-hand image is one participant's 'accurate' representation of a circuit. The right-hand image depicts a participant's understanding of the atom with electrons around the nucleus. It is unclear if there is a mental connection between the model atom and their construction of the graphite circuit or it is two separate things they remember.

Observations

FLEET members made the following observations about the workshops: Such observations were not part measured as part of the evaluation, therefore they are anecdotal only, but help support the pre- and post-evaluation data.

While there was a handful of children in one workshop that just wanted to play basketball in the creative time allocated at the end of each workshop, most children appeared to be engrossed in and enjoying the circuit kits, catapults and balloon rockets. Parents were allowed to join in during this session and were also engaged helping their children and asking questions.

There were 4-5 children that attended all four sessions because they said the first time was fun and they wanted to do them again.

The children playing with the balloon rockets were experimenting to work out ways to make the balloon travel further and competing with other children; the children playing with the circuits were trying to make the helicopter blades spin faster or to make more lights work, some children being more successful than others. But FLEET members facilitated the play time by asking the children questions about what they were doing and why, and to help them understand what they were observing and what was happening. This helped students modify their circuit or balloon rocket to achieve a desired outcome. As noted, such engagement was not measured, but the observations suggest some degree of scientific thinking and learning occurred with the children.

As part of the post-evaluation at the Mulgrave workshop, I asked students to draw a smiley face if they had fun, or a sad face if they did not have fun. There were six smiley faces (no sad faces) drawn on the butchers paper.

Impact

The core objective of these informal learning workshops was to provide a fun way to engage children aged 8-11 in science, specifically physics. Following the formal part of the workshop where participants completed an arranged set of activities with the atom models, balloon rockets and catapults, nearly all the participants continued playing with either the balloon rockets, catapults or circuit kits in the creative play time allocated at the end of the workshop. FLEET members noted how engrossed the participants were, that parents present were also participating with their children and asking questions. Other observations such as laughter and engagement in the activities suggested that most, if not all, enjoyed the workshops. The comparison of the pre- and post-evaluation data suggests that participants, to varying extents, learned something about the concepts of energy, atoms and electricity. For example, many thought critically about the construction and adaptation of their circuits, catapults and balloon rockets in an attempt to make them work differently or more effectively. To do this they applied what they had learned in the formal part of the workshops (Bending the catapult lever gave it energy – potential energy; I learned which is positive and negative; Electrons light LEDs). A lack of relevant post-evaluation responses makes it unclear whether participants increased their awareness about process of science or thought critically about their use of energy.

FLEET reflections

In the context of such workshops where the core objective is to have fun, an objective for participants to gain an increased awareness of the process of science and then be able to measure it is likely expecting too much. The structure of the workshop would need to change for this to occur and it is questionable whether it could be done in sufficient depth to achieve anything of value.

While we did have a brief discussion with participants early in each workshop about FLEET research and the energy consumption of digital technologies, we needed to follow this up with some reflection at the end of the workshop. This is something to consider for any similar workshops. To avoid primed responses, we would need to assess this reflective discussion itself rather than through the post-evaluation process that occurred on the whiteboard and butchers paper. That is, participants responding in a brainstorm session on the whiteboard or butchers paper immediately following a reflective discussion will likely repeat things they have just heard or that we emphasize.

The creative play time was where children became engrossed in the activities and applied what they had learned in the organized hands-on parts of the workshop. It is here they also experimented and tested ideas. There is scope to allow more creative play time and to more effectively record the conversations between FLEET members and participants (including parents). This will give us greater understanding of the impact of this particular part of the workshop and the workshop overall.