Chapter 2
Language Support Strategies in First Year Chemistry

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ABSTRACT

In-class and online active learning strategies, which have been implemented at The University of Sydney, are described to respond to the challenge of teaching chemistry at a first year level, to students with a wide range of abilities and levels of motivations. Core to the design of these activities is the belief that students learn chemical concepts most effectively when they are actively engaged in doing and talking, rather than rote learning and listening. The strategies described have been developed within the context of large classes and limited resources. They are fully adaptable to other topics beyond first chemistry and to other sciences. They are also necessarily designed to be scalable to large or small classes and to be sustainable. Online resources are useful for helping students become familiar with chemical language and symbolism and to provide them with a means of practicing their use. Online quizzes are an invaluable means of students self-assessing their progress and of providing meaningful assessment of their level of mastery. In-class activities involving student response systems and student-centred, inquiry based approaches are built around active learning and on-going formative assessment. To develop language skills, social interaction via peer instruction and group discussions can be utilized to ensure that classes are vibrant and engaging.

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INTRODUCTION

Chemistry is the central science. An understanding of chemistry is important in many scientific disciplines and for an informed appreciation of technological, environmental and medicinal topics. First year chemistry is thus mandatory or at least highly recommended for most science students and is also chosen by students on many other degrees desiring knowledge of the scientific method. For example, around 20000 students undertake chemistry units across 35 Australian universities (Barrie, Buntine, Jamie, & Kable, 2001).

Teaching chemistry has been compared to teaching a foreign language (Markow, 1988). It is necessarily an abstract subject, dealing with how processes and events at the microscopic level have an effect at the macroscopic level and in everyday life (Ben-Zvi, Eylon, & Silberstein, 1988; Maskill & Cachapuz, 1989; Zoller, 1990) (Nakhleh, 1992). Many choose to study chemistry because they want, for example, to design new medicines and materials or want to understand biological and environmental systems. Before a student can understand these applications of chemical science and the way chemist interpret chemical phenomena, a good basis in its language, grammar and symbolism is required.

As noted by (Markow, 1988), chemists often use common words to mean something either much more specific or even completely different to the everyday usage. Examples include ‘weak’, ‘strong’, ‘significant’, ‘concentration’ and ‘favorable’. To a chemist, these terms have a precise, conceptual connotation which is unlikely to be the same as that of the lay reader or a new student. Scientists have appropriated everyday adjectives like ‘weak’ and ‘strong’ and, at the same time, many scientific terms such as ‘gas’ and ‘quantum’ have entered the general vocabulary and had their original meaning changed or blurred. Perhaps most unfortunately, even the words ‘chemical’ and ‘chemist’ are often used in a completely different way in the media to how a practitioner would define them.

Probably the easiest language issues for an educator to deal with are the new words that a student will encounter. Sensitivity to the unfamiliarity and the pronunciation of terms like ‘nucleophile’, ‘electrophile’ and ‘stoichiometry’ is important. Such words can form a barrier to comprehension and a glossary can be an important addition to a course or text. Success in chemistry, however, requires a deeper mental representation and conceptual understanding of chemical terms than rote learning of definitions. For example, as well as being able to recite “mass per unit volume” and perform a calculation, a successful chemist will have a mental image of what density is (Beek & Louters, 1991).

As well as dealing with the different uses of words in everyday language and in chemistry, the educator must also be aware of misunderstanding and misconceptions in the definition of chemistry terms that students bring with them to university. The acquisition and development of chemical understanding and language is not built upon a blank slate (Beall, 1994; Bradley & Brand, 1985; Granville, 1985; Mason, 2006; Mayer, 2010; Nakhleh, 1992; Sanger & Greenbowe, 1999). Prior knowledge from high school can be particularly hard to alter, requiring awareness of the issue from both the educator and the student. In first year chemistry courses, students may not be open to such limitations in their knowledge and to their own misunderstandings. Preconceptions about the meaning of words are not easily changed (Cary, 1984).

Introductory courses also rapidly introduce and then rely completely on symbolic notation. According to Wellington and Osborne (2001), symbolic language have the highest level of abstraction of scientific words. As discussed by (Marais & Jordaan, 2000a), three types of symbolic notation are used in chemistry:

1. Letter symbols are used to represent the elements, units and physical quantities. Thus, the letter “K” is used to represent the element potassium, the unit of absolute temperature and (in italic form) the equilibrium constant.
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