Problem-solving in primary science

SUZANNE GATT DISCUSSES ITS USE AND GIVES SOME EXAMPLES OF ACTIVITIES DESIGNED BY STUDENTS

Activities in primary science may involve children in carrying out simple investigations, making observations, testing ideas, or investigating scientific phenomena. They can seek patterns and draw conclusions about how things work. Children may also carry out independent research, consulting books, CD-ROMs, etc., to find information about a particular science topic. Or, primary science may take the form of problem-solving activities.

In a problem-solving lesson, children are presented with a 'problem' or a 'challenge' (Tunnicliffe, 1990, 1992). Children are given time to think about the problem presented and to come up with possible solutions. The scientific concept or concepts involved are identified. The rest of the activities organised will then focus on ways to investigate these scientific phenomena in order to test the suggested solutions. The nature of the problem set will be influenced by the age and experience of the children involved. Should the problem be too demanding or too easy it will lose its effectiveness.

A problem-solving activity can be divided into four main sections (Harlen and Jelly, 1997):

- **Setting up the problem**. This focuses on ensuring the problem has meaning for the children. It is best to choose a situation relevant to the experience of the children, whether real-life or fictional.
- **Preliminary exploration**. The children consider the problem and think up ways of tackling it. The scientific phenomenon concerned should be emphasised to avoid the activity becoming design and technology.
- **Investigating**. Once a number of possible solutions have been put forward, children can design investigations to test the effectiveness of their ideas. This provides a good opportunity for children to practise controlling variables, deciding how to make observations and what measurements they need to take.
- **Concluding discussion**. When the investigations have been completed, the results are discussed and conclusions drawn. Children should also be given the chance to compare their observations to ideas they previously held. Construction of scientific knowledge should be an integral part of the activity.

However, problem-solving activities can also take other forms. In planning such activities, a number of issues, as Lock (1990) argues, need to be addressed:

- **Whose problem is it?** The problem presented to the class can be thought up and designed by the teacher, put forward by the children, or identified by teacher and children together. What is important is that the problem is relevant to the children so that they can readily take ownership of the activity.

How many solutions are there?
In closed-ended problems there is only one possible solution. In open-ended problems more than one solution is possible. Children tackling open-ended activities are encouraged to come up with as many possible solutions as they can.

Who knows the answer(s)?
Most often the teacher knows the possible solutions to the problem posed and can direct the children's investigations towards productive solutions. However, in other cases, not even the teacher will know the exact solution to the problem, and is involved together with the children in finding solutions. The latter usually occurs when the problem is put forward by the children themselves or together with the teacher.

Examples of problem-solving activities

Boxes 1 to 3 give examples of problem-solving activities developed by fourth-year BEd(Hons) primary specialist students at the University of Malta and tried out during their teaching practice.

Box 2 Who left the message?

The teacher tells her class of 7 year-olds that she has a problem. Somebody has left a note on her desk that morning but she cannot read it as she has smudged it with her coffee. She cannot make out the words because the ink from the felt-tip pen used has spread out. Nor can she ask her colleagues, as they are busy with their own classes, but she has borrowed their felt-tip pens from their desks. How can she find out who has left the note?
The children were allowed to brainstorm ideas for possible solutions. Some suggested asking the other teachers at the end of the school day, but what if the note was urgent? Eventually some children came up with the idea of testing the different felt-pens to see how the ink spread out on paper when water was spilled on it. The rest of the lesson was taken up with this chromatography investigation. The children studied the different patterns and colours obtained. They noticed that the ink from some of the felt-tip pens consisted of a single colour whilst that of others separated into different colours. The children succeeded in discovering which felt-tip pen was used to write the note.

Box 1 Sparkling Christmas presents

This activity for 9-year-olds is orientated towards Christmas festivities. The teacher is discussing the coming festivities with the children and asks for their help with a problem she faces. Traditionally, every year she buys presents for children at the local orphanage. The children really enjoy opening their presents. This year, however, she has a problem: she does not have enough money to buy the presents. All she has available are shoe boxes, several pieces of wire and a number of small bulbs and batteries (1.5 V). Can they help her come up with a solution?
The children came up with a number of options. Most of them involved setting up an electrical circuit to light bulbs. The lesson developed around learning about making circuits, that a closed circuit is needed to light a bulb, and that they can be connected in series or in parallel. They also investigated which bulb connections would make the bulbs brightest. The children then opted to build a Christmas tree with lights. This proved to be a motivating way of teaching about electric circuits.

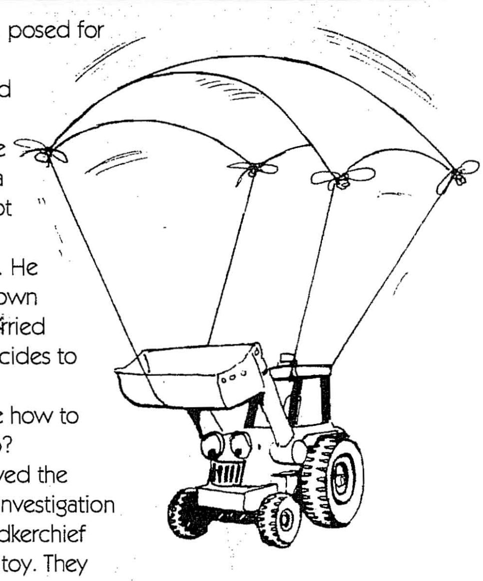
Discussion

These examples of the problem-solving activities developed by student teachers promise well for future good practice in science in Maltese primary schools. Such activities promote independent thinking while, at the same time, making science more interesting, enjoyable and relevant to children's everyday lives.

In organising problem-solving activities, however, one must bear in mind a number of points. The examples given here each have an element of design and technology in them. It is important to be careful not to allow the activity to develop into a technology activity rather than a science one (Harlen, and Jelly, 1997). The emphasis must be on the science concepts involved, and teaching needs to ensure that these are considered and investigated in detail. The problem is used more to set the scene than for rigorously testing the solutions to find the best one. Otherwise the activity would be an example of design and technology rather than science. On the other hand, problems can be set that do not involve an element of technology. Problems can be said to fall within a spectrum ranging from simple scientific questions such as 'Why do beans always sprout upwards, whatever direction you plant them in?' to those that make a greater demand on technological aspects.

Another concern is the nature of science presented by these activities. If such an approach is overdone, science is presented as being concerned only with producing solutions to problems. Problem-solving is just one aspect of science: science also involves a search aimed at understanding better how the natural world works, and testing out ideas that may not arise from a problem. It is important that the image of science given to children at an early age is not biased towards one aspect of science, that of problem-solving.

Box 3 **Parachute descent**



The setting for this problem posed for 9-year-olds involves two brothers, one on the second floor of his house and the other in the yard below. The boy upstairs wants to give a toy to his brother but cannot go downstairs because his mother is washing the floor. He will have to drop the toy down from the window but is worried about breaking it. So he decides to make a parachute out of his handkerchief but is not sure how to do it. Can the children help?
The activity following involved the children in carrying out an investigation on how the size of the handkerchief affects the rate of fall of the toy. They dropped various types of parachutes they designed from the school's second floor, observing the flight and timing the fall. Eventually they were able to draw conclusions about how the area of the parachute was affected by air resistance. This activity provided a good opportunity to study the relationship between air resistance and surface area. The discussion was extended to the effect of air resistance in other everyday situations.

Problem-solving activities must only be organised sparingly at primary level, enough to make it more attractive to children and to expose them to another aspect of science. They should also be focused more on the science involved than the success of the solution. Like any other activity, the effectiveness of problem-solving in science ultimately depends on the good judgement and delivery of the teacher.

Acknowledgements

Thanks to Dr Sue Dale Tunnicliffe for commenting on drafts of this article, and to the primary specialist students for their ideas, especially Michelle Cutajar and Karen Cutajar who also supplied the photographs.

References

Harlen, W. and Jelly, S. (1997) *Developing science in the primary classroom*. Harlow: Longman.

Lock, R. (1990) Open-ended problem-solving investigations: what do we mean and how can we use them? *School Science Review*, 71(256), 63–72.

Tunnicliffe, S. D. (1990) *Challenge science: Living things*. Oxford: Basil Blackwell.

Tunnicliffe, S. D. (1992) *Challenge science: Earth, air and space*. Oxford: Basil Blackwell.

Suzanne Gatt, formerly a science teacher, lectures in primary science and environmental education in the Faculty of Education, University of Malta.