Case Study: The Occurrence of OHS & Environmental Units in Undergraduate Chemistry Courses within Australia

Dr Neale Jackson
RMIT University

Co-Authors: Fred de Munk, Colin Findlay and Terry Elms

ABSTRACT

A survey of Australian undergraduate Chemistry courses was conducted to establish the contribution of Occupational Health and Safety (OHS) and environmental components to the curriculum. Institutions were classified into three categories depending on their level of OHS and environmental education. The broad classifications used were: no obvious contribution, narrow or minor contribution and broad OHS and environmental curriculum components contributing to overall course outlines. The survey demonstrated that OHS content in Chemistry courses was largely related to safety management issues concerned with the hazardous nature inherently associated with working in a laboratory and with dangerous chemicals. The broader aspects of OHS were rarely covered and it is concluded that Chemistry courses do not adequately prepare their graduates for the multi-disciplinary nature of the workplace, as it relates to OHS issues. The presence of environmental education in any broad sense is almost completely missing from these courses. In the light of Australia's commitment to Ecologically Sustainable Development (ESD) and the desire of the chemical industry to be seen as being environmentally responsible, it is recommended that Chemistry courses should incorporate environmental units into their curriculum with ESD being the determining paradigm.

INTRODUCTION

There are many undergraduate science courses within Australia which are taken by a wide range of students. The graduates from these courses are likely to be employed within industry and, in time, occupy management positions. One of the major barriers to environment, health and safety improvements in industry has been shown to be cultural. In other words there is a cultural barrier to establishing effective OHS and environmental practice in the workplace (Cooper 1998; Krause, Hidley & Hodson 1990; Cooper 1998). The authors now postulate that one possible method of removing this cultural problem is to train in a culture from the lowest common denominator. One method of change is to incorporate a significant environment and OHS component in undergraduate degree courses. With the mass of legislation and standards that effect the Chemistry practitioner in industry it is essential that environmental management and OHS become a major concern for students planning a career in this area. Furthermore, the Commonwealth of Australia, as a result of its international commitments made at Rio de Janeiro and other world summits, has demanded the inclusion of ESD into the curriculum (Commonwealth of Australia, 1992).

> "to incorporate ESD principles and approaches into the curriculum, assessment and teaching programs of schools and higher education" (Commonwealth of Australia 1992, section 26.1). and,
> "to develop and improve vocational education and training programs which incorporate ESD principles and which will give practical skills in achieving ESD". (Commonwealth of Australia 1992, section 26.2).

In a less formal sense, "to develop a high level of community awareness and understanding of the goal, objectives and principles of this ESD strategy." (Commonwealth of Australia 1992, section 32.1).

This current study has been undertaken to consider the present situation with respect to the ESD and OHS that is taught within undergraduate Chemistry degree courses within Australia and suggests that the reasons for content differences between Chemistry undergraduate courses derives from historical and institutional causes. The paper develops the thesis that the OHS and environmental curriculum should be comprehensive, responsive to community needs and universally delivered in Chemistry degree courses. The case for such a proposition has four foundations. Firstly, students of Chemistry need a base knowledge in OHS and ESD due to the inherent hazardous nature of practical components of Chemistry, and the environmental impacts of the products of their activities. This contributes to the safety of the graduate, fellow workers and the protection of the environment. Ecosystem integrity must be protected from possible pollution due to their activities. Students need to be aware of the consequences associated with discharging used chemicals to land, air and water. Secondly, once students have finished their current course of study they are likely to be employed within their field. There are multiple legislative and technical requirements for OHS and the environment when working in industry. These are more comprehensive and extensive than those required for just laboratory work when at University. These legislative requirements are driven by due diligence paradigms which operate on both OHS and environment behaviours. The theme of Ecologically Sustainable Development (ESD) has become pervasive through Australian industry and can only be supported as an effective strategy if appropriate environmental management training is conducted. Thirdly, there are employment opportunities for graduates who are knowledgeable and skilled in the OHS and environment management requirements of industry. These graduate attributes would greatly enhance their employment opportunities. Fourthly, there are a number of industries that are characterised by a lack of OHS and environment culture and knowledge. If new graduates who are employed by these organisations are empowered by this knowledge then they may act as catalysts for the development of an OHS and environment management culture within them.

METHOD

Course structure and content information were obtained via the World Wide Web about Chemistry and Applied Chemistry degree courses at twenty-seven Australian universities.
The twenty-seven degree programs studied were classified into one of three categories based upon their apparent environment and OHS content. Classifications were made separately for the environment and OHS components.

Category	**Content description**

A	Program has no definable and separate subjects concerned with environment/OHS.
B	Program contains at least one environment/OHS subject which is narrowly focussed.
C	Program contains at least one broad environment/OHS subject which covers broader environment/OHS issues

Classification was based on the information that was available on the Internet. When this information was not found to be comprehensive enough for classification further information was obtained from the course administrators. Allocating categories to each course was found to be difficult in some cases, particularly for the OHS component. As a consequence some of the courses were classified as A/B (intermediary between the two classes).

Identifying the ESD component of courses from publicly available information was a simpler proposition. Clearly, Chemistry degree programs are often involved in environmental analysis both from a laboratory and management perspective. The presence of this kind of teaching was transparent in many courses and they were classified as "B". However in many courses environmental Chemistry was available as an elective, or not available at all. It can therefore be concluded that not all graduates from these institutions would necessarily have been exposed to the environmental issues. Such Universities were classified as "A". The presence of a wider, more multidisciplinary approach to environmental issues as would be required by the ESD paradigm was difficult to identify and such courses were classified as "C".

RESULTS

It was found that a number of Universities do not currently teach undergraduate Chemistry as a major subject within a degree program or as an applied degree. It is thought that there has been an overall reduction in demand for Chemistry graduates with a consequent reduction in the overall number of courses available. This contraction is thought symptomatic of the overall reduction in demand for Chemistry graduates in Australian industry. As a result, only twenty-seven courses could be identified as containing significant Chemistry content and these were analysed.

OHS COMPONENTS

An analysis of the data in Table 1 indicates that of the twenty-seven courses classified, 17 (63%) were classified as A, 5 (18.5%) were classified as A/B, 2 (7.5%) were classified as B and 3 (11%) were classified as C. This indicates a predominance of traditional Chemistry degree courses which give no special status to health and safety related issues. There is no specific pattern that can be assigned to those universities that have an A/B, B and C status. That is to say that the common sense view that Universities of Technology would be more progressive in their curriculum development than the more traditional sandstone Universities is not observable in these data (see Table 1).

Table 1: OHS and Environment Units in Chemistry Undergraduate Courses in Australian Universities.

University	State	Course	Class	
			OHS	ESD
Adelaide	SA	BSc with Chemistry Major	A	B
ANU	ACT	BSc (Chemistry)	A	A
Canberra	ACT	BSc (Biological Chemistry)	A	B
Central Qld	Qld	BSc (Applied Chemistry)	A	B
Charles Sturt	NSW	BSc (Analytical Chemistry)	A	A
Curtin	WA	BSc (Applied Chemistry)	A	A
Deakin	Vic	BSc (Chemical Science)	B	A
Griffith	Qld	BSc with Chemistry Major	A/B	A
James Cook	Qld	BSc with Chemistry Major	A/B	B
La Trobe	Vic	BSc (Chemical Science)	A	A
Macquarie	NSW	BSc (Chemistry)	A	A
Melbourne	Vic	BSc with Chemistry Major	A	B
Monash	Vic	BSc with Chemistry Major	A/B	B
Murdoch	WA	BSc (Chemistry)	A	A
Newcastle	NSW	BSc with Chemistry Major	A	B
NTU	NT	BSc with Chemistry Major	A	A
Queensland	Qld	BSc with Chemistry Major	A/B	A
RMIT	Vic	BAppSci(Applied Chemistry)	C	C
S. Australia	SA	BSc (Chemistry and Process Tech)	A	B
Swinburne	Vic	BAppSci(Chemistry)	A/B	A
Tasmania	Tas	BSc with Chemistry Major	A	B
UNE	NSW	BSc (Chemistry)	A	B
UNSW	NSW	BSc (Industrial Chemistry)	A	B
SYDNEY	NSW	BAppSci(Chemistry)	B	A
UTS	NSW	BSc (Applied Chemistry)	C	A
UWA	WA	BSc (Chemistry)	A	A
Wollongong	NSW	BSc (Analytical Chemistry)	C	A

ESD

The majority (55%) of Universities did not demonstrate the presence of any unit in environmental science, analysis or ESD in their Chemistry core curriculum frameworks. These Universities followed traditional Royal Australian Chemical Institute (RACI) type accredited courses which focussed on the domains of organic, inorganic and physical Chemistry without clear reference to environmental issues or practice (see Table 1).

41% of Universities did specify the inclusion of some form of Environmental Chemistry usually concentrating on, and stemming from analytical Chemistry. Although the presence of such content is an excellent response to the increasing demands of industry in these areas, it can hardly be considered as adequate preparation for the multi-disciplinary aspects of environmental management as practiced in modern industries today.

Only RMIT University could be identified as extending its curriculum beyond environmental analysis to include some broader environmental as well as OHS issues. This is probably because the Department conducting this course is also responsible for degree programs with majors in Environmental Science and OHS.

DISCUSSION

De Munk (1999) has previously demonstrated the lack of ESD in the tertiary Australian curriculum. De Munk and Findlay (1998, 1999) and De Munk *et al*. (1998, 2000) have shown the importance of incorporating ESD into OHS courses and these authors have noted the rapid disappearance of any divide between the practice of these areas of management in industry. This paper now makes the case that both of these areas are fundamental to any Chemistry degree program and possibly to many other Science based undergraduate courses There is an obvious need to review the curriculum in ESD and OHS for Chemistry degree courses within Australia. The problem however, goes further than this. If a review was completed of all the Science degree courses within Australia, it is likely that most would contain a minimal quantity of ESD and OHS. This has been partially shown by De Munk (1999). Any such content is generally in line with that which is required for the practical components of the course. It is believed that both ESD and OHS content needs to be incorporated into all such courses so that graduates will be aware of the relevance of ESD and OHS within their own professions. It should be noted that National TAFE accredited Diploma courses are now required to contain at least one module of OHS in order for them to gain accreditation (ACTRAC). In line with this it is thought that every science and engineering degree course should contain at least one module/subject of OHS as well as ESD. This change needs to be driven by both professional organisations and government legislation but needs to be championed by the relevant industries.

CONCLUSION

There is a significant proportion of tertiary education institutions which provide only minimal OSH and ESD training in the Chemistry degree courses in which they teach. This low level of ESD and OHS course content is a concern knowing that the graduates from these courses are likely to be employed in a variety of roles within the chemical and related industries. If the education offered by these courses is to be vocationally relevant then ESD and OHS needs to be included in the curriculum. Industry organisations such as RACI (1994) and the Royal Society of Chemistry in the UK (RSC 1997) recognise the need for inclusion of OHS in chemical degree courses and it is a requirement for course accreditation and graduate registration. Regrettably, similar requirements are not present for ESD. Despite the recognition of OHS as a necessary component in Chemistry programs by professional bodies, strict guidelines and policing for the control of OHS content taught within the curriculum are not provided. As a consequence many tertiary institutions interpret the guidelines in a minimal capacity and only include OHS in the teaching for the practical component of their course. In other words they only include basic laboratory safety during practical work.

From this study it is possible to conclude that undergraduate Chemistry students should be provided with a broad ESD and OHS education and that this is currently not available. Such a study stream should incorporate material both as a dedicated subject

in ESD and OHS, as well as laboratory OHS. Ideally these areas should be integrated into appropriate general Chemistry subjects. The syllabus needs to be designed to allow students to have a functional ESD and OHS knowledge when they are employed by industry. A more specific analysis of these needs will be the subject of a later study.

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