A New Look at Categorization

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Introduction

Learning in physics is primarily problem based (Hestenes, 1987); That is, the focus of a physics classroom is on solving particular problems in the discipline. How individuals at various levels of expertise solve these problems has been a concern of many researchers of the past decades (c.f. Chi et al, 1981,1982; Larkin, 1981, 1983; Larkin et al, 1980). However, less emphasis has been given to understanding how these individual problems relate to knowledge of the domain of physics (Chi et al, 1981, 1982; Giere, 1994, Larkin, 1983). In particular, an understanding is needed of the relationship between the structure of students' knowledge of physics problems and formal physics theories. Using findings from research on concept learning, the present research aims to explore how individuals of varying levels of expertise in physics represent problems within the broader context of the domain of physics.

Method

This research extends work on expert/novice categorization of physics problems (Chi et al. 1981; Giere, 1994; Larkin, 1983) by proposing a representation of physics knowledge in terms of models and theories used to understand physical phenomena. Chi et al.'s finding that novices categorize problems based on surface features and experts categorize based on more abstract principles was reinterpreted by Giere who proposed that the experts were categorizing problems based on a hierarchy organized from general to more specific models of the domain. Giere's interpretation suggests meaningful links between and within categories of problems based on models of the domain. In the present study, the goal was to investigate the relationships within and between groups of problems, as described by expert subjects, in order to investigate the hierarchical arrangement that Giere (1994) proposes. Experts in physics were asked to categorize a set of 18 problems chosen from an intermediate level classical mechanics text (Marion & Thorton, 1988). These materials were chosen to represent a set of physics problems in Mechanics that could be solved using either Newton's Laws or Conservation of Energy. The subjects were asked to put the problems into groupings or categories based on their meaningful similarities. Once they were finished, they were asked again to make subcategories as well as more encompassing categories. All subjects' data was videotaped, and protocol analysis was used to determine the nature of subjects' representations of the domain.

Results and Discussion

Results indicate that representations are not hierarchical, as proposed by Giere; rather, the models tend to be clustered within the theories that subjects use in solving the problems. That is, for the experts, these theories are well structured corresponding to their understanding of how models and theories are used to solve problems. This research demonstrates that the categorization exhibited by experts reflects their models and theories with respect to their understanding of the domain. These data will be used to describe and specify a representation of physics knowledge in terms of theories and models that may be used to facilitate meaningful learning in physics.

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