Environment

A MAGAZINE OF SCIENCE

Issued once each term under the direction of
The Science Teachers' Association of N.S.W.

VOLUME I. FEBRUARY, 1934. NUMBER 2.

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SCIENCE, CULTURE, AND EDUCATION

(Extracted from *The Australian Quarterly*, December 14th, 1933.)

" I HAVE yet to meet a scientist who prides himself on his ignorance of the classics ; I have met many who had a far sounder appreciation of the great literary works of the past than had their contemporaries who received purely a so-called cultural training ; and I meet some who have maintained their familiarity with the Ancient Authors and are able to quote Latin or Greek for their purpose. Most people who have specialised in scientific work draw freely upon the storehouse of the past, maintain particularly an interest in the history of the development of science, and regret that they have not more time to spend in reading and thinking outside their specialised researches. We regret also that there are people trained as specialists in certain branches of science who are uncultured, not only in that they are unfamiliar with the ancients, but that they are unacquainted even with the best in modern literature.

" I meet many people who live mentally in the past, whilst accepting all the aids and conveniences of the present ; they regard the sciences as vulgar upstarts, who have blatantly disturbed the happiness of a peaceful world ; both in practice and in theory, metaphorically and literally, they would return to the one-furrow stick plough. It is possible that men were happier in those times, particularly when the sturdy women both drew and guided the plough ; whilst the men fought and killed one another in less civilised ways than they employ to-day. Would it be pleasant to go back only so far as Roman days, and live in the period when literature was much and science was little ? I rather feel that I might have enjoyed being a Senator, with plenty of slaves, in the few brief intervals when it was relatively safe to be a Senator ; I would have moved rapidly away from all centres of sickness, and of course would have been careful never to need a surgical

operation. I could dispense quite happily with radio, telegraphic communication, electric light, and many other blessings of applied science ; I feel no urge to go to England in four days by aeroplane, but prefer a comfortable, safe steamship to take me there in a month. In fact, we all want to accept all the benefits science has conferred, when and how we want them.

" No matter how much we may wish to revert further and further to the animal, we find ourselves in an environment which, though frequently uncongenial, is developing further and further towards that of a cultured human. Our civilisation is that of the main body of humanity.

" We have to accept the fact that we are advanced into a period in which the sciences, for some time wrongly regarded as the vulgar invaders of our educational system who refused to stay in their humble stations, are an essential part of our circle of cultural friends. They have never learnt to sing ' God Bless the Squire and His Relations ' —but we have to recognise that it was not necessary, as they were only the new poor of an aristocracy of that earlier period when the classics were modern. We will all agree that there are boorish and uncultured scientists, but scientists as a body demand the use of the precise phrase and word, and seek the aid of specialists in word and phrase ; that the wrong idea is frequently conveyed is not alone the fault of the scientist, but also the fault of those uncultured people who are unable to give him the specialised assistance he asks, because they have not even an unspecialised acquaintance with science.

" It is frequently stated that it is not sufficient to become familiar with the great thinkers of the past through translations of their written works, because it is not possible to render in modern language the precise value of the ideas conveyed ; the answer given to that is that very few of all who study ancient languages advance so far as to be able to get more from the original than from a good translation. To-day we want every boy and girl to be given a training in the fundamentals of Physics, because their lives depend on the applications of the principles of that basic science, and they are uncultured and uneducated if they are ignorant of such principles ; but we do not suggest that it is practicable to advance more than a very small percentage of them to the standard in which they could be regarded as physicists.

" One of the big advantages of Latin is that it is a dead language : furthermore, as taught in schools, the periods of its childhood and of its somewhat decrepit old age are not examined ; a grounding in Latin is valuable as teaching

orderly and formal presentation. A logical, experimental science such as Physics gives also a training in the formal examination and presentation of ideas; it endeavours to ensure precise observation, precise definition, and correct deduction; it also trains the student in the elements of induction.

" In addition to filling those functions in an educational course, Physics opens our eyes and our minds to what is happening around us. Whilst every happening must be natural, humanity is now so set on bustling old mother nature that we are completely out of touch with our surroundings if we saunter through life misquoting 'the classics,' writing bad verse, or criticising one another's indifferent music or paintings. There is quite a lot to be admitted in arguments that we should be trained to appreciate good music, good pictures, good literature, good living; but we require even more a knowledge of the elementary laws of our existence on this earth. It is quite time that we moved forward from a three-hundred-year-old interpretation of 'culture,' and recognised the fact that we are a considerable improvement on our ancestors; if we deny that improvement, then it is surely time to alter our standards of education, and give to science, including the sciences of Music and Art, an opportunity to show their cultural value.

" I have put forward particularly the claims of Physics; I would even go so far as to say that it, if any, should be the compulsory subject in a school curriculum, because it admirably fills the requirements of the 'educationist' and also supplies essential knowledge, and contact with the world; but I recognise quite fully that the contact is far from complete without an added grounding in biological science. Before we can know anything of living matter, we need to know laws within which inanimate matter acts; an introduction to elementary biology requires first of all a knowledge of the elements of physics.

" For Chemistry and Geology—fascinating subjects of study for all save a small percentage of scholars—there is also a very important place in modern education; but it must be admitted that they are more specialised sciences, and based on a preliminary knowledge of the fundamental physical laws. There is no doubt that the information gained from a study of general science subjects is very valuable: but they are all in a different class from Physics as a means of training the student, who can later pass readily on to an appreciation of these more technical sciences; in the same way students should not proceed to a consideration of special sections of applied physics (bio-

physics, physical chemistry, geophysics) until they have a knowledge of the principles and laws involved in both subjects thus fused.

" There has been, unfortunately, a tendency to think that we should cram the young student's mind with all things that are known ; when that fails we feel that we should offer him a smattering of everything, so that he will continue to fall into such errors as make it appear that he really understands nothing, whilst he thinks he knows everything ; then in despair we say, ' Put back the clock ; the education of our grandfathers produced cultured gentlemen.' This brings us back again to our happy days with the one-stick plough ; or further back to those spacious times when there were no worries over education at all, corresponding to the agricultural period of the acceptance of such grains, roots and fruits as grew, without our making effort to improve them.

" Our children are young ; and our contacts with life are changing, whether we like it or not. Our object in endeavouring to educate the children is to enable them to live happy and useful lives, not only whilst we are still here to help them, but in the future when we have permanently retired from mundane matters. We can clearly see the trend of human activities, how we are rapidly exploring new methods of utilising our accumulated knowledge, how we are moving into a period in which scientific marvels become commonplace conveniences. We may be content to accept, and to let others think for us ; humanity lags a generation behind its leaders, acting either as an effective brake or as a burden according to our point of view. Are we trying to hold our children back with us in our own generation, so that the gap will be even wider, or are we trying to thrust them further back into the period of our grandfathers ? We cannot do it ; by compulsion we can hold back the weaker ones ; we may even hold back temporarily a state or a country ; but the slogan of nature seems to be ' Advance or Annihilation,' and she has branded it across so many experiments that the scientist and the historian are as familiar with it as with many more modern phrases.

" Science is an essential section of modern study and of modern education ; it must be soundly based on quantitative experiment ; it must not be taught in qualitative scraps, so that the student acquires a useless smattering of information covering a very wide range (though the wide range soundly and reasonably presented would be a valuable equipment for to-day and for to-morrow) ; it is best approached through the formal,

fundamental science of physics, which enables the child later to appreciate even a qualitative presentation of modern biology, because he then knows that all experiment is based on precise measurement, and can appreciate stated laws and inductive reasoning."

A NEW KIND OF HYDROGEN.

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For about a century after Dalton first proposed his theory of atoms chemists believed that all the atoms of a given element possessed the same mass. This belief was, of course, quite consistent with all the facts known at the time. During the present century, however, the belief was shaken by the discovery of chemically similar but chemically inseparable radio-active atoms whose masses were undoubtedly different from one another. At first it seemed that such atoms, known as isotopes, were to be found only among the radio-active elements, but it was not long before it became quite clear that nearly every element is a mixture of atoms differing slightly from one another in mass, but identical in chemical behaviour. This discovery was perhaps a little disconcerting to chemists at first. It was not so troublesome as it appeared, since it was found that in nature the proportions of atoms of different weights in any element were always constant. Oxygen, the most abundant element in the earth's crust, consists almost entirely of atoms of mass 16 ; about one atom in ten thousand has a mass of 17, and this proportion is, as far as we know, quite invariable. Similarly silicon, whether it is derived from the earth's crust or from other bodies of the solar system in the form of meteorites, has always the same proportion of atoms of masses 28, 29 and 30 respectively. In other words, the atomic weight of an element as determined by chemical means is a constant and represents the average weight of the atoms. We do not know exactly how the constancy in the proportions of different isotopic atoms in an element came about. It may have arisen from properties inherent in the structures of the atoms themselves, or from a thorough mixing of isotopes during the gaseous and liquid states of the earth's crust. At all events the reverse process, the unmixing of the isotopes, has proved a very difficult one to effect.