Setlhare science curriculum trust

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Friday, 6 September 2013

Report on the *Energy transfers, conduction, convection and radiation* courses, dealing with CAPS content for primary schools

Contents

Dates and participants

The first course was held on 11 and 12 July and a repeat course on 15 and 16 August 2013. The people who attended were

Allen Barton, Veritas College

Irma Dudley, Sagewood College

Karien Hiscocks, Marian College Linmeyer

Mandy Karvelas, Marian College Linmeyer

Pierre Kibasomba, RADMASTE Centre

Elizabeth Leshaba, Kingsway Christian School

Cathy Linnell, St Peter's for Girls

Jane Ritchie, St Peter's for Girls

Christa Roberg, RADMASTE Centre

Debbie Underwood, Somerset House

Charmaine van der Merwe, St Catherine's

The intended outcomes of the course

The intended outcomes are that participants experience some personal satisfaction as they

- create opportunities for children to ask questions about nature, prompted by real equipment
- ask questions that are based on the process skills, and of course, know what process skills are

- teach energy in terms of systems that have energy-givers and energy-receivers, instead of teaching about “forms of energy”
- design solar systems that absorb as much of the Sun’s energy as possible and retain the energy for as long as possible and . . .
- use tools and materials to make one of these systems as a model to demonstrate the concepts of conduction, convection and radiation
- analyse a problem of recycling waste materials and apply concepts of magnetism to make a device that will separate different kinds of metals.

The course does not aim to take teachers through all the CAPS content for the Grade; that would be impossible in two days. Instead, it assumes that if teachers understand the Grade 7 content from the scientific point of view, and from the children’s point view, they will make good lesson planning decisions.

The activities and content in the course address each of the Learning Outcomes, now known in the CAPS as Specific Aims.

Specific Aim 1: ‘Doing Science and Technology’

Learners should be able to complete investigations, analyse problems and use practical processes and skills in designing and evaluating solutions. This means that learners plan and do simple investigations and solve problems that need some practical ability.

Specific Aim 2: ‘Understanding and connecting ideas’

Learners should have a grasp of scientific, technological and environmental knowledge and be able to apply it in new contexts. The main task of teaching is to build a framework of knowledge for learners and to help them make connections between the ideas and concepts in their minds – this is different to learners just knowing a lot of facts. Discussion must relate to previously acquired knowledge and experience and connections must be made.

Specific Aim 3: ‘Science, Technology and Society’

Learners should understand the practical uses of Natural Sciences and Technology in society and the environment and have values that make them caring and creative citizens. Issues such as improving water quality, growing food without damaging the land, and building energy-efficient houses are examples of everyday applications. Similarly, Science and Technology can lead learners to a range of career and job possibilities. An appreciation of the history of scientific discoveries and technological solutions, and their relationship to indigenous knowledge and different world views, enriches our understanding of the connections between Science, Technology and Society.

The key knowledge areas

1. Systems, potential and kinetic energy
2. Potential and kinetic energy in mechanical systems, and energy transfers in the system
3. Energy transfer; heating a material by working mechanically or electrically on it
4. Energy transfer; heating a material directly by
    a. conduction
    b. convection and
    c. radiation
5. Objects in thermal contact reach a thermal equilibrium

6. Renewable and non-renewable energy resources
7. Energy degradation and the problem that systems make energy less available at each transfer
8. Electric circuits and their magnetic fields
9. Magnetic fields or permanent magnets and electro-magnets
10. Magnetic and non-magnetic materials

The course methodology

It would be possible to cover the knowledge areas above by means of slides, demonstrations, videos and printed notes. This could be done quite quickly, but this approach would not address the intended outcomes and Specific Aims and it’s very unlikely that this approach would promote practical work lessons. The significance of practical work lessons is that pupils experience real matter and materials, and can talk about them and develop the language they need for thinking scientifically.

We all tend to teach in the way we were taught, so it’s very important for a course leader to model the approach practically, with real equipment.

During the courses I give files with notes and refer teachers to them but seldom teach directly from those notes. Teachers are able to read for themselves, so it is better to use the time for interacting with the equipment and each other.

Elizabeth Leshaba working on her solar cooker .

Cathy Linnell setting up a simple demo apparatus; it shows that black surfaces absorb radiated energy more quickly than silver, shiny surfaces.

Jane and Cathy setting up their solar water-heater on the roof of the building.

Irma Dudley and Christa Roberg on another solar cooker, with Peter Moodie asking questions.

Pierre Kibasomba and Charmaine vd Merwe making a part for their solar cooker

Debbie Underwood and Allen Barton use mirrors in sunlight to heat their water distiller; the day was cloudy.

Karien and Mandy setting up their solar water-heater, with Christa and Irma in the background setting up their solar cooker.

Mandy fitting a thermometer to the solar water-heater. It went to 107 °C

Charmaine vd Merwe, Jane Ritchie and Cathy Linnell setting up an array of mirrors to focus the sunlight onto a receiver that is out of sight in this picture. The oil in the receiver went to 90°C within a few minutes. .

The course design

The course design is loosely based on Kolb's model of experiential learning – participants do an activity that we then analyse for new ideas or new problems, and then go into a related activity in which those problems can be resolved or questions answered.

Participants normally write a personal baseline test near the beginning of the course and then re-write it on the last day. They mark their own pre- and post- tests and can see any gains they have made. (In fact the post-test didn't happen because we ran out of time.)

On each day, participants do technology or science practical activities in small groups, using mostly materials and equipment that can be bought from supermarkets or are clean, re-cycled materials. We try to make the point, by example, that a great deal of prac work is possible in an ordinary classroom and without formal laboratory equipment. We do not use a laboratory and we work in an ordinary flat classroom with loose tables.

The number of activities range between between three and five on any of the four days. Extended discussion activities range between two and three per day. The course includes short films of power stations that use coal and sunshine.

In this course the activities were

- using a mouse-trap, converted into a sweet-throwing machine, to explore the concepts of potential and kinetic energy
- heating a wire by bending it back and forth, to experience the meaning of mechanical working on a material
- heating steel-wool to make it burn, using just a battery of four torch cells - electrical working on a material
- using equipment to demonstrate to each other

  – conduction of heat along rods of different metals;

  – how paper will not burn when in contact with a good conductor like copper

  – convection in water (using food colouring) and in air (using smoke)

  – radiation is faster from a hot black surface than from a shiny silver surface

  – black surfaces absorb radiation faster than shiny silver surfaces
- setting up an array of mirrors to concentrate energy from the Sun onto a receiver
- designing making and testing solar devices

  – a solar cooker to cook some peas

  – a solar water-heater to heat some water

  – a distiller to purify salty water
- tracing the field of a bar-magnet using plotting compasses
- making a solenoid and investigating the effect of an iron core
- making an electromagnet to separate magnetic from non-magnetic metals.

We do use a few pieces of equipment that must be bought from lab suppliers, such as thermometers and meths burners.

Evaluation comments from teachers

Teachers wrote comments along with rating the sessions and activities. The ratings were generally good. I have extracted some of the comments below. If they seem a bit glowing, it is because there were no negative remarks among them for me to quote.

. . . I thoroughly enjoyed the course and will leave feeling totally inspired as well as comfortable knowing that I’m on the right track. . . .

My feelings about the course is that it gave me an open mind about teaching technology not using expensive equipment.

. . . Thank you for the very pleasant atmosphere and the friendly way in which all aspects were covered with the questions and topics. . . .

The hands-on running of the course is very beneficial. Thank you.

It was great, at a level that I could understand.

I know I can pass this knowledge to my students & I’m more confident to teach electro-magnetism & won’t be intimidated by the experiments in the textbooks. Worth every cent the school paid.