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A New Approach to Analyzing the Cognitive Load in Physics Problems

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I will present a Taxonomy of Introductory Physics Problems (TIPP), which relates physics problems to the cognitive processes and the knowledge required to solve them. TIPP was created for designing and clarifying educational objectives, for developing assessments to evaluate components of the problem-solving process, and for guiding curriculum design in introductory physics courses. To construct TIPP, I considered processes that have been identified either by cognitive science and expert-novice research or by direct observation of students' behavior while solving physics problems. Based on Marzano and Kendall's taxonomy [1], I developed a procedure to classify physics problems according to the cognitive processes that they involve and the knowledge to which they refer. The procedure is applicable to any physics problem and its validity and reliability have been confirmed. This algorithm was then used to build TIPP, which is a database that contains text-based and research-based physics problems and explains their relationship to cognitive processes and knowledge. TIPP has been used in the years 2006–2009 to reform the first semester of the introductory algebra-based physics course at The George Washington University. The reform targeted students' cognitive development and attitudes improvement. The methodology employed in the course involves exposing students to certain types of problems in a variety of contexts with increasing complexity. To assess the effectiveness of our approach, rubrics were created to evaluate students' problem-solving abilities and the Colorado Learning Attitudes about Science Survey (CLASS) was administered pre- and post-instruction to determine students' shift in dispositions towards learning physics. Our results show definitive gains in the areas targeted by our curricular reform.

[1] R.J. Marzano and J.S. Kendall, *The New Taxonomy of Educational Objectives*, 2^{nd} Ed., (Corwin Press, Thousand Oaks, 2007).