Science Education International
Vol. 19, No. 1, March 2008, pp. 85-88

International Council of Associations in Science Education

Health and Safety in Practical Science in Schools: A UK Perspective

The Safeguards in Science Committee of the Association for Science Education,
College Lane, Hatfield, Herts, AL10 9AA, UK
Contact: Peter Borrows (peter@borrows.demon.co.uk)

1 Sensible Risk Assessment

ABSTRACT *The tendency for the press and public to over-react on safety. The need to balance risk against benefit. The difference between hazard and risk. Preventative or protective steps (control measures) to reduce the risk from particular hazards. Examples in school science, including the use of eye protection and alternative strategies, if eye protection is not available. The ability of teachers to supervise a class dependent on the size of the class. The need for supervision dependent on the nature of the practical activity and the risk involved in it, as well as the nature of the class, and the skills and behaviour of the students.*

KEYWORDS: *Class size, health and safety, risk assessment.*

This is the first in a series of articles about how health and safety works – or is supposed to work – in school science teaching in the UK. It has been compiled by the Safeguards in Science Committee of the UK Association for Science Education. The intention is to give a rather different perspective on health and safety to that which has appeared in recent issues of this journal. Schools in developing countries whose educational and legal systems are modelled on those in the UK may find this approach more appropriate to their situation.

Health and safety tends to get a bad press, certainly in the UK and perhaps elsewhere. Science teachers, and the public at large, sometimes say that health and safety legislation is stopping them from doing what they really want to do, for example, a favourite experiment. There is a tendency, in the press or on television, to ask the question "Is it safe?" But that is the wrong question, because you can rarely make something completely safe. The question should be "Is it safer than it was?" or "Is it safe enough?" Driving a car is a dangerous activity, and many people die or suffer serious injuries as a result. On the other hand, there are many benefits from driving. By being careful, you may reduce some of the risks: you wear seat belts, the car has built-in air bags, you limit your speed, you keep glancing in your mirror, you comply with local legislation, and so on. However, some risk remains. We judge that the benefits of driving outweigh the risks. So, we all live with some risk in our everyday lives, and schools are no different.

In everyday talk, we tend to use the words hazard and risk almost interchangeably, and, in some languages, no distinction exists. However, in recent years in the UK, we have distinguished between these two terms in a way which can be helpful. **A hazard is anything which could cause harm.** So, for example, many chemicals present a hazard, because they are corrosive, highly flammable, toxic, etc. An electric cable trailing across the floor presents (at least) two hazards; it could cause you harm if you tripped over it, and it could cause you harm from an electric shock. **Risk is a combination of the probability (or frequency) of an adverse event occurring and the magnitude of its consequences.** In other words, it involves a judgement. If the electric wire trailing across the floor has good insulation and the plug is in good condition, even though the consequences might be very serious - death - the risk of electric shock is small, because it is inherently unlikely. The likelihood of tripping over it may be greater, although the consequences of tripping are unlikely to be so serious. Taking both likelihood and seriousness into account, the risk of tripping is probably greater than the risk of electric shock. Therefore, we take **preventive or protective steps** (also known as **control measures**) to reduce the tripping risk, for example, by covering the cable with protectors, re-routing it or posting warning notices. This illustrates an important point. There are often several ways of reducing the risk from a particular hazard. Some strategies may be more appropriate in some contexts than in others.

In UK schools, when handling hazardous chemicals, it is routine for students and teachers to wear eye protection (safety spectacles or goggles). Teachers sometimes joke that their school spends more on eye protection than it does on chemicals or test tubes, but at least UK schools do have the resources to be able to fund chemicals, test tubes, and eye protection. Sadly, that may not be the case in some schools in developing countries. There is not much point in buying eye protection, if you cannot afford the chemicals to put into the test tubes. But, if you cannot afford the eye protection, should you abandon putting chemicals into test tubes? Should you deprive young people in developing countries of the opportunity to experience science as a practical subject? No! Instead, you explore ways of reducing the risk to an acceptable level. For example, you might use a less concentrated solution – not only is it likely to be less hazardous, it will also be cheaper. You might avoid the most hazardous chemicals altogether. You might train the students not to point test tubes at their own face, or those of their neighbours.

Does this strategy imply a higher risk for students in developing countries than in the Western world? Not necessarily! In the UK, you have a choice between goggles (with an elasticated strap, giving a tight seal around the eyes) and safety spectacles, which rest on the ears and nose. There is no doubt that goggles to the European Standard EN 166 3 give better protection from chemical splash than safety spectacles. At least, they give better protection, if they are being worn. Because goggles tend to be uncomfortable and to mist up, students are often tempted to remove them. Spectacles that are actually being worn protect the eyes rather better than goggles, which are not worn, even if, theoretically, the latter offers a higher standard of protection. Risk assessment is a compromise, although a few chemicals do require high standards of protection.

Class size is often raised as an issue. A recent statement from the USA[1] sug-

1. See, for example, the recently published Position Statement from the National Science Teachers Association in the USA on the *Liability of Science Educators for Laboratory Safety* www.nsta.org/about/positions/liability.aspx

gested that class sizes should be restricted to a maximum of 24 students. In the UK, the ASE has suggested 20, although the reality is usually around 30. There are many good educational reasons for supporting a limit of 24. But to do it on safety grounds without considering, for example, the type of practical work or the nature of the students in the class is questionable. Other things being equal, heating chemicals in test tubes with a Bunsen burner presents a significantly greater risk than peering down microscopes or setting up simple circuits with bulbs and batteries. Hence, there is a much stronger case for limiting class size, when heating chemicals in test tubes than in the other two examples. The hazards are greater: there is a heat hazard, an ignition hazard, and perhaps several chemical hazards depending on the contents of the test tube. It is difficult to see any significant hazards in the microscope or circuit work, although perhaps if daylight is being used as a light source for the microscope, there may be a possibility of directly reflecting light from the Sun into the student's eye. Not only are the hazards of heating chemicals more serious, the likelihood of something going wrong and causing significant harm is also greater. In order to reduce the risk, the teacher needs to keep a close eye on what the students are doing. She/he needs to ensure that the students are wearing, and keep wearing, eye protection, that they are using suitably safe quantities of the chemicals, know the safe techniques for heating test tubes, and are avoiding pointing the tubes at their own or other people's faces. Clearly, this is much more likely to be achievable in a small class than in a large one. Thus, a risk assessment leads to the conclusion that a small-size class is more important for heating chemicals than it is for some other activities. If 24 is the limit for any practical activities, then less than 24 might be a suitable limit for heating chemicals in test tubes.

The nature of the activity is not the only factor to consider in a risk assessment. Every experienced teacher knows that not all classes are the same. In a class of 24 students heating chemicals in test tubes, some students will need closer supervision than others – to make sure they keep wearing their eye protection, observe all the safety guidelines, and to prevent fooling around. In some classes, there may be too many students presenting behavioural problems for the teacher to be able to supervise them safely, even if there are only 24. In such situations, the risk assessment leads to the conclusion that practical work cannot be safely attempted. It may be possible to ensure better supervision by having only part of the class carrying out practical work at one time, with the remainder engaged in an activity, which does not demand much teacher attention, e.g., bookwork or accessing information on the internet. A similar strategy may help to deal with the problem referred to earlier – an inability in some schools in developing countries to be able to afford the test tubes and chemicals they need, if they also have to buy eye protection. Eye protection might be dispensed with, especially if the chemicals or activities taking place are relatively low hazard and if supervision by the teacher is particularly good. If supervising a small group of, say, six or ten students, he or she would be in a position to insist that test tubes are pointed in a safe direction. Sure, this is inconvenient, because different students are engaged in different activities, but it is better than no practical work and a lot better than a blinded student, and it results from thinking about what could go wrong, and how the likelihood of this happening can be reduced.

Science Education International (SEI)

Guidelines for Contributors

Science Education International (SEI) is the quarterly journal of the International Council of Associations for Science Education (ICASE). ICASE was established in 1973 to extend and improve education in science by assisting member associations and institutions throughout the world to examine ways of promoting scientific and technological literacy for all, and to provide a foundation for the professional development of our science and technology educators and leaders. SEI provides a means for associations, institutions, centres, foundations, companies, and individuals concerned with science education to share perspectives, concerns, ideas, and information that will foster cooperative efforts to improve science and technology education throughout the world.

Section Contributions: Each section will offer a worldwide balance between a primary, secondary, and a tertiary level focus. Section contributions should be sent directly to the corresponding section editor. Section manuscripts sent to the journal editor will be forwarded to the appropriate section editor for review. All section articles are peer reviewed and should be relevant to an international readership.

Language: Articles and other materials are accepted in English only. If English is a second language for the author, please consider having the manuscript proof read and edited before submitting.

Feature Articles: Feature articles are normally solicited by invitation and should be submitted directly to the journal editor.

Science and Technology Education: This section includes discussions of issues related to the design, development, and implementation of technology-enhanced learning environments, curricula, and educational technology applications for science and technology education. This section should emphasize implications for society including decision-making and problem solving.

Teaching Materials and Strategies: This section focuses on the upgrading of science teachers and aims to communicate ideas and strategies that will assist science teachers enhance and enrich their programs.

Research on Curriculum, Teaching, and Learning: This section publishes research findings on curriculum, teaching, and learning, with the goal of bringing research information to the attention of science teachers and policy makers.

Science Teacher Education: Articles about science teacher education (both pre-service and in-service) should address professional development issues.

Assessment and Evaluation Trends: This section focuses on new trends in student, teacher, and program assessment and evaluation, and aims to communicate the latest educational reform efforts.

Non-formal and Informal Science Education: This section publishes articles concerning non-formal and informal science education, such as out of school or public science experiences.

ICASE News, Science Education Around the World, Resources, Calendar: Contributions for these sections should be brief and relevant to an international readership. It may be acceptable to submit excerpts from other publications and periodicals. These contributions should be sent directly to the SEI editor.

Research in Brief: This occasional section contains several brief, 300 - 400 word summaries, of published research related to the teaching and learning of science. The section may offer several summaries on varying topics or describe findings related to a central theme. Contact the SEI editor for additional information.

Profile: This occasional section features profiles of prominent science educators who have made a signification impact (e.g., ICASE Award Winners), and profiles of ICASE member association, institutions, centres, etc. Profiles should be limited to 400-600 words. A portrait photo must be sent with an individual profile; the logo of an organization and captioned photo of, for example, key officers, headquarters building, a project in action, delegates at a meeting, may be used to illustrate the profile of an organization.

Editorials: This occasional contributed or invited section represents an open forum to discuss science education concerns and perceptions. Profiles and editorials should be sent directly to the SEI editor.

Material Submission: All manuscripts should be submitted electronically, by e-mail or on disk, to the appropriate editor for review. Section submissions should be sent directly to section editors. Material may be directed to the journal editor, but this may delay the review process.

Authors submitting articles for publication must restrict the length of the article to 3000 to 10000 words, including references. Manuscripts should be written on A4 paper, doubled spaced, and with sufficient margins. An abstract of no more than 250-300 words must be provided. At the end of the abstract, the author(s) should give up to three key words. The first page of the manuscript is the Title Page and should carry the title, the author(s) name(s), affiliation, address, telephone the article is submitted and fax numbers, and e-mail. A second front page carrying only the title of the manuscript and the section of SEI to which the article is submitted should be included for the review process.

Authors are encouraged to include relevant diagrams, graphs, tables, and photos to illustrate their articles (see guidelines for supply of artwork and photos below). In addition, the authors should a portrait photo and a brief summary (50 words) of their position and responsibilities, institution, etc.

Materials should arrive using Word and should conform to the style set forth in the Publication Manual of the American Psychological Association (5th ed.). Macintosh submissions should send material as Rich Text Format, to ensure readability. If the manuscript includes data tables of some kind, please format the tables in **TABLE FORMAT** via your word processor. **Please check with the editor if questions arise.** Upon receipt of the electronic submissions, a confirmation will be e-mailed to the primary author only.

Supply of artwork, photos, etc.

Diagrams and graphs should be provided as finished black and white line artwork or electronic images. Electronic graphics included in your manuscript should be either inserted in the word document or as .gif or .jpg formats. Please check with the editor if you wish to submit any other type of graphic for conversion suitability. Photos should be supplied un-screened in original form or in electronic form. All illustration (diagrams, graphs, tables, photos) must be fully captioned. When there are a number of illustrations, the author should endeavour to reduce the amount of text to accommodate the illustrations in the limited space available for any article.

THE REVIEW PROCESS: Submitted manuscripts are reviewed anonymously by 2-3 international referees. All tracking of manuscripts and reviewers is done by the section editors, the editor, and associate editor. SEI will not review submissions previously published elsewhere through print or electronic medium. All attempts will be made to ensure submissions will be reviewed within **three months** after e-mail submission to the editor. Manuscripts will be returned to the lead author when each review is completed. Authors who are not SEI subscribers are required to pay the fee of 30 euros in order to publish a paper in the journal.

Dr. Nicos Valanides, Department of Educational Sciences

University of Cyprus	Office Phone: +357-22-753760
P.O. Box 20537	Office Fax + 357-22-377950
CY-1678, Nicosia,	Home Phone: +357-22-337966
Cyprus	E-mail: nichri@ucy.ac.cy
	seiicase@ucy.ac.cy