Chapter 1
Introduction

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1.1 Context of the Book: The ESERA 2013 Conference

The European Science Education Research Association (ESERA) is an international organisation of researchers and science educators, which aims at (a) enhancing the range and quality of research and research training in science education, (b) sustaining a forum for collaboration in science education research, (c) representing the professional interests of science education researchers, (d) identifying and elaborating connections between research and policy or practice in science teaching and (e) fostering links between science education researchers in Europe and similar communities elsewhere in the world. The biennial ESERA conference is the main forum for direct scientific discourse within the community and for the exchange of insightful practices.

This book is the second volume in the Contributions from Science Education Research series, published by Springer in partnership with the European Science Education Research Association (ESERA). This volume comprises a selection of papers presented in the 10th ESERA Conference, which was held in Nicosia, Cyprus. It consists of 18 representative, high-quality contributions chosen out of the proposals that were presented in the conference, either in the form of oral presentations, papers in symposia or posters. Overall, these proposals were organised into a total of 16 different strands that covered the diverse research areas within science education. In addition to the contributed proposals, the conference also hosted four invited, plenary talks given by prominent scientists in the field.

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1.2 Overview of the Procedure for the Selection of the Papers

1.2.1 Preliminary Selection

After the conference, each strand chair was asked to propose two papers from his/her strand, which he/she deemed most appropriate for inclusion in this book. They were informed that the book would include selected papers that are innovative in either, the issues they explore, the methods they use or the ways in which emergent knowledge in the field is represented, and they were asked to identify the papers that were more likely to fit this description. The various recommendations were collected and processed to narrow down the list so that it included no more than three proposals from each different strand. In doing so, we also took into account, and weighed, the variability in the number of proposals in each strand. We then extended to the authors of the selected proposals a formal invitation to submit a paper to be considered for publication in the book. As a result of this process, we received a total of 22 submissions.

1.2.2 Final Selection

The submitted papers were subjected to blind, external review by scholars within the Science Education community, who accepted to voluntarily contribute to the preparation of the book by undertaking this task. Each paper was evaluated by at least two reviewers. All papers went through at least one round of review, whereas most were also subjected to a second round. As a result of this process, we ended up with 18 papers which achieved eventual acceptance status and were therefore included in this book.

1.3 Structure of the Book

The 18 papers, which include both empirical and theoretical contributions, have been organised under five parts, each reflecting a different thematic category. Each paper appears as a separate chapter under one of these parts. Next, we briefly present these parts and the chapters included in each.

1.3.1 Science Teaching Processes

This part includes five chapters. The study reported in the first chapter, by Tiberghien, presents and discusses concepts that could help researchers characterise a class as a group. It presents examples of how to use the notions of didactic contract and milieu, to analyse two classroom situations in the context of a teaching sequence in mechanics, at grade 10. The author also introduces the concepts of identity and normative identity as a means to characterise the class in the framework of socio-cultural theories. The author discusses how this analysis of concepts drawn from different theoretical frameworks strives, on the one hand, to promote a better understanding between researchers in our international community and, on the other hand, to offer insights into classroom practices that could inform the design of resources for teacher education and science teaching.

The second chapter by Schreiber, Theyßen and Schecker sets out to compare (a) a process-oriented approach to the assessment of experimental skills, based on videos of students' actions in a hands-on test and their lab sheets, with (b) a product-oriented approach that solely focuses on the lab sheets. Data analysis revealed high correlations between the outcome of the two approaches on certain aspects but yielded low correlations on others. The authors discuss the implications that stem from these findings.

Bungum, Esjeholm and Lysne, in chapter three, report on a video study of three design and technology (D&T) projects, conducted in different schools in North Norway. It reveals that disciplinary knowledge of mathematics and science did not appear prominently in student projects, even though they had been explicitly designed to illustrate these connections. The authors offer evidence-based interpretations for students' tendency to avoid drawing on disciplinary knowledge and discuss the ensuing implications.

The next chapter, by Rollnick and Mavhunga, investigates the possible transferability of the principles of topic-specific PCK (TSPCK) across science topics. The authors report results from an empirical study aiming to explore the extent to which the principles of pedagogical reasoning about one topic can be transferable to other topics as well.

The last chapter of the first part, by Jones and her colleagues, investigates the efficacy of a real-time, interactive, visuohaptic simulation to teach students particulate motion and the concepts of thermal energy, pressure and random motion. It involved 78 middle school students who investigated particle motion using either the visuohaptic or a visual simulation (control group). Even though the results showed that there were no significant differences in post scores between the students in the two groups, students in the visuohaptic group reported that the investigation was highly interesting and enabled them to better understand particle motion as well as visualise movement. The authors offer a discussion of the role of haptic instructional technologies as tools to teach micro- and human-scale phenomena.

1.3.2 Conceptual Understanding

This part comprises two chapters. The first, by Guisasola and his colleagues, summarises the key ideas discussed in a symposium organised by the Groupe International de Recherche sur l'Enseignment de la Physique (GIREP), on content-focused research and research-based instruction. The chapter reports a synthesis of results from studies in physics education, carried out in different countries, including Belgium, Germany, Italy, Spain and the United States. It also conveys a sense of the variability in terms of research questions, methods, interpretative frameworks and the role of specific research findings in driving educational innovation.

Callinan, in the last chapter of this part, reports on a study, which explored the gestures used by children during discussions of their ideas about electricity. This chapter discusses how gestures can be categorised according to content and how content of gestures can reveal elements of knowledge that is not verbalised in speech.

1.3.3 Reasoning Strategies in Science Learning

This part consists of four chapters. Fotou and Abrahams, in the first chapter, present a cross-age study, involving 41 participants, which was designed to investigate students' predictions in novel situations and the role that analogies play in their reasoning. The findings of the study suggest that teachers need to be more aware of the nature of the analogies used and how, and why, reasoning on the basis of such analogies can, in many cases, lead students to make incorrect predictions.

The second chapter, by Redfors, Hansson, Hansson and Juter, presents a framework for analysing the role of mathematics during physics lessons in upper secondary school. It departs from the premise that the connections made during physics lessons between *Reality*, *Theoretical models* and *Mathematics* are of paramount importance. The framework was developed to analyse the communication during physics lessons. The authors describe this framework and demonstrate its use in the context of selected results from a physics class. The chapter also shows how students' and teachers' usages of links between the three entities, i.e. *Reality*, *Theoretical models* and *Mathematics*, can be brought to the forefront in an analysis of complex physics teaching situations.

The next chapter, by Zoller, focuses on assessing college science students' problem-solving capability in the context of "traditional" chemistry teaching. It reports on a case study that explores the extent to which contemporary/traditional university/college chemistry teaching contributes to the development of students' problem-solving capability and views concerning higher-order cognitive skills (HOCS)-type questions. The chapter offers insights into what can be learned from students' responses to HOCS-requiring problems that can be used for promoting both their generic and disciplinary problem-solving capabilities.

The next chapter, contributed by van Lacum, Koeneman, Ossevoort and Goedhart, elaborates a novel model, the Scientific Argumentation Model (SAM), for analysing original scientific articles. This model draws on ideas from argumentation theory and genre analysis and seeks to support students in acquiring the ability to productively and meaningfully engage with the process of reading original science texts. The authors also report preliminary results on the validation of this model.

1.3.4 Early Years Science Education

This part contains two chapters. The first, by Russell and McGuigan, reports on an iterative design- based research approach used to inform instructional design sequences in early years science. The main thrust of this approach involved the postulation of developmental trajectories through which children move incrementally across the age range 36–84 months. In this chapter, the authors report on how the addition of a programme of qualitative research with early years practitioners allowed them to collaborate to describe hypothesised developmental sequences, relating to conceptual development, enquiry skills and science as discourse.

The second chapter, by Stylianidou, Glauert, Rossis and Havu-Nuutinen, reports results from the European, FP7 project *Creative Little Scientists*, which concentrates on the synergies between early years science and mathematics education and the development of children's creativity. The authors discuss how the findings across the varied contexts in partner countries indicate potential for enquiry and creativity but also suggest a number of areas for policy development in early years teacher education.

1.3.5 Affective and Social Aspects of Science Teaching/Learning

This last part includes five chapters. In the first of these chapters, Kudenko and Gras-Velázquez examine secondary pupils' views on different aspects of learning STEM subjects and on STEM careers. The areas covered in the study include pupils' interest in science and technology, their views on school teaching of STEM subjects, social attitudes to the STEM sector as well as pupils' inclinations towards STEM-related careers. Findings suggest that when information about the modern state of STEM jobs and real-life applications is blended in STEM education in a meaningful way for young people, it can trigger important changes in career choices.

The next chapter, by Le Hebel, Montpied and Tiberghien, explores the answering strategies adopted by low achievers while solving PISA items. They report on an empirical study with video data, aiming to analyse the mental and behavioural processes in which students engage for solving PISA items. The authors discuss the facility of PISA items to accurately assess the competences of low achievers.

Adesokan and Reiners, in the next chapter, investigate what specific learning difficulties and special needs students in chemistry may have and what teaching concepts can be used in an inclusive setting. The aim of their project is to develop a teaching material on the topic of scientific reasoning and working, which is adapted for the needs of deaf and hard-of-hearing (DHH) students. The authors discuss implications for the development of inclusive chemistry education.

The fourth chapter, by Walper, Pollmeier, Lange, Kleickmann and Möller, seeks to track German students over the key period of ages 10–14, in order to longitudinally describe the changes in physics-related instruction from the students' perspective as well as the changes in their physics-related interests. They report results from a cross-age study, which confirm that the students' physics-related interest dropped after transition from primary to secondary school and indicate that students perceived significant declines in various aspects of the quality of physics-related instruction when they entered secondary school.

Finally, the last chapter of this part, but also of the book, by Kollas and Halkia, reports on a study situated in the context of *Second Chance Schools*. These are intended to promote the reintegration of adult school dropouts who have not completed their compulsory education, into society. The study sets out to investigate Greek science teachers' views about the meaning of the notion of students' scientific literacy and focuses on science teachers' practices when developing a curriculum to achieve the goal of reintegrating second chance schools' students. The data reported suggest that the ability to design scientific literacy curricula, which meet their students' needs, is not related only to their teaching experience. Rather it requires the science teachers' enculturation into their students' worlds and a paradigm shift in science teachers' own ideology of science teaching.