

Enhancing teaching and learning of fluid mechanics with interactive computational modelling

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Abstract

Contemporary research and other professional activities in science, technology, engineering and mathematics (STEM) increasingly require advanced knowledge about mathematical physics models and methods of scientific computation. In the corresponding STEM educational environments this entails the necessity to implement learning and teaching processes capable of bringing up a strong background in physics, mathematics and scientific computation appropriately adjusted to the specific requirements of each STEM area. STEM learning environments should thus be based on pedagogical curricula and methodologies that epistemologically balance the inclusion of interactive engagement sequences of computational modelling activities, and offer students opportunities to develop meaningful knowledge of physics, mathematics and scientific computation, as well as of the specific STEM concepts and processes. However, in spite of abundant fruitful research [1, 2] such balanced integration of elements of theory, experimentation and computation has not yet been achieved by the majority of current STEM curricula and learning environments.

Our approach to this problem is based on the development of interactive engagement learning activities built around computational modelling experiments implemented in the Modellus environment that span the range of different kinds of modelling, from exploratory to expressive modelling [3]. In this paper we describe research concerning a sequence of activities about hydrostatic pressure forces and torques, a theme of an

introductory fluid mechanics course we offered to a group of first year undergraduate university students enrolled in engineering majors, which had only elementary knowledge of secondary education physics and mathematics and no significant prior knowledge about scientific computation. We analyse student's perceptions about the activities and the effects generated on the learning process.

Using a Likert scale questionnaire, we show that students reacted very positively to the Modellus based activities, considering them useful to help the learning process of the mathematics and physics of fluid mechanics and for their overall professional training. The results also show that students considered Modellus a useful software for computational activities that help the learning of mathematical physics models, sufficiently easy to learn and user-friendly. Based on the analysis of student's work content, we show that students were able to construct and explore the proposed mathematical physics models and simulations, and establish meaningful and operationally reified relations with the relevant hydrostatic phenomena. We also show that the computational modelling activities were effective in resolving several difficulties persisting after theoretical lectures and problem-solving paper and pen activities.

Keywords: Teaching and learning; Interactive environments; Computational modelling; Physics; Fluid mechanics

References:

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