A guide on models and modelling for physics teachers

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Abstract. A new curriculum and examination programme for upper secondary school physics was recently introduced in the Netherlands. Models and modelling play an important role herein. But teachers need help in developing their PCK in this area. To this end we developed a modelling guide, which introduces physics teachers into the role of modelling in science and science education, the scientific base of teaching and learning routes of modelling in pre-university education, and curriculum relevant computer models. We expect that the design of the guide and its contents can inspire others who want to support teachers similarly.

1 Background

In the school year 2013-2014, a new curriculum and examination programme for upper secondary school physics started. It adopts a context-concept approach to education in which models and modelling play an important role. Both computer based modelling and a modelling approach to a given problem situation are considered cognitive tools for developing scientific literacy.

There is a long tradition in Dutch physics education in using models, in having students engaged in computer modelling, and in assessing modelling in school exams. The inclusion of models and modelling in the nation-wide physics exams and the introduction of new contexts for modelling has made the topic compulsory. This has forced teachers to update or renew their PCK. To this end, professionalization courses were organized and papers were written in teacher journals. Reports on this topic were also published by the Curriculum Innovation Committee [1] and the Netherlands Institute for Curriculum Development [2].

However, what seems missing is a guide that informs physics teachers about the achievement levels with regards to models and modelling, and contains suggestions and didactic advice for realizing a coherent modelling curriculum. With support of the Centre for STEM Education in Amsterdam, a heterogeneous team of persons with experience in modelling at secondary physics level have set themselves the task of filling this gap. At the beginning of 2018, a web-based modelling guide for Dutch physics teachers was finalized.

2 About the guide on models and modelling

The web-based guide on models and modelling consists of four parts:

1. An introduction into models and modelling in science and technology, discussing
    - how modelling is both a way of thinking and a way of working in physics
    - what is meant by the notion of scientific model;

- the role of modelling in the scientific search for insight in the real world.

2. An introduction into models and modelling in science education, discussing
   - the learning objectives for modelling at secondary school level, which are assessed both in school exams and in nationwide exams of science fields;
   - a modelling cycle that can guide the learning activities and contributes to a systematic instructional approach to modelling;
   - challenges in modelling instruction, which resemble the ones encountered in inquiry-based learning and practical work;
   - the learning cycle introduced by Kolb [3] as guideline for an effective instructional approach to modelling
3. A modelling learning path, extracted from a doctoral study [4].
4. Overview of models and modelling equations that are most commonly used in Dutch secondary physics education.
   - Examples come from four subdomains of the examination programme: Force and Motion (snapshot in Fig 1), Oscillations, Energy and Heat, and Quantum World.
   - Computer models are presented in the form of semi-finished deliverables instead of worked-out lesson materials;
   - Both text-based and graphical models are implemented in Coach [5], which is an integrated computer learning environment for STEM education and which is commonly available at Dutch secondary schools with also a home license.

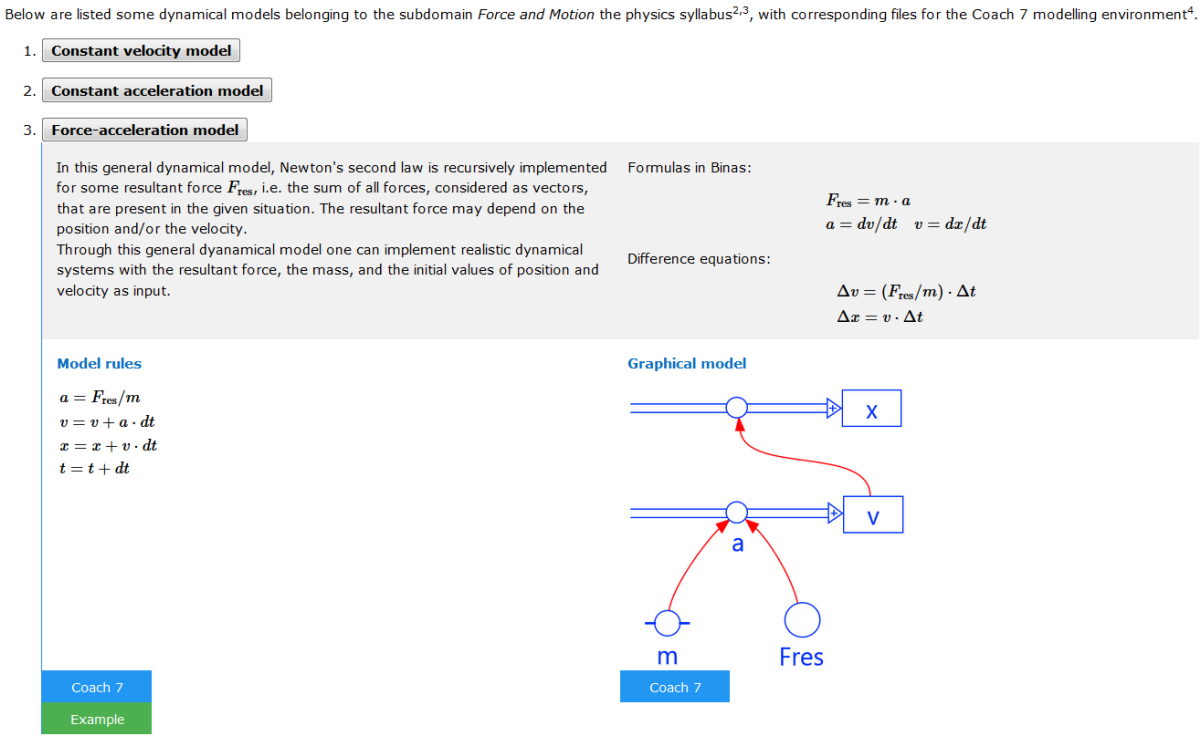

Fig. 1 Snapshot of part of a web page in the modelling guide.

References

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