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Opening Remark
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Abstract

Mathematical modelling is a process in which individuals use mathematics actively in real and meaningful contexts. Dealing with real problems, issues or contexts mathematically important and relevant aspects can be identified, realised and implemented. This approach – starting from the concrete problem – makes mathematical concepts, tools and processes more comprehensible and understandable. In the last decades the topic of mathematical modelling in mathematics education has been discussed exhaustively within science. As a guest editors for MSEL, we report here on mathematical modelling in German speaking countries based on school practice examples or on project related perspectives.

La modelización matemática es un proceso en el que los individuos utilizan activamente las matemáticas en contextos reales y significativos. Partiendo de problemas, cuestiones o contextos reales se pueden identificar, realizar y aplicar aspectos matemáticamente importantes y relevantes. Este enfoque, que parte del problema concreto, hace que los conceptos, las herramientas y los procesos matemáticos sean más comprensibles. En las últimas décadas, el tema de la modelización matemática en la educación matemática se ha debatido exhaustivamente dentro de la ciencia. Como editores invitados de MSEL, presentamos en este número una perspectiva de la modelización matemática en los países de habla alemana, basándonos en ejemplos de prácticas escolares o en perspectivas relacionadas con proyectos.

Keywords: Mathematical modelling, mathematics education, mathematical concepts, tools and processes, school practice, German speaking.
Palabras clave: Modelización matemática, educación matemática, conceptos, herramientas y procesos matemáticos, práctica escolar, habla alemana.

1. Mathematical Modelling: A German perspective

Mathematical modelling is a process in which individuals use mathematics actively in real and meaningful contexts. Dealing with real problems, issues or contexts mathematically important and relevant aspects can be identified, realised and implemented (cf. Bruder, 2001). This approach – starting from the concrete problem – makes mathematical concepts, tools and processes more comprehensible and understandable. Blomhøj and Højgaard Jensen (2003, p. 126) summarise this as follows: "By mathematical modelling [...] we mean being able to autonomously and insightfully carry through all aspects of a mathematical modelling process in a certain context. In mathematical modelling (in class) the focus of attention is on the students' concrete experience". The parameters mentioned in the problem must be ordered (several times), summarised or delimited against each other, so that ultimately a valid model is created which should be compared with the real situation by validation. In secondary school lessons it is also possible that real situations are considered and taken up which initially seem to have no mathematical content at all or in which mathematics initially plays a rather minor role.

By appropriate considerations and preparations in the field of subject didactics they become accessible for teaching. In the process of modelling mathematical models should be meaningfully expanded, reflected upon and confined from one another. In addition, these models should be constructed as independently as possible and their results should be compared and related to the real situations which are described in the initial problem formulation. According to Winter (1995, p. 37) in mathematics education students should

1. perceive and understand phenomena of the world around us, which concern or should concern us all, from nature, society and culture, in a specific way (G1)
2. get to know and understand mathematical objects and facts, represented in language, symbols, pictures and formula, as intellectual creations, as a deductively ordered world of its own kind (G2)
3. acquire problem-solving skills that go beyond mathematics (heuristic skills) in dealing with tasks (G3).

In the last decades the topic of mathematical modelling in mathematics education has been discussed exhaustively within science. Guest editorships of important journals in mathematics education at Educational Studies (Kaiser & Schukaljov, 2022), Mathematics Teaching and Learning (Kaiser, Schukajlow & Stillman, 2022) or Quadrante (Carreira & Blum, 2021a & 2021b) show that this exciting topic can be investigated from different perspectives and foci. We are very pleased that we were invited to be guest editors for MSEL, and the desired topic – to report on mathematical modelling in German speaking countries based on school practice examples or on project related perspectives – appealed to us immediately, and we very quickly decided to accept this invitation. All the projects presented in this issue have already been used in school, i.e. they proved to be suitable for teaching practice. This does not release the responsible teacher from the obligation to become familiar with the topic, but the contributions of this issue can facilitate the start of project practice. It is obvious that mathematics is by no means a "spectator sport". On the contrary – the projects presented motivate learners and give a valuable insight into the world of mathematics.

The articles which can be found in this special issue are characterized in short as follows:

- Ableitinger and Humenberger describe their experiences and reflections concerning a seminar for student teachers at the University of Vienna. On the one hand student teachers

themselves should gain experience in modelling, on the other hand they should get first experiences to create modelling problems for students at school and to supervise their modelling processes during a modelling activity at school.

- Bracke and Capraro focus in their paper on different possibilities to answer the question of automatically creating a choreography for musical fountains using mathematical modelling. In the article different variants are described, supplemented by experiences from practice and extension possibilities are pointed out.
- The paper of Dorner shows how to prepare students for planning to raise a loan by modelling amortization schedules with random interest rates. It examines parts of a learning environment that focuses on mathematical modelling and financial literacy, published earlier by Dorner. After some theoretical considerations concerning mathematical modelling and financial literacy two worksheets are presented which deal with influences of the interest rate on the repayment of loans.
- Durandt, Blum and Lindl report on a mathematical modelling unit specifically developed for first-year engineering students in South Africa. The main idea with the unit was to foster students' mathematical modelling competence.
- Hattebuhr and Frank emphasize that it is important to understand the mathematical models behind climate predictions in order to be able to keep up and evaluate public, political or scientific statements They present a simple model of the Earth's energy budget developed by high school students themselves during a project week and show how this mathematically challenging question can be didactically reduced in such a way that students can deal with these kind of models independently without having been taught the theoretical background.
- The paper of Kiehl shows a possibility of supporting gifted students by an annual autumn school. Students are invited for one week, to participate in working in groups on realistic problems, which first need to be transformed into mathematics and then be solved by mathematical analyzation and numerical approximation and implementation by the help of technology.
- Ostkirchen and Greefrath point out that heterogeneity can be taken into account in the classroom by using self-differentiating tasks. Therefore, from the point of view of mathematics didactics, modelling tasks are of particular interest in this regard. The paper focuses on a case study concerning the heterogeneity dimension of mathematical achievement and modelling competence of 15-year-old students.
- The paper of Schönbrodt, Wohak and Frank presents a concept for the development and implementation of modelling activities – which could especially be fruitful in times of homeschooling and distance learning.
- Vorhölter and Freiwald introduce a project of the Hamburg Modelling Days in detail. They describe how students gain experience in working on modelling problems and in acquiring modelling competencies especially by supervision.
- In the paper of Vorhölter and Haier the authors present the perspective of teachers, who have been participating in modelling activities for several years. Furthermore, they report on the opportunities but also on the difficulties of participation. Supplementary research is reported from another group of students regarding their participation in the modelling days.

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