Evaluation: Year 7 Horsham College
Energy and forces workshop

Date: 14-16 June 2022
Location: Horsham College, Horsham, VIC
FLEET staff: Jason Major, Tich-Lam Nguyen

Overview

FLEET visited Horsham College in Western Victoria to conduct the Energy and forces workshop for its eight Year 7 classes. The workshops were conducted for all the Year 7 students over three days. Each workshop ran for 90 minutes and there were two classes per workshop for all but one of the workshops. The workshop consisted of an introduction to FLEET, an overview of the concept of energy and hands-on activities. There was a pre- and post-evaluation exercise also conducted to assess the impact of the workshop relative to the objective outlined below.

Highlights

- 200 Year 7 students engaged with FLEET research and hands-on activities to learn about energy and forces
- Students could effectively recall and think critically about FLEET's research problem of increasing energy consumption of digital technologies
- Some evidence (albeit limited) that students conceptualized the concept of energy and learned the relevant physics.

Workshop objectives:

- For students to understand the basic types of energy and the concept of conservation of energy
- For students to understand the difference between kinetic and potential energy
- To introduce students to FLEET research, to get them thinking critically about FLEET's research problem and how we value digital technology.
- To think critically about society's use of energy

Method

Following an introduction, the workshop was divided into two hands-on activities: the balloon rockets and the catapults. Students were divided into two groups. Each group would do one activity, then swap and do the other. Students conducted pre-and post-evaluation activities and a short reflection. A detailed description of each component of the workshops follows.

Introduction

At the beginning of the workshop students were given an introduction 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.

After the ball drop demonstration, we introduced FLEET's research and the motivation for this research, which was framed around the problem of the increasing energy consumption of digital technologies. A FLEET member facilitated a short discussion in the context of FLEET's research problem 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.

Reflection

After the hands-on activities, students came together for a short reflection to examine what they learned. This was facilitated by FLEET and covered what they learned about energy from their hands-on activities and its link to the energy consumption of digital technologies.

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? Initially students were asked to write down or draw their thoughts on butchers paper. Pencils, crayons and textas were provided for this. This required a lot of encouragement from FLEET members and teachers to get the process started and there was an inclination for the students to simply chat about other topics. This took up more than the allocated time. We switched to brainstorming on the whiteboard where we prompted students for a response and we wrote those responses on the board. This was more successful than the butchers paper, but still not ideal as there was still some reluctance to be to student to volunteer information.

The process was repeated at the end of the workshop as part of the post-evaluation. Pre- and post-evaluation data were compared to determine the impact of the workshop.

Hands-on activities

Catapult

Following instruction from a FLEET member, the original plan was for students to build a catapult from icy pole sticks and rubber bands, the same ones that appear in the FLEET home science experiment found here - https://www.fleet.org.au/blog/catapult/

It took students longer than anticipated to make the catapults, so after the first day of workshops, these were pre-made for the students.

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 effect of different fulcrum points to do three tasks:

1. Students had to adjust the fulcrum point of their catapult and measure the height and distance their catapult flung their projectile at three different marked points along the lever that created three different fulcrum points. The height and distance for each point was plotted on a graph that the class contributed to and the outcomes discussed.
2. Students modified their catapults to produce a desired effect (eg greater height or distance that the projectile could be flung). Student had to come up with a prediction/hypothesis for what their modification would do, test that idea and observe and record the effect.
3. Students used their modified catapults to play a game that involved flinging their projectile into bowls and cups that represented food and medical drops. 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. Students received prizes for reaching a certain level of points, though there was a higher than anticipated degree of difficulty to achieving a score so any student that scored got a prize.

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. Student 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 and applied Newtons 2nd and 3rd laws.

As an introduction, a FLEET member demonstrated the balloon on the horizontal string and asked students to predict what will happen with each of the following scenarios:
Scenario 1. Balloon fully inflated
Scenario 2. Balloon half inflated
Scenario 3. Balloon with straw inserted into the opening to reduce the amount of air that can escape/per time.

Students then worked in their teams to complete the tasks associated with the balloon running up the vertical string. Students had to record the height their balloon reached without any weight and then with increasing amounts of weight (blutack stuck to the straw). Students conducted the different experiments, recorded their results in their worksheet tables (See Table 1. below) and then plotted the results from the table on the class graphs set up on large sheets of butchers paper. Students were asked to think about the relationship between mass and height, and acceleration, and how this related to their observation of the balloon rockets.

Table 1. Going vertical. Table used for students to record their observations and measurements for Experiment 1.

Balloon variables on the vertical string	**Your observations**	**Height balloon travelled (cm)**	**Average height balloon travelled (cm)**
Balloon (no weight)		1. 2. 3.	
Balloon with weight 1		1. 2. 3.	
Balloon with weight 2		1. 2. 3.	
Balloon with weight 3		1. 2. 3.	

Results

This was considered a pilot workshop because it had not been conducted with this year level before and where students were required to record and graph their results. There was some adjustment made after day 1 and again after day 2 to improve student engagement and learning, and to ensure the workshop ran to time. This included pre-building the catapult and using the whiteboard instead of the butchers paper for the pre- and post-evaluation.

Catapults

It was expected that given the large number of variables in the catapult designs and how students used them that it would be unlikely that a relationship between the different fulcrum points and distance/height of the projectile would be found. Indeed, this was the case. The exercise became a discussion of what would be required to improve the scientific rigour of the method, for example how to reduce the number of variables. Students came up with ideas such as making sure the rubber bands were all the same, and that the amount of force used to depress the lever was the same each time and that possibly the same person should fire the catapult each time.

Balloon rockets

The variables in this activity were easier to control. The vertical strings were all the same height and angle and the balloons were identical. The blutack used as weight was cut into the same length to ensure that students added the same amount of weight each time. This produced a graph that clearly showed a relationship between mass, force and acceleration that was discussed as part of the activity.

Reflection

Just before the post-evaluation exercise, students discussed the rigour of the methods in each activity and what they learned about energy and forces, and scientific method. Students were able to articulate ways to improve the method applied in the catapult activity to ensure greater scientific rigour. The was considerable variation in the students' ability to talk about the relationship apparent between mass, force and acceleration in the balloon rocket data, though once prompted. There was some discussion about the role of energy in digital technologies and potential solutions. Students were able to raise potential solutions such as more solar/wind or reducing use of digital technologies (eg gaming devices).

Pre- and post-evaluation

When using the butchers paper, students drew pictures and wrote words that came to mind when they considered what energy was. On the last day, this was done on the whiteboard. Students engaged to some extent with the pre-evaluation though it required considerable effort from FLEET members and teachers to encourage that engagement. Unfortunately, student engagement in the post-evaluation exercise was negligible on the butchers paper. This prompted the switch to brainstorming on the whiteboard for Day 3 groups. While useful themes emerged from the pre-evaluation data, the post-evaluation data is limited and it effects the ability to draw any strong conclusions about the impact of the workshops.

Students' pre-evaluation responses to the question, What comes to mind when you think of energy? Were grouped under the following themes:

- Electrical equipment – energy users
- Energy generators
- Scientific reference
- Energy types

- Human reference
- Energy generic
- Experiential generic

Most student pre-evaluation responses to the concept of energy could be associated with devices or equipment that use energy or with energy's connection to the human body, such as its effect on our ability to do things and the energy in the food we consume. There were nine responses that associated wind turbines and solar with energy, which is unsurprising given the large number of wind farms in the district and the number of solar panels on roof tops and used on farms to power pumps, etc. Batteries and lightning were two other phenomena that students strongly associated with energy. See Table 2 and Figures 1(a) and (b) below. Note, Table 2 contain the pre-evaluation data for the workshops conducted on day 1 and 2 only. The pre- and post-evaluation data for day 3 is compared separately below.

Table 2. Pre-evaluation. Student responses to the question, What comes to mind when you think of energy?

Theme	**Number of responses**
Electrical equipment – energy users	
Computer/Ipads	3
Lights/light bulb/light switch	12
Devices	3
Power point/power cord	5
Fans	2
Microwave/ovens	2
TV	2
Fridges	1
Energy generators	
Wind turbines	4
Solar energy	5
Nuclear energy	1
Things that spin around	1
Water	1
Scientific reference	
Atoms	1
Energy types	
Kinetic energy	3
Battery	9
Static (electricity)	1
Electrical energy	1
Radioactivity	1
Human reference	
Movement/physical	6
Emma has lots of energy/ human energy/ Feel like you want to do everything/motivation	4
Hyper/crazy	3
Speed - fast/slow	5
Flash (superhero)	1
Lollies/sugar/food/energy drink/caffeine	8

Energy generic	
Electricity	5
Sun	3
Power	4
Stars	1
Lightning	9
Energy is energy	1
Energy cycle	1
Stuff	1
Power poles/lines	7
House	1
Flowers/plants	2
Experiential generic	
Friction	3
Zap on trampoline	1
Heated floors	1
Crystal (healing crystals)	1
Cars/Tesla	3
Bouncing ball	1
Static electricity ball demo	1

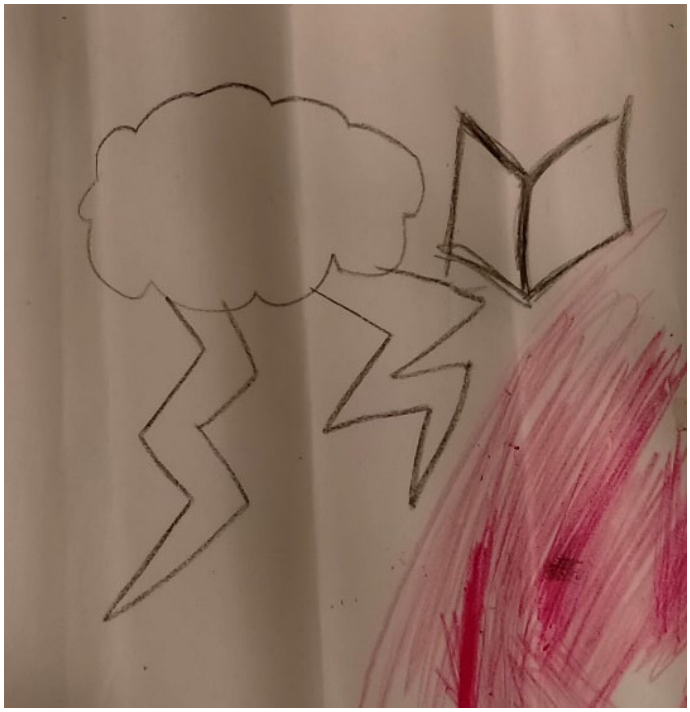

Figure 1(a) Student responses to the question, What comes to mind when you think of energy? Lightning was a common response

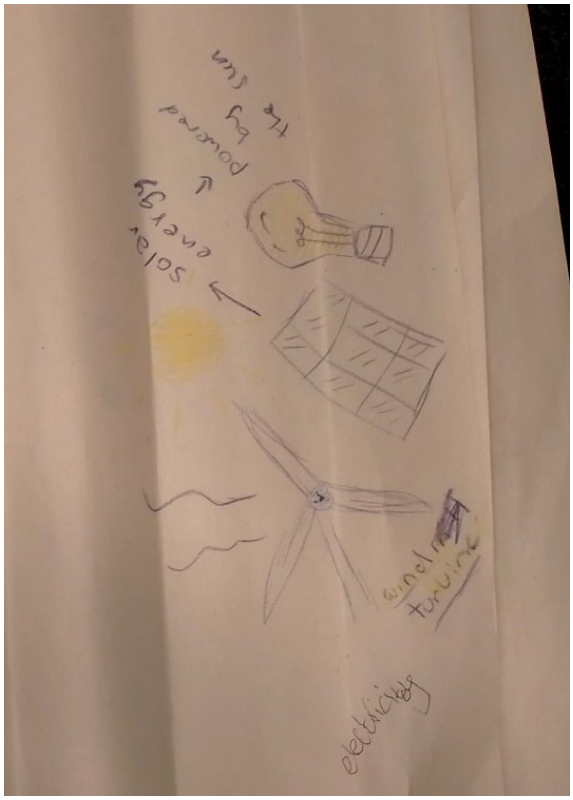

Figure 1(b) Student responses to the question, What comes to mind when you think of energy? Wind turbines, solar panels and images associated with light were common responses

Day 3 pre-and post-evaluation data

There were only two groups that provided post-evaluation data, both were part of the day 3 workshops. Each group had only one class. I have provided their pre-evaluation and post-evaluation data together here for a direct comparison. Tables 3 and 4 contain the pre-evaluation responses. The relevant post-evaluation responses are immediately below each table.

Table 3. Pre-evaluation responses for Day 3, Group 1 students to the question, What comes to mind when you think of energy?

Theme	**Responses**
Energy generators	Nuclear, Solar
Energy types	Kinetic, Radioactivity, Electrical
Human reference	fizzy cola, Emma has lots of energy
Experiential generic	heated floors, friction static, zap on a trampoline

Post evaluation responses for Day 3, Group 1 students

Can't make or destroy energy
We use more energy than we think
Energy is everywhere
Increasing digital tech could lead to us running out of energy

Balloons – equal force out and in of balloon, Catapult – potential and kinetic energy in projectile

Table 4. Pre-evaluation responses for Day 3, Group 2 students, to the question, What comes to mind when you think of energy?

Theme	Responses
Electrical equipment/energy users	ipads, computers, lights, devices, gaming
Energy generators	wind turbines
Scientific reference	electrons, atoms, force
Energy types	elastic energy, potential energy, potential gravitational energy, heat, kinetic
Human reference	movement
Energy generic	electricity, science

Post evaluation responses for Day 3, Group 2 students
Electrons, Gravitational energy, Heat, Wave energy, Force, Protons

Post-evaluation themes

As noted, students did not readily engage in the post-evaluation on the butchers paper and post-evaluation is restricted to the data from the day 3 workshops only. This limitation makes it difficult to draw strong conclusions about the impact of these workshops. There were two groups (two classes) that contributed to the post-evaluation data. The data from Groups 2 is essentially a carbon copy of its pre-evaluation data, which suggests the workshop had no impact. Therefore, all the thematic analysis is based on the responses from Group 1 outlined below.

The themes that emerged from analysis of the post-evaluation data of Group 1 can be grouped into the following:

- Students thinking about/conceptualizing what is energy
- Students considering the problems with human use of energy
- Students remembering the physics behind their hands-on activities (catapults/balloon rockets)

Impact

Pre- post-evaluation data

All four Horsham College Year 7 groups (eight classes) from the first two days that participated in the workshops contributed to the pre-evaluation data. There were strong themes to emerge, but this can only be compared to the post-evaluation data from one group on Day 3. The following analysis therefore has severe limitations and no definitive conclusions can be drawn.

In the pre-evaluation, students' responses were largely images they drew of objects and actions, or single words that reflected objects that use energy (computers, devices, lights), what generates energy (wind turbines, solar panels) and how they connect energy to the human body, for example, movement and how it affects our speed or the amount of work we can do, or food that give us energy (lollies, sugar, energy drinks). Under the theme, Energy types, nine students mentioned batteries and four mentioned kinetic energy.

Of the two groups that provided post-evaluation data, only Group 1's responses, when compared to their pre-evaluation data, is suggestive the workshop had an impact on learning and critical thinking.

As indicated by the post-evaluation themes, the workshops' impact is suggestive that students from Day 3 Group 1, at least, were able to conceptualize and understand energy with greater depth; they could apply that understanding effectively to their hands-on activities; and they started to think critically about FLEET's research problem and its implications for society. For example, there was some consideration of how we value specific digital technologies and the acceptability of proposed solutions to the energy consumption of such technologies.

Student reflection

While not qualitatively recorded and analyzed, in the student reflection that occurred after the hands-on activities, there was some student recall and critical thought about the problem of the energy consumption of digital technologies. Giving up gaming was a surprising sacrifice some students were prepared to make to reduce energy consumption of digital technology. With one or two exceptions, students did, however, struggle to articulate with any clarity what FLEET's research was relative to developing new materials to reduce resistance in electronics. In contrast, most students were able to consider the flaws in their experimental methods and come up with improvements to improve the rigour of their data. They could also, to varying extents, talk about kinetic and potential energy in relation to the balloon and catapult activities. The teachers did note that for a lot of the students this was probably their first time at measuring and recording data in this way.

FLEET Reflection

This pilot workshop revealed flaws of which some were rectified over the three days the workshops were conducted. Further, the method to conduct the pre- and post-evaluation needs further consideration to ensure we can collect data of value to assess the impact of the workshop. Suggestions following discussion with teachers include using butchers paper but getting student to work in small groups of 3 or 4 friends to brainstorm, or create concept maps based on the question(s). This was considered a way to overcome student unwillingness to put their hand up and volunteer a thought during the whiteboard version of the evaluation, and to circumvent the ability to sit and do nothing when left as individuals to contribute on the butchers paper. FLEET has found the whiteboard brainstorming experience is effective with primary school students in years 4 and 5 where student inhibitions appear less prevalent. There is some tightening up of the workshop required to ensure it does not run overtime, yet still be effective, but the modifications that were made over the three days of these workshops helped achieved this to a large extent.

In this particular workshop some consideration needs to be given to linking FLEET's research more effectively to the concepts of energy and force that are presented. Student recall about FLEET research was limited and if we are to achieve our objective of raising awareness of FLEET research then we need to develop better ways to communicate this in this workshop. Students did, however, think critically about the research problem and acceptability of different solutions, they just struggled to directly connect it to FLEET research.