CONSTAT 2019: 5-8 seminar; Saturday 30 March

STEM starting with Hero

Introduction:

- This is a session to promote the Tasmanian Science Talent Search STEM challenge, previously known as the Technology challenge and celebrate the 50th Anniversary of the first moon landing.
- For Grades 5-8, particularly, there are three challenges:
  - A retro-rocket
  - A lunar buggy and
  - Hero's engine.
- The challenges are designed to develop STEM-related concepts and skills.
- This session will not emphasise the communication aspect of the challenges apart from:
  - Maintaining a log book and writing a report.
  - Not neglecting the write-up of the "so-called the failure" as this endorses the process.
- **Learning outcomes e**xpressed simply are:
  - Concept: an enormous amount of energy is required to launch a rocket and achieve a soft landing.
    - The amount of energy can be expressed informally.
    - Energy may be stored
    - Newton's first law – body at rest or uniform motion in a straight line – the rocket on the launch pad or travelling through space
    - Newton's third law – for every action (force) there is an equal and opposite reaction - the thrust of the rocket motors against hard surface and atmosphere at the take-off
  - Skills: mostly measurement-driven activities but other skills could be developed; viz
    - Problem solving
    - Using space and time relationships
    - Hypothesising

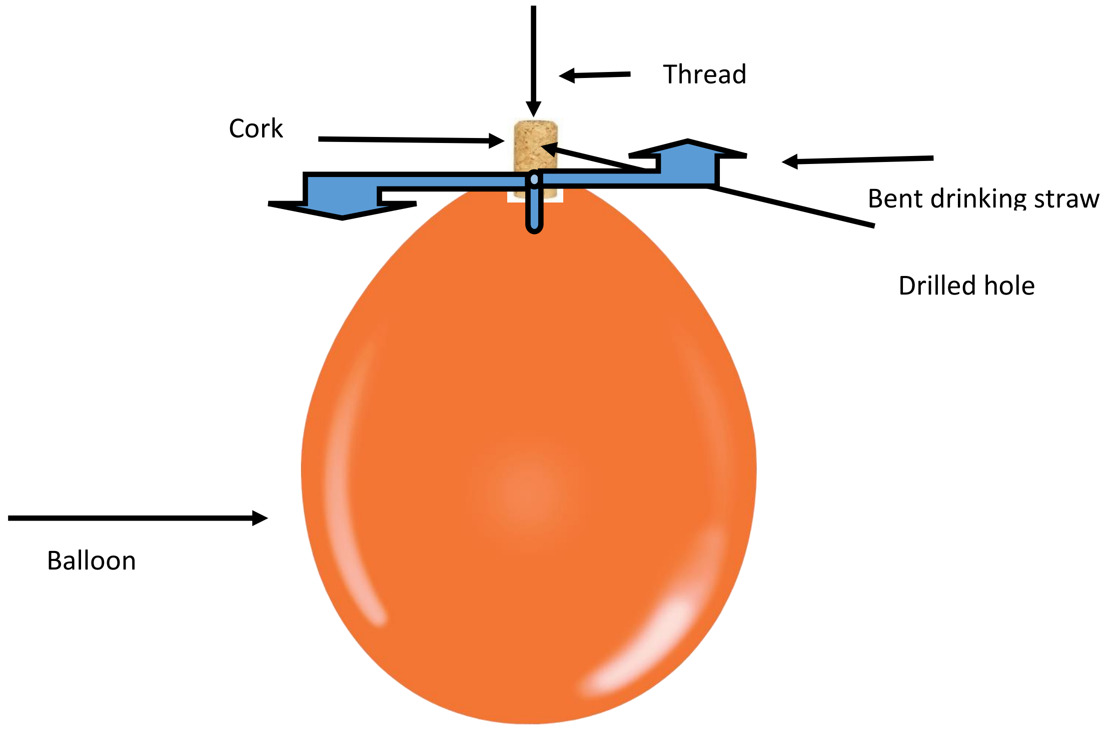
TSTS STEM Challenge 5: an open investigation

- Hero of Alexandria lived in Roman Egypt and invented a device which operated because of the potential energy within water. When water was converted to steam things happened.
- Hero's importance to this 50th anniversary of the Apollo 11 Moon Launch celebration is because of his "engine".
  - STEM debate – E section: Was Hero's engine a machine?
- He lived at the time of Jesus of Nazareth -10 AD to 70 AD – and was an inventor
  - Students studying energy from first principles (grade 6, grade 8) might well start with replicating Hero's devices and understanding the science and technology behind them.
    - A coin in the slot Holy Water vending machine;
    - Wind-powered organ;
    - Wind-wheel for harnessing wind energy on land;
    - A force pump as in a fire engine;

        - An air-pressure fountain
- Inside Hero's engine was the potential for energy from steam, not utilized until:
    - 1698 by Thomas Savery – primitive;
    - 1712-ish Thomas Newcomen – advancement;
    - 1763 James Watt's application and the birth of the industrial revolution
- **Hero's engine encapsulates the principles that reached from the industrial revolution to space exploration.**

The STEM Challenge detail

a. Make a balloon-powered Hero's engine (design below) and improve on it.
b. Make a balloon-powered Catherine wheel operating in a horizontal plane and improve on it.
c. Make a simple and safe steam-powered Hero engine on an established design as shown on-line - search engine - "Steam -powered Hero's Engine" or try, as a start,
d. Apply the design to a working model
e. In a report, describe the science of Hero's engine and relate that to the creation of factories, motor cars and rockets.



Challenge 3: for children in Grades 5 and 6:

Make a balloon retro-rocket "capsule", which when released from a height of 3 metres, descends slowly to the floor.

Time the capsules' descents and calculate the speeds. (S=d/t) The slowest speed will be the best.

Present the project computer-ready (thumb drive or disc) and include a table of information and photographs. Video elements may also be included.

Winners could be asked to demonstrate their projects at the TSTS award presentation.

Limitations:

1. Entries will be individual or small group only.
2. The minimum mass of the balloon and attachments will be 5 grams.
3. On the floor below the launching point design a target and demonstrate the descent accuracy. Control of the capsule is important.
4. An entrant will climb onto a launch platform and, prior to the capsule's release, the length of the drop will be measured.
5. There will be three (3) attempts per entrant and redesign time will be allowed between drops.

The STEM starter

The retro-rocket landing was a major problem for NASA and therefore an achievement for the Apollo 11 expedition.

NASA's objective was to achieve a soft landing at a designated site. In one sense it failed, but only because the earth-bound scientists could not get a close enough look at the Sea of Tranquility.

The students' objective is to soft land a capsule on a designated spot and determine how much energy was needed to achieve the result.

<u>English starter:</u>

- The story of the moon landing is exquisite for drama.
- The videos available should be shown but it is recommended that they not be shown until a teacher narrative and question and answer time has been conducted.
- The size of the landing module was important because it determined:
    - Who exited the module first and who made the grand statement, "One small step for [a] man one giant leap for man-kind."
    - How much fuel was required to achieve a soft landing? As it was, the astronauts landed with less than 30 seconds of fuel left.
- The human emotion must not be ignored.
    - When Aldrin and Armstrong entered the lunar module, they knew that this could be a one-way trip.
    - So did Collins aboard the command module and he would have to be the one to decide that the astronauts would be left to die on the moon if something went wrong.
- "Moon landing, Apollo 11", in the search engine brings us some terrific images shots which need to be enhanced by prior teaching.

Science starter:

- Problem: "Use a balloon as a retro rocket and soft land a gondola/capsule of 'x' weight from 'y' height. Draw up the plan of attack

Technology starter:

- A balloon retro rocket demonstration.
  - Exercise: make a better one and then increase the demands for accuracy
  - Might two or more balloons be used to develop a retro-rocket?

Mathematics starter

- Mock up the lunar module for size. 7m x 9m approx. in 3 components
- Compare the module's weight with a well-known object, e.g. Holden Barina
- Draw up a bar graph which shows several temperatures such as ice, body temperature, hottest place in Australia, boiling point of water, melting point of glass (aluminium, steel), re-entry temperature of the command module
- How much energy is required to soft-land a capsule with a balloon retro-rocket?

The lunar buggy

This challenge is for students who want their technology challenge in electrics or electronics.

The challenge does not relate to the 50th Anniversary celebration of Apollo 11 as Apollo 15 was the first to have a moon buggy, however its conception, manufacture and performance was remarkable but (to my mind) not as remarkable as the achievement of getting it to the moon, soft landing it and releasing it from the lunar module.

Challenge 4: for students in Grades 7 and 8

Make a solar-powered lunar buggy which will travel across a lunar terrain of crushed concrete (or sand, gravel, rocks of different dimensions) spread over a tarpaulin.

Measure the time taken to manoeuvre the course.

Present the project computer-ready (thumb drive or disc) and include photographs. Video elements may also be included.

Winners could be asked to demonstrate their projects at the TSTS award presentation.

Limitations:

1. Entries will be from individuals and small groups only.
2. The terrain will be set on a picnic blanket tarpaulin or similar surface.
3. Run the event indoors with room lighting and some auxiliary lighting.
4. The buggy may be steered by being wired or wirelessly.
5. Entrants must build the buggy, not use a ready-made buggy, but commercial materials may be used in the construction.

6. The buggy should have a maximum wheel base of 200mm and a maximum wheel diameter (including tyre if any) of 50mm.
7. There will be no restrictions on the number of wheels or the style of wheel/traction.
8. There will be starting and finishing gates and the buggies will have to negotiate through three other gates on the track. The finish gate should be a minimum 5m from the starting gate.

Further information - The K-4 challenges:

a. Balloon rockets in horizontal flight and
b. Air propelled (NASA designed) paper rockets and seeing if this could be linked to a balloon lift.

- The K-4 session, a unit of work with STEM starting points is available on the thumb drive.
- Emphasis was given to:
    - Constructivism – finding out what the students already know
    - Assessing the knowledge through SOLO
    - Starting with the English aspect of STEM as the story is the thing.
        - The Apollo 11 mission, which landed man on the moon, will not be fully appreciated unless teachers tell the tale.
        - Human anxiety and drama are not conveyed enough via video.
        - The videos are essential for the understanding of the achievement.
    - Starting with demonstrations because of time but some other K-4 starting points were:
        - <u>Science:</u> How far does a balloon rocket travel on 1, 2, 3, etc lungsful of air? or How far does a balloon rocket travel when it is inflated to 10cm, 15, 20 cm diameter?
        - <u>Technology:</u> What is being learned by working with these commercial toys? How might they be improved upon? What lessons are there in these toys that might be applied to the STEM challenges – balloon rockets and retro-rockets.
        - <u>English 2:</u> Make the NASA paper rocket and test its flight capability. What might be done to improve it? Now make it balloon powered.
        - <u>Mathematics:</u> Saturn V was a mighty rocket, but how mighty? What were its statistics? Measure the rocket and the other components on the oval.

Rocket Activity: 3...2...1...PUFF!

Materials

Sheet of A4 paper

Scissors

Metre stick or tape measure

Eye protection

Copy of paper rocket plans

Adhesive tape

Ruler

Fat, round pencil or dowel

Drinking straws

Procedure

Demonstrate the construction technique for making paper rockets.

- Cut a strip of paper for the rocket body (about 4 cm wide by 28 cm long).
- Use a round pencil as a form and roll the strip around the pencil.
- Tape the long seam.
- Close off one end to make a nose cone.
- Cut out three or four fins.
- Tape the fins to the open (lower) end of the rocket. Bend them outward to space them equally.

After students have constructed their rockets, show them how to perform drop tests to check for stability.

- Hold the rocket horizontally at eye level and drop it to the floor. If the nose of the rocket hits the floor first, the rocket is stable and ready for flight.
- If the rocket falls horizontally or the fin end hits first, the rocket is unstable. Larger fins may be needed to stabilize the rocket.
- Have students perform their own stability tests and make adjustments to their rockets if needed.

demonstrate the launch procedure for the rocket.

- Stand at one end of your launch range.
- Insert a straw into the rocket body.
- Aim the rocket down range and puff strongly into the straw.
- Lift off!