The effectiveness of an inquiry-based computer-simulated lesson in physics

Abstract

Robust as they are, the existing instructional design prescriptions (Reigeluth, 1983; 1999) which are content-based, expository- and individual-oriented, and generally technology-free are of little use when the task is to design inquiry-based computer-simulated lessons for teaching scientific thinking skills in cooperative learning environments. Thus, the aims of this study were to design a computer-based simulation lesson employing currently available PC and internet software and investigate its effectiveness in various learning situations. The heart of the lesson was the utilitarian Gas Law Simulation program developed by Abraham, Gelder, and Haines (2002) that was incorporated into a hypertext interface display with active links to related notes and worksheets and a superimposed Microsoft Excel table and chart-plotting facility. This package allowed students to review the concepts involved and see relationships between the variables in graphical forms when a selected independent variable was manipulated and all the corresponding values were keyed into the Excel table. A science process skill and HD thinking worksheet was drawn following Lawson's (1995) prescriptions and the questions and activities were further modified to fit the local syllabus and physics texts. A pilot study was conducted to evaluate and refine the lesson and field testing was conducted using a 3 x 2 factorial design. The first factor was the inquiry-based computer simulation lesson with three modes of cooperative learning, namely, heterogeneous-ability cooperative learning (HACL) group, friendship-based cooperative learning (FCL) group, and traditional group work (TGW) group. The HACL and FCL group were trained following the Kagan (1994) Cooperative Learning Structure while the TGW group which was essentially another friendship-based learning group was not instructed on the Kagan (1994) Cooperative Learning Structure. The second factor was student reasoning ability, namely, empirical-inductive (EI) and hypothetical-deductive (HD) abilities. The sample consisted of 301 Form Four (16-year-old) science students. The results showed that students in the HACL group significantly outperformed their counterparts in the FCL group who, in turn, significantly outperformed their counterparts in the TGW group in scientific thinking and conceptual understanding. The study found that the inquiry-based computer simulation program was effective in enhancing scientific reasoning and conceptual understanding of students of all reasoning abilities but for maximum effectiveness cooperative learning groups should be composed of students of heterogeneous abilities.