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Welcome to **ATTACK!** a two-page occasional publication. Most of **ATTACK!** will be concerned with the holistic curriculum which, if acted on, is a fundamental way to undermine the present undemocratic education system. Don't be discouraged if opportunities to teach holistically are limited, do your best, be a guardian, and act as a witness to this culturally significant and inspiring way of teaching and learning. **ATTACK!** is a partner to https://networkonnet.wordpress.com

Attack! 52 Where is the science?

This is an exercise to set out a structure for science in a way similar to the one I use for social studies. In a sense, it is something of a game for my own interest that may be of some interest to the reader. The purpose is to make science more approachable and manageable for the classroom teacher. It is intentionally placed before **Attacks! 53-54** which are based on an article written some decades ago by Tony Fisher a highly respected science adviser. Tony's **Attacks!** set out with wonderful clarity how to undertake structured science investigations which he said, and everyone in science agrees, are at the heart of school science – at the heart because they are about how science knowledge is developed and how it is changed. Tony, however, is somewhat dismissive of other forms of studying science, calling them 'study skills'. I understand his caution and reservations; readers will know I am dismissive of much that goes under the heading of 'inquiry learning', but I disagree with Tony in his apparent disregard for less structured forms of science, for instance, that might be based on open-ended science studies involving curiosity-arousing opening activities, careful observation, hypothesising, activities exploring hypotheses, discussion, and changes to hypotheses as decided on information brought forth. I see such approaches to science as contributory to, and supportive of, structured investigations, and crucial to making science manageable for classroom teachers. As well, even Tony agrees there are a good number of important science topics, not amenable for classroom investigation or not easily amenable.

With the purpose of making science more approachable and manageable, first, how to structure the science programme overall.

In a 2007 posting on the science section of the new curriculum I wrote:

I suggest that teachers plan for science on the basis of aims: the same aims for all children no matter their year level.

As it happens, the Level 3 achievement objectives, on the whole, seem to provide the most centred contributory aims to the overarching aim. In writing school plans, teachers should move freely around the levels (as I have) looking for what strikes them as the most appropriate for that part of science. The contributory aims for junior children in, say, a material-world topic, can work for older children and in that way provide a sense of cohesiveness and clarity in school science – it is up to, and better for, the teacher to develop the teaching and learning processes from there.

As for the actual science topics, these can be allocated in the time-honoured way, odd and even year, but the allocation should not be mandatory, it is the contributory aims that should control. No matter what the column: as science opportunities occur, any contributory aim should be able to be picked up and extended.

The part of science most important to children's science literacy, and perhaps somewhat neglected in past practice, is 'Nature of science'*. It gets consistent attention in the lists that follow.*

A key question throughout is: Where is the science?

To make science work for children, clear connections with understandings gained from previous science topics should be sought and established, also from the processes followed in 'Nature of science'*.*

As for science knowledge, the Building Science Concepts *series of booklets, provided to all schools by the ministry, is excellent.*

Main aim for science at ... School: Children's willingness and ability to make sense of the world by understanding the nature of science, and observing and investigating phenomena from the living world, earth and beyond, the physical world, and the material world – the main purpose being to develop in children scientific literacy.

Key learning process: The interaction of the cognitive and the affective.

Key contributory aims

Nature of science: Appreciate that science is a way of investigating and explaining the world and that science knowledge changes.

Ask questions, find evidence, explore simple models, and carry out investigations.

Use science knowledge when considering issues of interest or concern.

Living world: Understand that there are life processes common to all living things and that these occur in different ways.

Understand how living things are suited to their particular habitat and how they respond to environmental changes.

Understand the interdependence of living things in an ecosystem.

Group plants, animals, and other living things into science-based classifications.

Earth and beyond: Understand the processes that shape and change the surface features of Earth.

Understand how natural events and human actions affect conditions for living on Earth.

Understand the cycles that result from interactions between the Sun, Moon, and Earth.

Understand the interrelationship between human activities and the geosphere, hydrosphere, atmosphere, and biosphere over time.

Use the concepts of distance, time, and gravity to explore information about stars, galaxies, and the universe.

Physical world: Understand scientific ideas to explain physical phenomena, such as movement, forces, electricity and magnetism, light, waves, sound, and heat.

Understand how energy unites a range of phenomena and can be transformed from one form to another without loss.

Use physics understandings to consider technological solutions to a range of issues.

Material world: Investigate the physical and chemical properties of a range of materials and changes that occur when materials are mixed, heated, or cooled.

Understand the particle nature of matter and use this to explain observed changes.

Investigate chemical reactions of a range of substances and identify these occurring in everyday situations.

The following is Tony Fisher's four step investigation process.

1. **My question**: The investigator records what he or she discovers in response to that question.
2. **What I know now**: The investigator records all he or she knows about the question. If the person already knows the answer, then there is no point in investigating it further. The educator can also at this stage make a judgement as to whether it is possible for the learner to investigate it in the time available. Many topics like volcanoes and dinosaurs lend themselves to study-skills rather than investigation processes.
3. **What I did**: This is the vital stage. What differentiates science from propaganda? It is a step-by-step record of what actually happened; it is often in diary, note-taking form. It records how the children went about observing, testing, and trying out their question. It is vital to record the failures as well as the successes. Others can read what went on and may suggest ways to revisit the investigation by another route. More importantly, it may help show others not to go along that path. Investigators also need to include references about their sources, those who helped, and testing methods used.
4. **My answer now:** This should answer the first step, above. It is the conclusion reached on the basis of the evidence above. Are the conclusions reached validated by the evidence?

Can I replicate your methods and reach the same or similar results?

Thus, to be scientific, an investigation must:

- Be observable
- Be capable of being tested
- Be capable of replication with the same or similar results
- Have conclusions able to be verified from the data presented.

Terrific! Where the science is, is obvious in such an investigation but what about in the less structured forms of science referred: how can the science be confirmed as having occurred in them?

My response is that it can be confirmed as having occurred if it meets most of the criteria in the following list.

Children's willingness and ability to (*willingness* encompasses the attitudinal and *ability* knowledge and skills) –

- Be at ease with science complexity
- Ask questions about science
- Make careful observations
- Be interested in science phenomena and their causes and significance
- Recognise that science is about change
- Think creatively about science
- Think logically about science
- Recognise patterns and connections in science
- Make valid comparisons amongst science phenomena
- Develop hypotheses for explaining science phenomena
- Plan and undertake science investigations
- Use and understand text types, models, diagrams
- Gain information and express their understandings using a range of sources and technologies
- Pursue science inquiry and understandings in their own time.

This list of criteria is for evaluating children's science behaviours. It is also, as referred to, there for confirming or otherwise, the answer to the question: Where is the science?

To help my thinking about science I read *Constructing your primary school's science curriculum* (NZCER). A thoroughly recommended publication