

Chapter 1

APPROACHING LABWORK: FRAMES AND TOOLS

Introduction

The four studies in this chapter describe frameworks for constructing and analysing labwork, both theoretically and empirically. They present a frame of tools, methods and basic research results related to research and development of labwork environments. The aim is to capture and classify the varieties of laboratory work, to reflect design problems of determining its effectiveness, to offer a new method for analysing video tapes from labwork and to summarise some basic results of students' epistemological beliefs in relation to labwork.

Millar, Le Maréchal and Tiberghien give a systematic orientation regarding the central features influencing labwork in what might be called a map of labwork. The authors describe a model of the process for developing a labwork task and for evaluating its effectiveness. The description of varieties of labwork in this map can serve several different purposes related to comparing different labwork approaches, developing new labwork tasks and planning evaluation of labwork effectiveness.

Researchers and teachers around the world are concerned with the effectiveness of labwork. In the second study in this chapter, Psillos and Niedderer discuss extensively the concept of labwork effectiveness from a research perspective. Two types of effectiveness are distinguished in this study. One (effectiveness 1) examines what students actually do in the lab, while the other (effectiveness 2) is related to an analysis of the learning outcomes. This distinction is one of the results of the whole European "Labwork in Science Education" project. The same distinction is used by Millar, Le Maréchal and Tiberghien. Psillos and Niedderer present and discuss a twofold model relating effectiveness 1 and effectiveness 2, arguing that such a model is linked to the nature of labwork as a practical activity.

Niedderer, Buty, Haller, Hucke, Sander, Fischer, von Aufschnaiter, Tiberghien start by giving an overview of categories used by other authors for analysing labwork. In a second part, special categories are developed for analysing effectiveness 1 of labwork in relation to the objective of "linking theory to practice". This means that special categories are developed to analyse the use of physics knowledge – or more general science knowledge – in different contexts of labwork, such as taking measurements or developing a computer model related to a special labwork task. This "category based analysis of videotapes (CBAV)" in physics labwork has been used in several detailed studies of effectiveness 1 of labwork. Four of these studies are presented in Chapters 2 and 5 of this book (Theyßen et al., Hucke et al., Sander et al., and Buty, all *in this volume*).

Leach studies how students' understanding of the nature of science influences their actions and learning during labwork. In the form of hypotheses, the author gives some basic findings about students' epistemological conceptions related to labwork. He covers students' images of data and measurement, of the nature of investigation, of the nature of theory, of the nature of explanation, and of the nature of public scientific knowledge. Altogether nine hypotheses are formulated, each with several more specific statements of details, and each based on specific research results from literature.

Varieties of Labwork: A Way of Profiling Labwork Tasks

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Abstract

If we wish to explore the effectiveness of labwork for achieving its goals, we need to be clear about the aims of each labwork task and be able to describe its essential features in a systematic way. A model is presented of the process of developing a labwork task and evaluating its effectiveness. Two senses of 'effectiveness' are identified: the match between what students are intended to do in the task and what they actually do (effectiveness 1); and between what students are intended to learn from the task and what they actually learn (effectiveness 2). A classification scheme is then described which can be used to produce a profile of any labwork task. This provides a useful tool for exploring systematically the effectiveness of labwork tasks.

Introduction

The aim of science education is to help students develop an understanding of the natural world: what it contains, how it works, and how we can explain and predict its behaviour. So, in teaching science, we build upon students' everyday knowledge of the world around them – and augment this by providing carefully designed activities in which students observe or interact with real objects and materials. These activities are usually carried out in teaching laboratories or, in the case of some biology and earth science topics, in the field. We will use the term 'labwork' for all activities of this sort. The fundamental purpose of any labwork task is to help students to make links between two domains: the domain of real objects and observable things, and the domain of ideas (Figure 1). Through labwork, students also learn about the scientific approach to enquiry.

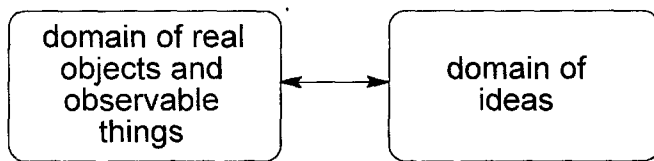


Figure 1: The fundamental purpose of labwork: to help students make links between two domains

In some countries, it is common for school students to carry out labwork tasks for themselves, usually working together in small groups. In others, there is a tradition of teacher demonstration at school level; introducing labwork for school students is often seen as a desirable reform. Where there is an established tradition of student labwork in school science, however, its effectiveness is often questioned. Students often fail to learn the things they are intended to learn. Because labwork tasks are

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