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ABSTRACT
This short article consists of some thoughts derived from a longer paper (Palmer, 1992), together with some more recent ideas. I became interested in buckminsterfullerene (Buckyballs) as a result of an E-Mail discussion of the topic in 1991. The chemistry of buckyballs is now evolving very rapidly and is gradually creeping into school curricula. The focus of this article is thus not on buckminsterfullerene, but on how, at what level and in what form, material about buckyballs is being or should be included in school curricula.

One earlier paper on this topic may be found at:

http://ssrn.com/author=1148166

BUCKMINSTER FULLER, BUCKYBALLS AND THE TEACHING OF CHEMISTRY

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This short article consists of some thoughts derived from a longer paper (Palmer, 1992), together with some more recent ideas. I became interested in buckminsterfullerene (Buckyballs) as a result of an E-Mail discussion of the topic in 1991. The chemistry of buckyballs is now evolving very rapidly and is gradually creeping into school curricula. The focus of this article is thus not on buckminsterfullerene, but on how, at what level and in what form, material about buckyballs is being or should be included in school curricula.

R. Buckminster Fuller (after whom buckyballs were named) was best known as a successful architect who is popularly supposed to have invented the geodesic dome, though strictly speaking, this was not the case. Buckminster Fuller was interested in a whole range of ideas, which included education generally and science education in particular. Cohen & Petrillo (1972) explain some of Fuller's ideas in science education and their efforts to put these ideas into practice in a Californian elementary school. Another author (Lund, 1978) considers the geodesic dome as an example of solid geometry. However he expanded the idea, from small scale straw models to be made in the classroom, which he carefully explains, to a major school project constructing geodesic domes for sale to the community as greenhouses, storage sheds, jungle gyms and doghouses. It is interesting to note here that a Sydney-based firm now has a cheap home construction kit based on the geodesic dome, available for sale.

Most of the attempts to include buckminsterfullerene in the curriculum are to get the children to make paper or straw models of the C_{60} molecule. In a sense this is really repeating existing curriculum ideas (Viz. Lund, 1978), which were often part of mathematics curricula. Nonetheless it is perfectly valid curriculum development, but it is strange that so much curriculum emphasis is related to the geometrical structure of this molecule, rather than its chemical properties. I have found a number of such references and the target audiences for these articles vary from primary to upper secondary, some directed to chemistry teachers, but others to biology teachers (through the shape of viruses), and also to physics teachers. The instructions for making buckyball models seemed adequate in all cases. Good (1992) probably gives the simplest and most straightforward of the modelling instructions. He does this by providing a template for the hexagons in buckyballs, explaining that when the model is put together correctly the pentagons will be left blank. He gives instructions for making models of both C_{60} and C_{70}. Of the various modelling techniques suggested, this looks about the easiest and neatest, though the author does not explain much about the subject.

Making models of the buckyballs molecule may be one appropriate activity to include in school curricula, but are there others? Is there is any possibility of carrying out experiments at a school level on buckminsterfullerene. At first sight this would seem reasonable, as its cost is said to be falling rapidly and its synthesis seems comparatively simple, but there are safety doubts, such as the possibility that buckminsterfullerene might be a carcinogen. Very recently, at ChemEd '93 a workshop was given that included instructions for separating C_{60} and C_{70} by thin layer chromatography, so practical work in this area is already starting to enter school curricula. In my opinion, widespread experimental work in schools is not advisable until more of the risks associated with buckminsterfullerene are known. As an alternative I would suggest that a film about the history, preparation and properties of buckminsterfullerene is made for schools, as another way of introducing a knowledge of the fullerenes into the science curriculum. At least one film about buckminsterfullerene already exists. It is a film in the 'Horizon' series by the BBC called "Molecules with Sunglasses" (The program was transmitted on 20th January 1992). From the transcript I can see that the film gave much useful information, but it is somewhat expensive for individual school purchase.

There is also a question of the accuracy of statements in school text books and elsewhere about the allotropy of carbon. Interested readers may check the statements in the text books that they use and with which they are familiar. After the discovery of buckminsterfullerene, textbooks should state that there are three or more allotropes of carbon. In fact with the more recent discovery of buckminsterfullerene in a carbon-rich Pre-Cambrian rock 'shungite', books can now state that there are at least three naturally occurring allotropes of carbon and name them as diamond, graphite and buckminsterfullerene.

Allotropy as a concept seems to have been pushed very much to the sidelines of chemistry in more recent text books with the different structures of carbon being given only a mention in passing, as diamond and graphite, but with the name ‘allotropy’ being omitted. Older text books delighted in the variety of allotropes amongst the elements, giving considerable detail about their discovery (and often discoverers) and the properties between the allotropes. I have found that a number of elementary text books state the existing information inaccurately and few, if any yet mention buckminsterfullerene. I also hope that some author will seize the opportunity and tell the whole human story of the discovery of buckminsterfullerene, as very well summarised in a New Scientist article (Baggott, 1991), perhaps even choosing it as a starting to explore the vast array of uses of the element carbon.

This paper has covered a variety of ideas, so I would like to close by summarising the main points.

(1) E-Mail (and in particular its news service) can introduce academics to new topics, although interest can only be sustained through reading the literature in popular and academic journals.

(2) The story of the discovery of buckminsterfullerene is of great interest and full of lessons for the future.

(3) The applications of the discovery of buckminsterfullerene seem extremely promising, with the possibility of a whole new branch of chemistry about to open up. This on its own is a good reason for including some reference to buckyballs in school curricula.

(4) Text books should use the new information, about buckyballs as soon as possible, at a junior and senior high school level.

(5)We should always attempt to find ways of making the latest research findings available and exciting for students at school, and this is one obvious candidate for inclusion.

(6) One way in which this could be done for buckminsterfullerene is to make a new film of the buckminsterfullerene story, and this is something that I believe should be done.

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