

CHANGES IN COLLEGE STUDENTS' CONCEPTIONS OF CHEMICAL EQUILIBRIUM

JOCELYN LOCAYLOCAY¹, ED VAN DEN BERG²,
MARCELITA MAGNO³

¹*University of San Carlos, Philippines,*

²*Vrije Universiteit, Netherlands*

³*UP National Institute of Science and Mathematics Education Development (UP-NISMED), Philippines,*

ABSTRACT

The purpose of this study was to describe the evolution of conceptions about chemical equilibrium based on observations/interactions with selected chemistry students using an instructional design which included constructivist strategies such as POEs, analogies, small group discussions, and journal writing. Two intact classes with a total of 75 students enrolled in a general chemistry course participated in the study. The conceptual evolution of six students was followed through the use of pre-tests, transcripts of audiotaped and videotaped group discussions, written answers to activity sheets, learning journals, interviews, and post-tests. The students started with concepts of complete reactions and progressed to developing concepts of reversibility but had difficulty with the dynamic nature of reversible reactions. The use of an analogy using double-sided disks helped in the students' visualization of the microscopic processes taking place and in the properties of systems as they approach and when they reach equilibrium. However, students' conceptions of complete reactions still competed with their conceptions of reversible reactions.

1. INTRODUCTION

Chemical equilibrium is considered to be one of the most difficult topics in general chemistry. Several studies have investigated student difficulties in understanding the topic (e.g. Camacho & Good, 1989; Gussarsky & Gorodetsky, 1988; Hackling & Garnett, 1985; Bergquist & Heikkinen, 1990). The main alternative conceptions regarding chemical equilibrium have been summarized by Bucat & Fensham (1994), Huddle & Pillay (1996), and Van Driel and Gräber (2003). The most problematic concepts are the dynamic and reversible nature of chemical equilibrium, the use of Le Chatelier's Principle, and the equilibrium constant.

Prior to the teaching of chemical equilibrium, chemical reactions are presented as going to completion, meaning that all reactants are used up and converted into products. If the original amounts of reactants are not stoichiometrically equivalent, then one or more reactants might remain but then certainly one of the reactants is used up. This assumption is strongly reinforced by the kind of classroom work and homework problems given to the students.

The introduction of chemical equilibrium in the latter part of a two semester chemistry course exposes the student to the possibility of incompleteness and reversibility of chemical reactions. The students are confronted with the idea of two opposing chemical reactions occurring at the same time but for which no visible evidence is available. These concepts are at odds with well established conceptions that students have about chemical reactions.

In order for conceptual change to take place, it is necessary for students to become dissatisfied with their present conceptions (Posner et al., 1982). In order to teach chemical equilibrium successfully, one must have knowledge of student preconceptions about the topic and what revisions are necessary. Furthermore, one has to understand the cognitive mechanisms responsible for the development of these personal theories and models, and why they are resistant to change (Glynn, Yeany & Britton, 1991).

Many studies of misconceptions have measured pre- and post-study conceptions of students. To obtain optimal insight into the cognitive mechanisms of conceptual change, as well as the interaction of the teaching strategy with learning, a better approach is to monitor conceptual development throughout the learning process (White & Gunstone, 1992; Mazur, 1997; Berg, 2003).

The purpose of this study was to describe the evolution of conceptions about chemical equilibrium based on observations/interactions with selected chemistry students using a well-tested instructional sequence. Specifically, the study aimed to answer the following research questions:

1. What conceptions do Philippine general chemistry students have before instruction about chemical reactions, regarding reversible reactions and the attainment of chemical equilibrium?
2. How do students' conceptions of chemical equilibrium evolve during the different stages of teaching and as a result of diagnostic activities, POEs and other experiments, analogies, and small group discussion?

2. PHILIPPINE CONTEXT

Unlike most other countries, the Philippines has 4 years rather than 6 years of secondary education. Subsequently, up to 40% of the age group attends some form of post-secondary education. This is one of the highest proportions among developing countries. Chemistry is taught in the third year of secondary education in daily lessons. Unfortunately 80% of the chemistry teachers are not qualified to teach chemistry but have been forced to teach the subject due to the lack of teachers with a chemistry background. As a result high school chemistry is taught as a set of definitions plus some tricks to be memorized to solve standard problems. Typical lessons consist of lecture/dictation followed by low level questions or fill-in-the-blank exercises, as reported in observational studies (Somerset et al., 1999; Berg et al., 1998). Systematic development of concepts and reasoning is lacking. Therefore, this study, with its emphasis on concept development and reasoning with evidence, provided students with (what is for them) an unusual educational experience. Both