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Developing techniques for improving functional understanding of vectors LEONARDO RODRIGUEZ GUTIERREZ, KARLA CARMONA, JORGE DAYER CARRILLO, MARIA GONZALEZ, SERGIO FLORES, ROY MONTALVO, The University of Texas at El Paso, THE UNIVERSITY OF TEXAS AT EL PASO PHYSICS EDUCATION GROUP TEAM — Many introductory physics students encounter challenges in understanding vector operations. We present data collected from more than 300 students and related to traditional instruction. This data describes students' conceptual difficulties with vector addition/subtraction. These students were organized in small groups led by student Teaching Assistants (TAs). The TAs help students understand vector operations during a hands-on 50 minute session. Analysis of the data suggests that, after traditional instruction, some students were unable to reason qualitatively about the vector operations. We describe some specific procedural and reasoning difficulties we have observed (e.g. 1. Closing the loop, 2. Tip-to-tip, 3. Use of Pythagorean Theorem, and 4. Adding as scalars) and describe modifications to laboratory instruction that we have design on the basis of our research into student's understanding. The modifications are intended to improve the student's understanding of the vector operations, and to promote the student's use of vectors when solving mechanics problems. We also describe initial measures of the effectiveness of the modified instruction approach.

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