

## Introduction

This book has arisen out of lectures, discussions and seminars of a course planned for the education of physics teachers. This course has been held biennially since 1981 under the title "Foundations of physics". While the structure of the course in broad outline has become established, the modes of realization have varied and the thoughts discussed have developed year by year.

The book is not a textbook in the traditional sense but rather a collection of subject matter and thoughts intended to inspire discussions and reasoning. However, at the same time, it also relates the results attained by the course. It consists of material from different years, and hence repetition could not be entirely avoided - particularly as the different subject areas are so tightly related, and because opinions about the significance of topics have developed leading to the necessity to scrutinize them in new contexts.

The starting point has not been a ready doctrinal structure but "THE GREAT PROBLEM" together with the subjective experiences of the instructors and participants alike regarding teaching and learning physics. At its best, the course has functioned as a bank of ideas for the development of physics teaching. The thoughts developed have been applied and tested at different levels of physics teaching ranging from primary school to basic university courses, with quite encouraging results. Might it be that the great problem is not insoluble?

The course aims at creating a Gestalt for didactical physics. It approaches physics teaching from the point of view of the conceptual and methodical structure of physics and of different kinds of significances and meanings. Its purpose is not to teach more physics but to organize what has already been learnt. There has been a wish to exclude pedagogical methodology and the problem framing of ordinary didactics although the problems examined inevitably lead to thoughts which could be interpreted as revire violations.

The same also concerns philosophy. The methodical and structural questions of physics are also basic philosophical problems, as also are the questions of values, which, in pursuing educational objectives, arise in discussions about the significance of physics. Hence, philosophical problems are unavoidable. The course could then help the participants to grasp the basic philosophical problems of their field and to become conscious of the teaching philosophy they have assimilated, to develop a capacity to deliberate on its grounds and hence, perhaps, to improve their instructional skill. The one underlying philosophical task of the course is, however, the questioning of thinking habits and self-evident starting points.

The initially hastily composed working title of the course, "Foundations of physics", has remained in use for lack of a better one and has become established, although it corresponds poorly to the aim and content of the course. The title of the textbook, which indeed would be a poor one for the course, reflects the gradually matured conviction of the authors, that meanings come first. The teaching should build upon meanings and induce meanings. On the other hand, meanings are composed of structures and develop via the structures induced by them.

The first chapter is largely based on the Education Ministry directed planning over the years 1975-1981 for 'course-orientated' upper secondary school education, when one of the authors also participated as a member for the science section of the planning group, also acting as the chairman of the working group for physics. The framework then created is now being replaced by a new one but the considerations concerning the objectives and educational grounds gave rise to concepts and ideas, using which the significance, meanings and structures of physics teaching can be discussed independently of any framework. Here the conflict of significances which forms the core of the great problem is encountered.

*The present significance* of physics realized through teaching - that which the pupils have experienced and which is reflected in public debate, attitudes and decisions - is in strong contrast with *the ideal significance* of physics potentially achievable through the educational objectives and possibilities. Hence, the starting points of the course are regrettably negative. Our belief is, however, that aspiring physics teachers must know this problem because admission of facts is the beginning of wisdom.

By describing the phases of planning, one has wished to convey a picture of the human, professional and social contradictions at work which any coming teacher is bound to meet. The pressures can then hopefully be met with dignity and consciousness of the value of physics as a necessary element in the greater entity of human

education. Positive impulses are offered in this chapter by initiating the discussion about the educational, cultural, social etc. significances of physics on the ideal level of possibilities and about the means, by which these significances could be realized by teaching of physics.

The challenge of the second chapter is not equally problematical. The significance of physics as a science is known and generally acknowledged. In the methodical respect it is honoured as one of the central basic sciences. The scientific world picture is drawn in the hand-writing of physics, and through technology physics affects our life everywhere and in everything. However, the historical point-of-view is essential here, since it illustrates *the developing significance* of physics in interaction with numerous human, ethical, cultural, political, commercial and social structures and values.

The significance of physics as a science is no longer securely self-evident but it is under the crossfire of many different pressures; nowadays, more and more frequently, there are public attacks which question the most central methodical principles of physics. One should learn to deal even with these by means of rational argumentation based on the meanings of the principles of science, by discussing their grounds, the results arrived at using these, and the available alternatives and their potentialities.

The third chapter turns to look at *empirical meanings*, meanings assigned to our perceptions, and on which depend the construction of models, interpretations and applications of natural phenomena. Learning and research can be understood as different phases or levels in the continually expanding process of creating human knowledge, which amounts to creating meanings based on empiricism, conceptualizing these meanings, elaborating on them and building them into structures of hierarchical layers. The motto "meanings come first" hence expresses the central principle of the empirical concept formation, which also grows into the guiding idea of teaching, the perceptual approach.

The fourth chapter opens the discussion about application of these principles to the teaching of physics. What does the compliance with them *mean in practice*, in connection with the different modes of teaching and in the treatment of different kinds of topics? Means and methods are sought, which could advance, support and guide the perception and construction of meanings in the pupil's mind.

The last chapter, the fifth, tries to lead the thoughts deeper, to *the meaning of meanings*, to the problems of reality and world picture. What can the network of meanings, hierarchically layered and cumulatively developing, finally mean to man? Does it satisfy the need for knowledge of man? How does it answer his questions?

On the basis of this introduction it is perhaps unnecessary to mention, that the course and the book presenting it are unfinished. It took indeed a long time to adapt to the realization that such rammifying thoughts always pursue the unattainable. They can never form more than a part or an intermediate phase in an endless process. There are phases in this process, when one believes that something has been understood but yet others, when all efforts seem futile.

The participants of the course "Foundations of physics", from the very beginning until today, their seeking, their problems and insights, have immutably influenced all in the thoughts of this book that could possibly serve the development of physics teaching. Without their encouragement and support such a school ship ploughing the shoreless high seas of teaching, ever seeking out new routes, could not have had the buoyancy to remain above water in the fierce gusts of headwind of the strict scientific practice of the university.

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