



## NSF Award Abstract - #0206683

### Investigation of Diverse Representational Modes in the Learning of Physics and Chemistry

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### Abstract

The goal of this project is to investigate the role played by diverse representational modes in the learning of physics and chemistry concepts. We will explore the relationship between the form of representation of complex concepts in physics and chemistry, and students' ability to learn these concepts. We will determine the specific learning difficulties that arise as students struggle to master concepts posed in different representational forms, and we will apply our findings immediately to the development of improved curricular materials and instructional methods. We will then assess the effectiveness of these new materials and methods in bringing about greater student mastery of the targeted concepts. The issues we will investigate include the following: 1) What subject-specific learning difficulties may be identified with various forms of representation of particular concepts in the introductory physics and chemistry curriculum? 2) What generalizations may be possible regarding the relative degree of difficulty of various representational modes when compared with each other, in learning of particular concepts? 3) Do individual students do consistently well or poorly with particular forms of representation, with widely varying types of subject matter? 4) Are there any consistent correlations among students' relative performance with different

representational modes, and parameters such as major field, gender, age, learning style, etc.? 5) Does the overuse or under-use of certain types of representational forms in standard instruction have any potential impact on members of traditionally underrepresented groups? Test instruments, consisting of sets of closely matched problems presented in several different forms of representation, will be administered simultaneously to all students in a class. Analysis of students' responses will allow us to determine whether the learning difficulties are concept-related or representation-related, or both. We will develop and validate many of these closely matched problem sets, dealing with a wide variety of basic topics in the introductory curricula. These will be administered to students enrolled in both algebra-based and calculus-based courses, at Iowa State University and at other institutions. We will also conduct and record many clinical interviews with individual students in order to probe in more depth their understanding of multiple representations. As we identify widespread learning difficulties related to representational mode, we will develop and test curricular materials specifically designed to address and remedy these obstacles to learning.

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