Microcomputer-based Laboratories: Interpretation of Graphical representations and Phase Transformations

Christiana Th. Nicolaou, Iolie A. Nicolaidou, Zacharias C. Zacharia and
Constantinos P. Constantinou
Learning in Physics Group,
Department of Educational Sciences
University of Cyprus

Abstract

This article reports on a research effort through which we aim to investigate whether the use of Microcomputer-Based Laboratories (MBLs), implemented through inquiry-based curriculum concerning phase transformations (melting and freezing), contributes to the development of fourth grade (9-10 year-old) students' ability to interpret, comment on and explain graphs. The subjects of the study were sixty five fourth graders (organized into an experimental and two control groups) studying at two technologically well-equipped public elementary schools in Larnaca and Nicosia. The experimental treatment involved the use of the inquiry-based curriculum along with the use of Microcomputer-Based Laboratories. The control treatment for the first control group involved the use of the inquiry-based curriculum without the support of instructional technology. The second control group used more traditional methods that relied on the textbooks by the Cyprus Ministry of Education and Culture.

Data collection was accomplished through the use of a paper and pencil test which was administered to the students both before and after instruction. Phenomenographic analysis was used to define the basic students' ideas concerning phase transformations and construction and interpretation of line graphs. Quantitative analysis, One-Way ANOVA and Paired-Samples t-test, was also conducted. More specifically, One-Way ANOVA was used to analyze (i) the achievement of the three groups on the pre-test to verify equivalence of groups and (ii) the achievement of the three groups on the post-test to identify differences among them; the Paired-Samples t-test was used to compare the achievement of each group on pre- and post-test in order to determine whether the learning objectives of the redesigned curriculum had been achieved.

Phenomenographic analysis of the students' responses revealed: (a) a lack of familiarity with the use of the scientific terminology to describe states of matter, (b) understanding of melting at a greater extent compared to freezing, (c) improved understanding of the effect of the variable of mass on the time needed for a material object to melt, and (d) better understanding of chemical changes (irreversible phenomenon) compared to physical changes (reversible phenomenon). Moreover, most of the students are not able to construct a correct graph when provided with data, and are not able to identify which part of the graph corresponds to which state of matter.

The results of the quantitative analysis revealed a statistically significant difference between the experimental group and both control groups in students' understanding of phase transformations as well as in their ability to interpret graphs. This result suggests that there is a significant added value in employing MBLs in an instructional effort to enhance students' ability to interpret graphs and as a tool that enhances learning in the specific context of state changes.