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A Secondary Analysis Study of Student Conceptions on the Behavior of Gas Particles by Utilizing the Cognitive Map Approach

Mei-Hung Chiu

Graduate Institute of Science Education,
National Taiwan Normal University
Professor

Chih-Kang Chang

Keelung Municipal NuanNuan Senior High School,
Keelung City
Teacher

Jing-Ping Jong

Graduate Institute of Science Education,
National Taiwan Normal University
Graduate Student

Sheng-An Bai

Graduate Institute of Science Education,
National Taiwan Normal University
Graduate Student

Abstract

The purpose of this secondary data analysis study is to explore the cognitive maps (CMs) held by the students and their constraints of conceptions while forming their qualitative inferences regarding the behaviors of gas particles. The data used in this study was derived from the National Science Concept Learning Study via the use of two-tier diagnostic instruments proposed by Treagust (1988, 1995). Unlike other studies only comparing student performance, the analytical method of this study adapted a model of scientific explanations proposed by Hempel (1958), and cognitive maps by Wellman (1994) and others (Chaib-draa & Desharnais, 1998; Peña, Sossa, & Gutiérrez, 2008). The results are as follows: (1) although the performances of 11th graders were superior to those of 8th and 9th graders, the percentages of correct answers were still relatively low; (2) in similar contexts, due to the constraints (gravity, pressure, and randomness of motions) of factors, the students held various CMs of gas particles and causal inferences. The identified CMs of gas particles provide information regarding the constraints that students held in their mental representations. This study presents a discussion of the educational implications for designing two-tier diagnostic instruments, and the limitations of CMs.

Keywords: secondary analysis, concept survey, cognitive maps, two-tier diagnostic instrument