FLEET ARC CENTRE OF EXCELLENCE IN FUTURE LOW-ENERGY ELECTRONICS TECHNOLOGIES

Great Western Primary School evaluation

Workshop: Blast off: Look out below
Year levels: 1-6
Location: Great Western Primary School (Regional VIC)
FLEET members: Jason Major, Ivan Hererra Benzaquen
Date: 24 May 2022

Overview

This report is an evaluation of the impact of the workshop, Blast off! Look out below conducted with years 1-6 at Great Western Primary School.

Workshop description: 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.

Great Western Primary School has 20 students in total. For the workshop, we split the classes into Years 1 -2 (10 students on the day) and Years 3-6 (7 students on the day).

The workshop ran for 2-hours

We had the following objectives for the workshop:

- To create awareness and understanding about the process of science
- To understand the basic concept of energy and conservation of energy
- Understand the difference between kinetic and potential energy
- To think critically about how we (society) use energy
- To think critically about their own use of energy

Highlights

- 17 students in year 1-6 from regional Victoria were exposed to FLEET research and their outreach program.
- Students enjoyed the experience. “The balloon was fun and I liked the way you had to problem solve.”
- There was a potential shift in how students conceptualised energy.
- Students increased their awareness of the problem with the increasing energy consumption of digital technologies and some could think critically about how they and society use energy and the implications of that.

Method

Pre- and post-evaluation

Pre- and post-evaluation was conducted to assess the impact of the workshop. Before the introduction and the hands-on activities, students were asked to think about the following question: What comes to mind when you think of energy? Students wrote words and drew pictures on butchers paper to reflect their answers to this question.

The process was repeated at the end of the workshop as part of the post-evaluation. We compared the pre- and post-evaluation responses an attempted to use thematic analysis to determine the impact of the workshop. As noted, however, the pre-evaluation data was difficult to interpret and find emerging themes. It is difficult therefore to make comparisons to post-evaluation responses.

Double bounce demo

At the beginning of the workshop 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. Students then have to observe what happens and consider why it happens.

A discussion about energy

This discussion was framed around how we use energy, the increasing energy consumption of digital technologies and FLEET's research to reduce the energy used by these technologies.

Hands-on activities

Two hands-on activities were conducted: Balloon rockets and catapults. They are outlined in more detail below. The depth of explanation and discussion was adjusted for the two year level groups (1-2 and 3-6).

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. Students had to consider where the potential and kinetic energy existed in the balloon rocket system before and after the release of the balloon. The students were introduced to Newtons 2nd and 3rd laws asked to think about how they applied in the balloon rockets.

Students used horizontal and vertical rockets (the string was horizontal between two chairs or attached between the floor and ceiling/rafter for the vertical rockets). Participants 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

Students built, used and then 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, students 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. Students had to adjust the fulcrum point of their catapult and observe how that affected the height and distance their catapult flung their projectile.

2. Using their understanding of potential elastic energy, students modified their catapults to produce a desired effect (eg greater height or distance that the projectile could be flung).
3. Students 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.

Observation

FLEET members observed and wrote short notes on student engagement.

Results

The results sections examines the outcomes from the pre-and post-evaluation responses to the question, what comes to mind when you think of energy; and FLEET members' observation of the workshop that recorded student conversations, questions and behaviour.

Pre- and post-evaluation

Pre-evaluation generated only minimal data that made thematic analysis difficult and therefore difficult to compare to the post-evaluation responses. I suspect, based on the drawings on the butchers paper that this was because the majority of the students were in years 1-3 and they had difficulty conceptualizing their thoughts into words and drawings*. A lot of the drawing are impossible to interpret and a lot of the writing is illegible. For some reason there were four pre-evaluation responses that mention atoms alongside drawings of atoms. While they are relevant responses, it is unclear how the students connected energy with atoms at the primary level unless they had recently done some subjects on this topic at school.

The post-evaluation responses, however, were more comprehensive and, while still minimal there was sufficient data for one dominant themes to emerge and to draw some conclusions about the impact of the workshop. This theme was Learning, conceptualizing energy and indicates that students formed different conception about energy and had learned something about different forms of energy and role of force in kinetic energy – making something move. For example, students learned that energy is movement and that a bouncing basketball involves energy; to get a balloon rocket moving there has to be a force applied that comes from Newton's law that if there is a force coming in the form of air escaping from the balloon one way, there is an equal force pushing the balloon the other way (along the string). See Figure 1.

Table 1 below outlines the pre- and post-evaluation responses.

*In subsequent workshops we have used a whiteboard in a form of a brainstorm session and a FLEET member has written down students' ideas as they were presented. This has been a more effective technique and it also enables FLEET facilitators to get students to elaborate on vague ideas or thoughts that students struggle to articulate.

Table 1. Great Western Primary School (Years 1-6) pre- and post-evaluation responses to the question, what comes to mind when you think of energy?

Pre-evaluation responses (number of responses)	**Themes**
Dragon fire / lightning (3)	Energy forms
Running fast / running	Human energy
Trees, sun outdoors / outdoors	
Power drill, power lines	Using energy
Sun, solar panels	Producing energy
Atoms (4)	
Post-evaluation responses	**Themes**
Basketball bouncing / Movement is energy / Movement of a balloon / Balloon rockets / balloon rockets – Newtons 3rd law (See Figure 1) / I learned about kinetic force / Spaceship's fuel (See Figure 2.)	Learning, conceptualizing energy
The balloon was fun and I liked the way you had to problem solve / I enjoyed the balloon part because it was so fun	Enjoyment in engagement
To fly	Wishful thinking
I built a balloon rocket	
atoms	

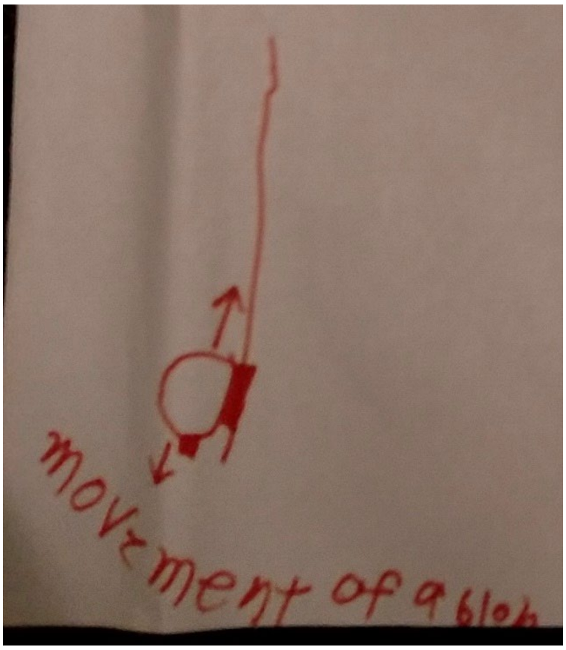

Figure 1. Great Western Primary student's post evaluation response. Their engagement with the balloon rockets conceptualised their understanding of energy. They understood that energy as a force coming out of the balloon in one direction meant there would be an equal force pushing the balloon up in the opposite direction

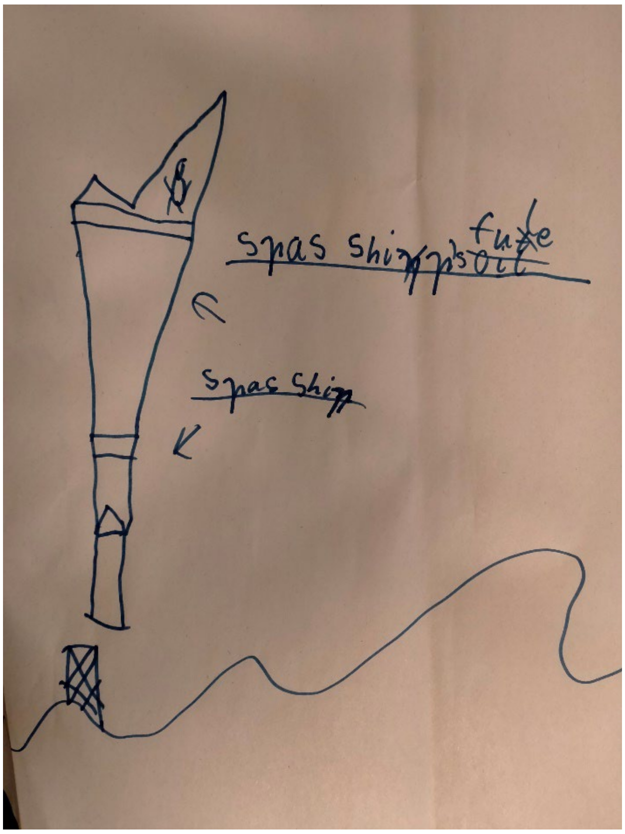

Figure 2. Great Western Primary student's post-evaluation response. The drawing reflects their recollection of the discussion with FLEET about how much of a rocket is fuel – or the amount of energy required to lift the rocket (space ship) into orbit. The drawing represents the tiny space for astronauts at the top and the rest of the rocket space taken up with fuel.

Observation

FLEET members noted the students across all year levels actively engaged in the testing and experimenting of the balloon rockets and catapults.

During the reflection session, the older students, while likely repeating a lot of what FLEET members said, were able to articulate their thoughts about the energy use of digital technologies and the implications of this. The discussion did, however, appear to reinforce ideas about how much energy digital technologies use.

Students used what they learned about kinetic and potential energy to modify their catapults. See Figure 3 and 4 below. Students also experimented with the balloon rockets in their races to see which team could get their rocket furthest along the string. Students modified the size of their balloon and ensured it was stuck to the string straight so the force of air escaping was parallel with the string. See Figure 3 below. The students in Figure 3 also reflect the overall enjoyment the students got from the two activities. Reinforcing this are post-evaluation responses from the following two students:

> *"I enjoyed the balloon part because it was so fun"*
>
> *"The balloon was fun and I liked the way you had to problem solve."*

When students added weight to their vertical balloon rockets, most of the older students could discuss the relationship between force, mass and acceleration in a simple way. For example, after some discussion students could articulate that the weight affected how far up the string the balloon would travel therefore mass affected acceleration. When they got to a weight where the balloon would not move, students were asked to consider that if this was a real rocket and the weight was essential food for astronauts on the space station, what would you have to change about the rocket to get it into space. That is, you were not allowed to remove any weight. After some discussion, most students worked out that they would need a bigger balloon (more force, therefore more energy). See Figure 4 below.

One parent commented to me (Jason Major) after the event that their child came home and talked about how he had loved the FLEET visit.

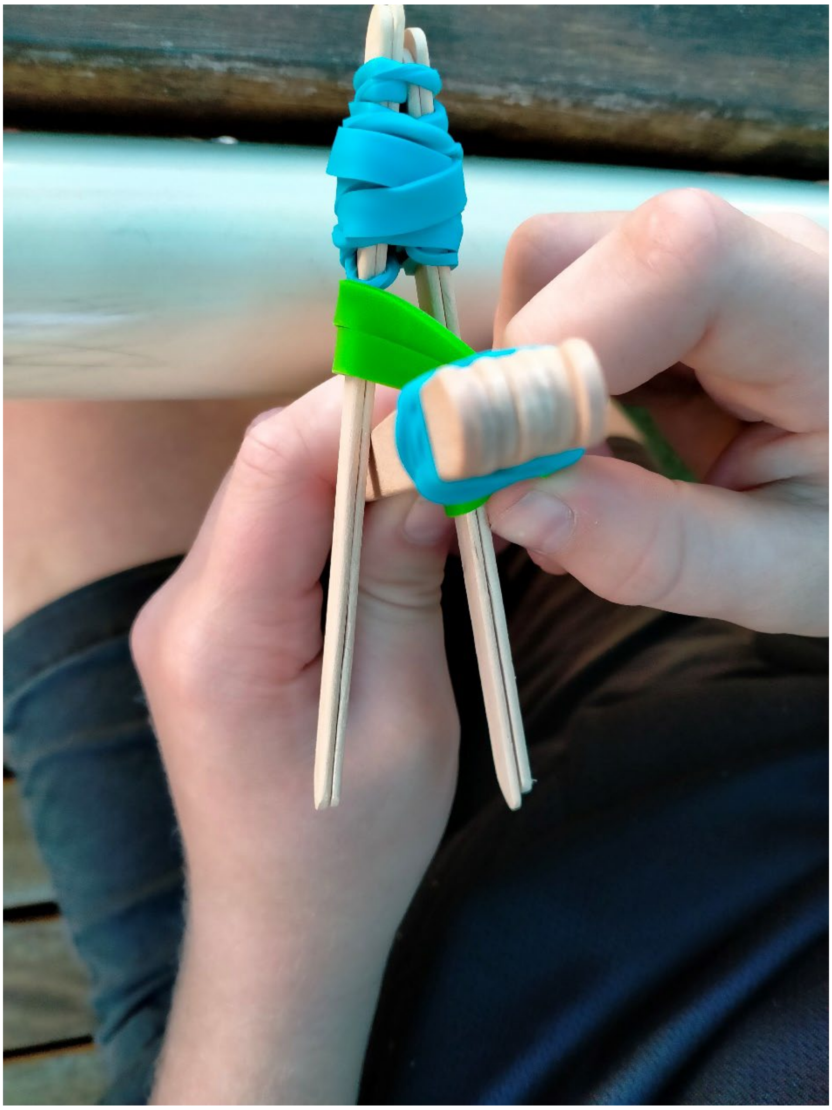

Figure 3. Great Western Primary student applying what they learned about potential elastic energy to increase the potential energy in the catapult lever (using two icy pole sticks), adding extra twists to the rubber band connecting the levers at the end and adding an additional rubber band closer to the fulcrum point. The aim for the rubber band modifications was to increase their elastic potential energy.

Figure4. Great Western Primary students rising to the challenge to test out their modified catapult to get as many projectiles into the targets (bowls) as possible. It is harder than it looks.

Figure 3. Great Western Primary students competing in the balloon rocket challenge. Who could get their balloon furthest along the string. The students enjoyed the competition and firing balloons along a string just seemed fun.

Weight added to the balloon in increments. Weight was blutack cut into 10 gram sections that was incrementally added to the straw

Figure 4. Great Western Primary students testing the relationship between force, mass and acceleration. Students had to add more and more weight to the balloon and think about what effect the weight was having on the rocket.

Impact

It is difficult to determine if the students had greater awareness and understanding of the process of science, but the post-evaluation and observation data suggests that students had a potential shift in how they conceptualised energy. As noted, however, the limitation is the lack of pre-evaluation data to compare this to. We cannot determine how they understood or conceptualised energy before their experience in the workshop so we can only speculate about the interpretation below. Further, the evidence we do have typically applies only to years 3-6. The few responses from the younger year levels were unable to be analysed effectively.

The following is based on an examination of the post-evaluation and observational data only and is subject to the limitations described above.

The post-evaluation and observational data suggest that students could apply what they learned about potential and kinetic energy, and Newton's 2nd and 3rd laws to improve their catapults and balloon rockets. They could actively participate in conversations about the relationship between force, mass and acceleration and apply that understanding to what was happening to their balloon rockets when they added weight to it. See Figures 1, 3 and 4.

The same data also indicated that the students enjoyed the experience. For example, “The balloon was fun and I liked the way you had to problem solve.”

The observational data suggested that the older students, at least, had become aware that there was a problem with the increasing energy consumption of digital technologies. And although direct student quotes were not recorded, a small number of these older students articulated, to varying extents, critical thoughts about how they and society use energy and the implications of that.

FLEET reflection

As noted, we need to be careful how we conduct the pre- and post-evaluation exercise. Younger children appear to struggle to contribute in a meaningful way when asked to write or draw their thoughts on butchers paper. For primary school children, the use of a whiteboard to brainstorm a question can be more effective.

Consideration is also needed to find a way to record the reflection session. This could be done by a FLEET member taking notes, or seeking permission to digitally record the oral part of the conversations.

There is the potential also to ask students specific questions during the workshop about what they are doing and why, and to explore in greater depth what they have learned. The time constraints to get through each activity on time will mean this idea may not work in all workshops.