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Physical models: A crucial link between reality and mathematical models

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Physics describes real-life phenomena with the aid of models; mathematical modelling is a prime goal of physicists. All models, even abstract mathematical models, are embedded in real life experiences and Physics students should learn to look at the world through this lens and to handle modelling cycles with ease. Major processes of a modelling cycle are mathematical modelling of a physical system followed by mathematical processing of which the outcome is interpreted and validated in the physical system. In this paper it is argued that crucial attention should be paid during physics instruction to understanding of physical models (that incorporate physical systems) as an initial phase in the modelling process. Physical models involve simplifications of real life situations and the assumptions, features and limitations of physical systems; conceptual understanding of physics concepts, relations, basic principles, laws and theories and the ability to translate between various representations thereof as well as application of scientific causal, proportional and analogical reasoning. Research-based problems that students encounter when physics tuition commences with mathematical models or when these are directly built into real life situations without sufficient attention to physical models are discussed. Teaching strategies to circumvent these problems are proposed. These include experimental work using inquiry learning principles and ICT, refinement of daily-life and laboratory experiences to generalize relations and principles that form a coherent explanatory framework as well as attention to the nature and epistemology of science. Students' understanding and appreciation of physical models further requires consideration of socio-cultural aspects, such as their background knowledge, world views and ways of doing, thinking and reasoning. All the above-mentioned features of physical models should progressively be introduced in the teaching of physics to aid students' comprehension of what physics is all about, its nature, methods, principles and reasoning and their becoming physicists themselves.

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