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On the positive influence of product-orientation in mathematical modeling: A research proposal

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Motivation

The term *mathematical modeling* as we have observed in 25 years of modeling projects (Bock & Bracke, 2015), bears for many students and teachers the notion of something visible and touchable. In our opinion mathematical modeling can and has to be considered in a broader fashion, also allowing what Blum and Leiss (2007) call a mathematical model, namely the mathematical description of a real process. Experts in applied mathematics, i.e. scientists working with mathematical modeling, however describe the necessity of an *end product* to be presented as solving a client's problem in a suitable way (see Neunzert & Prätzel-Wolters, 2015), like a real prototype made from metal or plastic or developing a software or a process simulation, all based on the mathematical model. In the last CERME, Bock, Bracke, and Capraro (2017) defined the term product, closely related to the notion given in economics or marketing:

Definition

In a mathematical modeling situation (with an authentic and real-world problem) a product is a deliverable in the language of the client which satisfies the needs incorporated in the task given by the client to the provider in such a way that the client can use it directly for his purposes.

Based on former modeling week reports since 1993, Bock, Bracke, and Capraro (2017) proposed a second cycle within the modeling cycle based on client interaction. This poster is an outline for our future research, i.e. the analysis of the positive influence of product-orientation in mathematical modeling processes.

Best-practice examples for product-orientation in modeling

During different modeling activities (Bock & Bracke, 2015) a positive influence of product-orientation for the motivation and the quality of the mathematical modeling process was observed in contrast to projects without product orientation. Recently several product-oriented modeling activities have been carried out (Lantau & Bracke, 2019; Lantau, Bracke, Bock, & Capraro, 2017). During a modeling week (3.5 full days + 1 day for presentations), 5 students of Grades 11 and 12 were asked to build a 3d scanner. They were provided with electronical devices and components, such as *Raspberry Pis*, microcontrollers, sensors, etc. The students handled electric circuits and learned to control the stepper motor, the sensors and data processing. As the construction is mainly a problem of electrical engineering and programming, the data processing contains many mathematical questions. In fact it is impossible to build a working device without having a good mathematical model and awareness of the mathematical toolbox! Due to the project-orientation however, mathematical difficulties had no need to be pointed out explicitly, since the product itself is going to raise the right questions.

Research questions

A positive influence of product-orientation in mathematical modeling has been observed. The next step is to analyze this fact both in an empirical as well as in a theoretical way. The aims are: 1. *To model and understand the underlying processes*; 2. *To analyze the influence of product-orientation on students' learning processes*; 3. *To analyze the influence of product-orientation on the quality of results*; 4. *To develop new methods for interventions and guidance in mathematical modeling*. For this we plan to analyze several product-oriented, long-term modeling projects. We are going to use videotaping, questionnaires, interviews. Moreover we plan to analyze of the modeling processes using a new model of dynamical network graphs. Finally, it will be important to create and study adequate forms of teacher training suitable to train teachers in creating and supervising product-oriented modeling projects. First steps have already been undertaken (cf. Lantau & Bracke, 2019; Bock, Bracke, & Capraro, 2019; Lantau, Bracke, Bock, & Capraro, 2017).

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