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Consolidating and Organizing Subject Matter Content Knowledge: Didactical Reconstructions in Physics Teacher Education

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Physics teachers are in a key position to form the attitudes and conceptions of future generations toward science and technology, as well as to educate future generations of scientists. Therefore, in physics-teacher education, effort is needed to guarantee the best available education to pre-service physics teachers; deep knowledge of physics should be combined with a good understanding of the didactical and pedagogical aspects of teaching and learning. The situation is often that after introductory and intermediate physics courses, the pre-service physics teachers know laws and definitions but their knowledge is still quite fragmented and does not form coherent wholes. I discuss here a research-based approach that is developed for advanced-level physics courses of pre-service physics teachers for consolidating and organizing their subject matter content knowledge. In the core of the approach are graphical tools called didactical reconstructions. The idea behind the reconstructions is that "new" physics knowledge is always constructed on the basis of previous knowledge (quantities, laws, theory). It means that every new concept is connected to previous concepts when it is formed; this is captured in the didactical reconstruction of processes (DRoP). Then, when the knowledge is constructed further, the formed concept will be connected to other new concepts. This approach leads to the didactical reconstruction of structure (DRoS): networks of quantities and laws, where the experiments and models construct the connections between quantities and laws. Finally, I discuss the application of didactical reconstructions in instruction through different case studies and show that the didactical reconstructions help students to connect the knowledge pieces into meaningful and more coherent wholes.