Chapter 4

LEARNING CHEMISTRY IN A LABORATORY ENVIRONMENT

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INTRODUCTION

Laboratory (or practical) work is an integral component of learning chemistry (or any science, but we will stick with chemistry in this chapter). Yet, researchers have not fully investigated several pertinent questions. (1) What are our goals for laboratory work? (2) What are the students' goals for this same laboratory work? (3) How and under what circumstances do students construct chemical understanding in this ill-defined, information-rich environment we call the laboratory? (4) How do the instruments that students use in the laboratory influence what phenomena are perceived and learned?

In this chapter we will review a selection of the vast literature on laboratory work and see what answers we currently have for the questions posed. We will provide highlights from the older literature for the historical perspective; then we will look at two models of the school laboratory: one based on curriculum and one on learning. Next, we will explore how the concepts and methodology of distributed cognition might prove to be a fruitful framework for new research investigating how students actually learn in a laboratory environment. Finally, we will propose some suggestions for revising current laboratory instruction towards more research-based practices.
HISTORICAL PERSPECTIVE OF LABORATORY WORK

Tertiary Level

At the university level the science teaching laboratory (in contrast to the non-teaching or apprenticeship science laboratory) dates from the start of the nineteenth century (Layton, 1990) and more recently at the secondary level. It is interesting to trace the path by which laboratory work came to be part of the science curriculum in the United States and in Europe, particularly the United Kingdom, at both the secondary and tertiary levels because this path can help explain many of the constraints which operate to keep the laboratory component of the curriculum from responding well to innovations.

The natural sciences were growing in importance throughout the eighteenth and nineteenth centuries, and this new prominence was accompanied by a strong interest in practical work and direct experimentation. This interest began to manifest itself in the academic curriculum as well. John Maclean, appointed professor of chemistry at Princeton in 1795, argued strongly for the importance of the teaching laboratory by stating that 'I am of opinion it is impossible for one to require even a slight knowledge of chemistry without either making experiments or seeing them performed, and that to become proficient in the science it will require much practice as well as extensive reading' (Foster, 1929, p. 2106).

A Manual of Inorganic Chemistry, written by Francis H. Storer and Charles W. Eliot in the 1860s, was the first textbook of its kind to be published in English (Davis, 1929). The textbook was a standard reference for several decades, and in the preface the authors stated their underlying philosophy that 'the study of a science of observation ought to develop and discipline the observing faculties and that such a study fails of its true end if it becomes a mere exercise of the memory' (as quoted in Davis, p. 876). This philosophy has been the cornerstone of the teaching of chemistry in the American and European university and secondary schools up to the present time.