ZMATH 2016e.01052

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Examining the effect of the computational models on learning performance, scientific reasoning, epistemic beliefs and argumentation: an implication for the STEM agenda.

Comput. Educ. (Exeter) 68, 253-265 (2013).

Summary: Computational experiment approach considers modelling as the essential feature of Inquiry-Based Science Education (IBSE) where the model and the computer take the place of the "classical" experimental set-up and simulation replaces the experiment. Modelling, as a pedagogical tool, involves the model construction, the exploration of model characteristics and the model application to a specific problem, resembling authentic activities of scientists and mathematicians. *D. H. Jonassen* and *J. Strobel* ["Modelling for meaningful learning" in: D. Hung (ed.) and M. S. Khine (ed.), Engaged learning with emerging technologies. Dordrecht: Springer. 1–27 (2006; doi:10.1007/1-4020-3669-8_1)] state that in addition to modelling domain knowledge, learners can apply modelling skills in different ways: by modelling domain knowledge, by modelling problems (constructing problem spaces), by modelling systems and by modelling semantic structures. The purpose of this study was to explore the effects of the Computational Experiment Mathematical Modelling (CEMM) approach on University students': a) reasoning abilities, b) learning performance, c) epistemological beliefs, and d) argumentation. Students worked in a learning environment which contained applications in Physics created by the author and all of them were based on mathematical models, as the model was considered as the fundamental unit of instruction. Fifty (50) pre-service primary school university students participated in this project and results indicated a strong relationship between students' learning performance, performance in the scientific reasoning abilities test, epistemic beliefs and the ability to use arguments during computational experiments. This paper suggests an implementable integration strategy that uses mathematical models for physics phenomena that are developed using algorithms, aiming to deepen students' conceptual understanding and scientific reasoning. After completing the course, the mechanics baseline test (MBT) and a test on Heat were administered. The results indicated that there was a significant difference in problem-solving skill test mean scores, as measured by the MBT, and the test on Heat among concrete, formal and postformal reasoners. Overall, this study provides evidence that scientific reasoning has a strong impact to learning performance, scientific reasoning, epistemological beliefs and argumentation while the methodology of the Computational Experiment provides essential tools to students to implement Inquiry based scenario. Students developed their scenarios using an open source repository using the computational experiment approach and created their experiments using the Argument-Driven Inquiry (ADI) laboratory approach. Results have implications for the effectiveness of the computational experiment as a methodology to be included in the STEM agenda.

Classification: U79 M59
Keywords: modelling; computational experiment; reasoning abilities; epistemological beliefs; argumentation
doi:10.1016/j.compedu.2013.05.015