

Teaching University Physics from First Principles

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As physicists, we all fondly remember our first encounter with "real physics" during the early years of our university studies. It was at that stage that the use of rigorous mathematical tools first enabled us to progress from fundamental concepts to models capable of providing a remarkably accurate description of a wide range of natural phenomena. Part of the beauty of learning physics at this level lies in the fact that virtually no "why?" question is considered off limits, and that such questions are (almost) never answered dogmatically.

Unfortunately, traditional physics textbooks only partially reflect this spirit. They quickly become overloaded with technical and often secondary details, leaving little room for the careful construction of conceptual foundations. This rush through the fundamentals is, in fact, counterproductive, as the resulting gaps in understanding frequently become apparent when students encounter more advanced topics. Nevertheless, this approach has become the norm and is rarely questioned.

Throughout his teaching career, Prof. Dulčić devoted himself to reversing these priorities by placing complete and fundamental understanding of physical phenomena at the heart of his teaching, without skipping essential steps or leaving important concepts insufficiently explained. In this contribution, I will discuss my experiences collaborating with Prof. Dulčić in developing and implementing this philosophy of teaching [1-3]. Using the examples of elastic forces and friction, I will illustrate how these concepts can be introduced naturally from first principles and Newton's laws, leading students to a deeper and more coherent understanding of the underlying physics.

References:

- [1] A. Dulčić, M. Milin, N. Poljak, M. Požek, *Elektromagnetizam*, Školska knjiga, Zagreb, 2024.
- [2] N. Poljak, A. Dulčić, M. Milin, M. Požek, *Eur. J. Phys.* **46**, 065204 (2025)
- [3] N. Poljak, A. Dulčić, M. Milin, M. Požek, *Eur. J. Phys.* **47**, 035202 (2026)