

Chapter 2

STANDARD LABWORK BASED ON HANDS-ON EXPERIMENTS

Introduction

In standard labwork students normally work in small groups, carry out hands-on experiments using conventional laboratory apparatus, and are engaged in a variety of complicated yet distinctive activities. This form of organisation, which is widespread, particularly in universities, has attracted the attention of researchers as it is evidenced from numerous studies. Yet it seems that not much is known about the nature of the specific activities that constitute laboratory contexts or of how the students perceive and understand the intended learning experiences. In this context one important issue, to which the case studies in this chapter contribute, is how laboratory tasks may be described, what aspects of their structure, organisation and sequence may elucidate and clarify different models of laboratory activities. . A second issue is what knowledge, scientific or not, is used by students in carrying out laboratory experimentation at large and specific tasks in particular.

How students' actions and procedures as employed during experimentation are, or are not, intertwined with the theoretical knowledge which the experimental design draws upon relates to laboratory effectiveness and more specifically to effectiveness 1 as mentioned in various studies in this book. Several of the studies in the present chapter try to assess labwork in terms of effectiveness 1. All the studies are based on extended research programs which provide for rich data concerning students' understandings in labwork In addition, the suggested new courses are innovations that rely on extended research data.

Detailed descriptions of the various tasks at different levels of complexity and learning demands are what characterise the first two studies, which analyse specific laboratory situations in depth and provide a wealth of data. The study by Robinault and Tiberghien deals with energy teaching in secondary school. The study by Beney and Séré deals with introductory university laboratory experiments of a type that may be encountered in many universities The first study focuses on students'

modelling activity in relation to teaching situations aiming at conceptual learning, while the second draws upon concepts of cognitive psychology applied to model laboratory tasks. This study investigates what happens during the action phase of labwork, examining both students and expert teachers in an attempt to shed light on the relation between doing thinking and learning.

Neither study argues in favour of eliminating standard labwork. Rather they make a case for improving the effectiveness of this type of labwork with regard to the acquisition of scientific concepts or procedures, and make a number of specific suggestions, in particular concerning the style and objectives of labsheets, which play a crucial role in guiding students' activities.

The next two studies deal with research-based innovations concerning labwork, which is addressed to university non-science majors. Prospective elementary teachers are the subjects of the first study (Kariotoglou), while medical students are involved in the study by Thyssen, Aufschnaiter and Schumacher. The related laboratory-based courses are not reduced versions of courses for science students, but involve the educational reconstruction of the scientific content, implying new links with the world of phenomena. Kariotoglou focuses on promoting student teachers' conceptual and procedural development towards a suggested scientific model and experimental method, and provides interesting insights into the effectiveness of labwork in promoting either type of knowledge as well as into their relation within specific tasks. Thyssen, von Aufschnaiter and Schumacher base their work on a specific theoretical approach to learning as fostering an increase in level of complexity. The linking of physics and medical knowledge and the development of meaning is affected by the labsheets used.

While the above mentioned studies investigate and model laboratory tasks as represented in labsheets and students' activities during labwork, the last study (Bandiera) focuses on the representation of labwork in scientific textbooks in secondary education. This study thus addresses a rather neglected, yet nonetheless important, issue: namely the relation between textbook and labwork, which can affect the image of scientific knowledge developed by the students, particularly in countries where labwork is not widespread.

Modelling Activities of Students During a Traditional Labwork

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Abstract

This case study is integrated in a research program on students' modelling activity in relation to teaching situations. This research is also a part of a research development project involving secondary school teachers and concerning energy. This case study deals with a quantitative approach of modelling energy phenomena. The data were collected by audio and video, and whole dialogues were transcribed. The transcriptions were analysed by categorising students' interventions on the basis of their modelling activities. The results obtained concern the role of the different proposed tasks in learning the targeted concepts.

Introduction

The teaching of the energy concept has been a widely debated theme within the science education community during the past twenty years (Solomon 1985; Brook & Driver 1984; Duit 1981, 1985; Lemeignan & Weil-Barais 1992). If many modifications have been proposed, few justifications have been advanced to justify the relevance of labwork to promote better understanding of this concept, or of any concept in general (Hofstein & Lunetta 1982; White 1996). In order to study the role of labwork in learning the concept of energy, we choose to examine the strategies of students when they carry out and interpret an experiment. We focus our analysis on modelling activities. This choice emerges from research carried out on modelling and cognitive activities of students (Niedderer & Schecker 1991; Martinand 1992; Wiser 1993; Meheut, Chomat & Larcher 1994; Niedderer 1996; Millar & Lubben 1996).

Our case study thus concerns two important aspects in science education, the role of experiments in learning physics and the teaching of energy. It aims at studying labwork at the second year of the French upper secondary school level (16 to 17 years old). The labwork studied was carried out in regular teaching but in the framework of research development aiming at designing new teaching materials on energy. Energy is the main part of the official curriculum at this level. This study is also integrated in a research program on students' modelling activity (see the contribution of Buty in Chapter 5 of *this volume*).

Teaching approach

Framework

A similar case has already been studied where the tasks proposed to students were only qualitative (Tiberghien & Megalagaki 1995). In this case the tasks include quantitative aspects. They deal with measurements, quantitative data, concepts and experimental facts. The teaching situation is characterised by the possible sources of information given to the students: the experimental setting including measurements apparatus and the labwork sheet. We analysed the relations between these

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