

First Experience of Science

The Art of Introducing the Essence, described

by ROLAND EVERETT

*My heart leaps up when I behold
A rainbow in the sky:
So was it when my life began,
So is it now I am a man,
So be it when I shall grow old
Or let me die!
The Child is father of the Man:
And I could wish my days to be
Bound each to each by natural piety.*

W. Wordsworth

Does your heart still miss a beat, when you see a rainbow in the sky? Or, as the years are slipping by, has it become dulled by habitual sense perceptions? How easy it is to take the phenomena of nature for granted. And yet, each phenomenon is a kind of question, silently waiting to be answered or, as with Goethe, 'an open secret' whose discovery can renew the links with the powers of creation, with the divine world itself. Wonder at the wisdom and beauty of the world sets the mood in the first science lessons, given to twelve year olds.

All these rainbows

Several years ago I was asked by a parent during an exhibition of young children's paintings at Elmfield School, 'What is the significance of all these rainbows hanging on the wall?' If only I had had the presence of mind to answer him, 'Children paint rainbows simply because they love them.' For the young the world retains the freshness of a spring day, it remains as new as at Creations Day. Who does not feel that no

apple can match the taste of those savoured in early childhood? Which summer can be as glorious, which winter as bright and exhilarating as those of the good 'old' days? Children today still look at the rainbow with the eyes of Noah after God had put it there into the sky as His sign. And it is this same rainbow which still hides the secrets of light and darkness and their interactions, quite apart from a host of other questions, such as Where is its exact position in the sky? Can we pass under its arch? If not, why not? Which colour is uppermost and in which sequence are the colours arranged? What makes a double rainbow appear in the sky and how are the two sets of colours related to each other? Can we ever see a complete rainbow circle? If so, what must our position be? etc.

Fingerprints of God

The teacher, entering this situation in his class six, now has the task of leading his pupils into observing the world in quite a practical and 'down to earth' way, while at the same time fostering their natural piety in the sense of Wordsworth's lines. Accurate observations of simple and homely experiments made in the classroom now become a kind of whetting stone upon which the emerging powers of thinking can be sharpened. If for instance a resined violin bow is drawn across the rim of a glass bowl until a clear note rings out, and then water is poured into the bowl, the pitch of the note

will become lower and lower as the water-level rises. Why should this be? To discover such underlying causes, the young scientist must become a kind of detective who, when following his clues, will not be led to the customary criminal at all, but to a pattern of order and wisdom, comparable to the very fingerprints of what we conveniently call God. But how difficult it is to learn to look and observe, not to be misled into ready-made answers or preconceived and vague ideas which can be completely off the mark! (Example: When in lessons on 'Heat' the expansion of water inside a bottle was shown, a pupil who was asked to think of other examples in daily life wrote: 'In a similar way rivers rise in summer until they burst their banks with a flood . . .')

Artificial sunset

First only the phenomenon, i.e. the experiment, must speak while the young observers must try to develop an inner silence, and this is very hard at the age of twelve! Then, one or two days later, the exact recounting of the relevant sequence of events may lead to an understanding of underlying causes. Finally — and this is the hardest step of all — these findings have to be put down clearly in writing without unnecessary repetitions or padding, while at the same time no leading point must be overlooked. One girl began her 'scientific' account of the string-telephone experiment with: 'Yesterday it was a gorgeously sunny day, just right for doing our experiment with the string-telephone outside . . .' A boy, following the exhortations to be exact, began his composition about how pupils could identify objects by the sound made when knocked or tapped, with quite ominous sounding words: 'On Wednesday, 26th of April 1978, at 9.45 a.m., Mr. E. blindfolded a pupil who had to guess what was knocked because sound tells you exactly what things are.' Another girl described how sound can reveal symptoms of illness by writing: 'If you go to the doctor's, he always knocks your chest to make sure you're alright.' In a composition about how smoke appeared blue when seen

against the dark background of the blackboard, one (slightly delinquent) boy found it necessary to justify his teacher's action with the words: ' . . . but Mr. E. only smoked a cigarette to show us how blue comes about. He would never have done it otherwise.' Other descriptions showed a delightfully imaginative approach. When for instance strips of glass were held over a burning candle flame in order to allow a layer of soot to form on the underside, pupils were asked to make one part of the glass opaque and another translucent, leaving one small area clear or transparent. Several of them described it thus: 'One part of the glass we made into night, another into twilight and the rest was left daylight. And when we looked at the sun through the twilight part, it looked orange. We had made an artificial sunset at midday!'

The compound is happy, Sir

Which adult has the heart to interfere with such innocent charm? And yet, just as the young child learning to speak, eventually has to be weaned from making its own quaint words, these children now have to learn to lift their own rich feeling-life into the clearer mountain air of thinking. This means hard work which cannot be achieved from one day to another. Among a mainly dreamy approach towards observing experiments, instant comprehension and pure logic can also be witnessed. Thus, while blacking his glass strip over the candle flame, a boy shouted excitedly, 'I can see myself in it — that's how mirrors work!' In a flash he had recognised the principle of the mirror, viz. light being reflected from a smooth surface with an opaque background. Another boy, after having been shown some days previously by several experiments how light itself is invisible, challenged me with the following words, 'Why do you draw sunrays on the blackboard, if they are invisible?' I asked him, 'What about your thoughts, are they visible? Can I see what you are thinking? But how do you make your thoughts visible?' He realised that writing was a means of conveying invisible thoughts. I

Blowing across
the mouth
of a test
tube or
bottle causes a
moving air-lid.
The breath
makes the
column of air
inside
the test tube
vibrate.



Vibrating column of
air inside the recorder
produces high and low
notes according to
closing or opening of
finger holes.



continued, 'In a similar way a diagram can make light visible, so that we may understand better how it spreads and what it does.' In this way the difference between drawing a picture, a geographical map and a scientific diagram could be made clear. However, despite such an unusually logical attitude, any direct appeal to the intellectual grasp of scientific phenomena would be completely meaningless to most children of about twelve, because their as yet latent thinking capacity needs to be gradually awakened from below upward. One begins with where they are in their present stage of development: They respond to the world mainly by physical activity directed strongly by inner feelings, rather than by logical thinking. This posed quite a few problems. We held a vibrating tuning fork closer and closer towards the opening of a sea shell until suddenly the volume of the tuning fork's sound increased many times. How could one explain this principle of resonance in a 'feeling' way? A long forgotten episode came to the rescue: A colleague who had lived in Africa, once described how one evening in a native kraal he heard ringing laughter coming from one of the many huts. This laughter appeared so infectious that ripples of it spread from hut to hut until the whole village was full of laughter. Then the chief of the tribe announced to the white man with a beaming face, 'The compound is happy, Sir.' — Well, that vibrating tuning fork laughed in its own way. Its laughter was so contagious that all the air inside the shell — inside the compound — joined in with it, thus swelling the sound. Is such a picture an unforgivable sin in the eyes of a real scientist, I wonder? It certainly helped to convey some meaning to what is generally referred to as 'vibrations in sympathy'.

Discerning ears

When studying the laws of Pythagoras in Acoustics, a good opportunity offered itself to link up again with a past main-lesson period of Greek History. The cultural life which blossomed on so many Aegean islands was recalled, especially that of Samos, where

Pythagoras had his famous school. One day, while walking through the beautiful Mediterranean landscape, his curiosity was evoked by the sounds issuing from a nearby smithy. Thousands of other Greeks had heard these same musical sounds of hammers striking red hot pieces of iron on anvils before, but to the searching mind of Pythagoras they were like questions knocking at his door: 'What is the difference between a musical sound and a mere noise?' he asked himself and in time discovered the laws governing the number relationships of harmonious and discordant intervals. (A subject as yet too advanced for pupils of this class). 'In what way does the particular pitch of a note arise?' he wondered, and experimented with metal plates, making a first glockenspiel. He found out which characteristics determine the pitch of a plucked string and this the pupils could easily discover for themselves by plucking ordinary household strings of varying length and thickness. They could also play melodies on one and the same length of string, simply by changing its tension, i.e. by pulling and releasing the string. Every time we play a violin, we apply these three laws of the pitch depending on length, thickness and tension of strings: The tuning pegs alter the tension, the lower strings are thicker than the higher strings and when playing a melody, the string is shortened or lengthened by the playing fingers of the left hand. Pythagoras continued in his search: There are innumerable sounds in the world. In how many ways can all these sounds differ from each other? Through his thinking he could reduce them to only three kinds: to volume, pitch and quality (the latter caused by overtones, another subject best left out at this stage). Yet, how could one explain the quality of a note? Two girls were asked to come out and sing the same note with their backs turned to the class, one girl singing at a time. To discerning ears it was quite easy to identify each voice, for each sound has its own and quite individual 'voice', and this is called its quality. We can always distinguish which

particular instrument is playing a note by its quality or timbre.

Blown, plucked or struck

These studies quite naturally led to the three kinds of instruments of the orchestra, where instruments are either blown (wind), bowed and plucked (strings) or knocked and struck (percussion). The following remarks may be touched upon if the right moment offers itself during class conversations, for children at this stage are too young for any conceptualised or philosophical ideas. However, if they live in the teacher's mind, they may nevertheless set the mood of what he has to say:

With which part of our body do we blow a musical instrument? With the mouth, the breath being lifted up into the region of the head. With which part do we knock or hammer? With our limbs. What is the characteristic movement of bowing a string instrument? A forward-backward movement, just as we make it with our lungs and ribcage when breathing. And so, among the head, chest and limb instruments of the orchestra, the familiar picture of a hidden man appears. (Let anyone disagreeing with the comparison of bowing a string instrument with breathing observe his own breathing, when he has not enough bow left to sustain a long note! The bow makes the string vibrate in a very similar way in which the breath activates the vocal chords. Bowing is very akin to breathing, although in speaking and singing we produce sounds only on the outgoing breath. When plucking strings, we already approach a sublimated percussive quality. Plucked string instruments, such as the harp and the harpsichord, were the forerunners of the piano, where hammers hit strings).

All instruments of the three sections must play together just as our thinking (head), feeling (breath) and our doing (limbs) always have to work together, although usually one or the other of them predominates. As with people in life, some instruments will come more to the fore, while others may have to play 'second fiddle'. Some may have to wait

patiently, but they must be awake at the crucial moment to deliver the one and all important sound that will release a built up tension in a climax of clashing cymbals or thundering kettledrums.

Down to earth

But among all these players there is one man who stands erect, almost aloof from all the rest, right in the centre, and who does not produce a single note at all: the conductor. His baton is like the extension of his pointed finger with which he inscribes his musical inspirations into the plasticity of the air-space, communicating his ideas by means of gestures and by sheer telepathy. He is like the all embracing 'I', which impresses its individual seal upon the whole body of players.

And so, from the rainbow in the sky the teacher tries to lead his pupils down to earth, right down to the technicalities and natural laws governing musical instruments. The children help him to uplift his vision to those pristine and untainted regions where life began in childhood. At times, the roles of teacher and pupil become interchangeable in quite a remarkable manner. The Child becomes father of the Man.

With thirty-one years' teaching experience, Roland Everett is starting a new class at Elmfield School.

An Elmfield 12-year-old illustrates acoustic phenomena. They respond to the world mainly by physical activity directed strongly by inner feelings. . . . ▷



String Telephone

