

Preface: Goal of This Book

The teaching and learning of mathematical modeling has become a key competency within school curricula and educational standards in many countries of the world. It happens very often, when someone is confronted with a “new thing” and does not know a lot about this “new idea”, that they are doubtful and then perhaps neglect this innovation. This is what has happened with the educational standards for mathematics in Germany since 2003 (Blum et al. 2006) and in Chile since 2012. This could happen now with the Common Core State Standards in the United States (2010), which have a more extensive guidelines than NCTM-Standards concerning the goals and abilities that learners have to achieve from kindergarten up to high school, which then help them to be successful at college, university and in their life.

Mathematical modeling is now explicitly exposed in the Common Core State Standards: “Students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace.” (NGA Center and CCSSO 2010, pp. 6–8). This means concretely that extra-mathematical contexts and real life situations have to be solved with the help of mathematics (while taking into account the ages of the students). A true mathematical modeling activity involves processes that transition back and forth between reality and mathematics.

Not only in the United States, but in other countries all over the world, teachers now face the challenge of teaching mathematical modeling. During my workshops on the teaching and learning of mathematical modeling in many countries I was confronted with many questions and doubts from teachers concerning this new part of education. My experience shows, that as well as motivation for teaching modeling, you also need knowledge and competency.

One central goal of this book is to show researchers, teacher educators and teachers of all grades that mathematical modeling can be taught and learnt, on the basis of several examples and teaching concepts. Mathematical modeling activities will change the minds of your students at middle, high-school and university concerning (the subject) mathematics. On the basis of my experiences as a former school

teacher and a university professor, I am aware that it will also change your own way of thinking and understanding mathematics. So further goals of this book are:

- to give you a theoretical background about mathematical modeling.
- to make connections between theoretical concepts or results of empirical studies and what you actually do in school.
- to analyze and make transparent what is meant by modeling in the Common Core standards and in the syllabus.
- to give examples of how modeling can be taught and why it is necessary to have well-defined criteria for effective teaching.
- to train and qualify you in basic competencies for the teaching and learning of mathematical modeling with some integrated exercises, so that you are able to equip your colleagues.

Learning and teaching go hand in hand, but the focus on this book lies specifically on how to teach mathematical modeling to your students. The structure of this book follows a model of teaching modeling competencies for that has four dimensions (Borromeo Ferri and Blum 2009): theoretical, task, instructional and diagnostic.

So Chap. 1 starts with a short overview of research into teacher education in mathematical modeling and presents an example of a well-evaluated course concept for pre-service and in-service teacher education and training. The aim is to show how educators can be taught how to teach mathematical modeling. Furthermore, the four competencies needed to teach modeling are briefly explained.

Chapter 2 builds the necessary theoretical basis for your practical work at school or in teacher education, which means, for example, that you understand the goals and aims of mathematical modeling, and how you can use the modeling cycle as a multi-purpose learning instrument.

Appropriate modeling problems are the key instruments for reality-based lessons and understanding the criteria for modeling tasks is important. In Chap. 3 the ‘Task’ competency is highlighted. Different aspects of handling multiple solutions to modeling problems are shown and discussed. To support the importance of cognitive analysis of modeling problems for assessment, you will start a mini project and develop a modeling problem for your class the next day.

Chapter 4 starts by presenting concepts of mathematical modeling lesson planning and execution. During modeling activities, which can be complex at first, it is important that students of all grades do not lose their motivation and stay focused on their modeling problem; especially when you start with modeling activities. This means that the teacher must understand how to intervene, support students and give feedback. Theoretical background concerning these aspects and practical examples are presented, to indicate how you could do this in school. While you are working on Chap. 5 you will recognize that topics you have covered earlier in this book become important and make sense. The basis for diagnosis and assessment in mathematical modeling is your knowledge and experiences with modeling cycles or the development of modeling problems, and the way you are able to differentiate between phases of the modeling process/cycle.

Finally in Chap. 6 we go for more – mathematical modeling not only in single, short mathematics lessons, but three whole days concentrating on one complex real life problem. Goals, aims and structure of these days are presented, as well as how teacher education on mathematical modeling can be effectively linked with this activity. The book ends with reflections and an outlook in Chap. 7.

Each chapter contains some exercises to help you reflect and apply your understanding and knowledge of the topics. Ideas for directly implementing the examples and methods presented in your own lessons are given throughout all chapters.

My wish is to arouse your interest in a new and important part of the mathematics standards and curriculum, as well as in mathematics education overall, and to provide a new view of mathematics for you and your students.

He who wants to get new answers has to ask new questions.

– Johann Wolfgang von Goethe

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