Teaching the Control-of-Variables Strategy Through Different Forms of Active Learning

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Introduction

A broad spectrum of teaching approaches is found in K-16 schools, ranging from highly teacher directed to highly student directed. One method that has been widely used in the education literature is *active learning*. However, the term appears to include differing amounts of teacher-led instruction and student participation along with different types of student activities.

Given the diverse intensities and implementations associated with active learning, it is important to provide operational definitions of the term and then to test experimentally one form against other operationalized definitions of the term.

We developed four operational definitions of active learning, focusing on the instructional side of active learning as compared to student activities. We implemented and contrasted these forms of active learning in the context of teaching students about basic processes and concepts in simple experimental design, often called the Control-of-Variables Strategy (CVS).

Method

- Participants: 145 third- and fourth-grade students from two local charter schools and one local private school
  - 33.1% Caucasian, 54.5% African American, 4.8% Asia American, and 7.6% Other

Condition	Phase 1 of lesson	Phase 2 of lesson	Phase 3 of lesson
1	Minimal Guidance (MG)	Minimal Guidance (MG)	Independent Activity (IA)
2	Minimal Guidance (MG)	Direct Guidance (DG)	Independent Activity (IA)
3	Model (M)	Direct Guidance (DG)	Independent Activity (IA)
4	Model (M)	Model (M)	Independent Activity (IA)

- Materials: CVS lesson conducted using physical ramps
- Procedure:
  - Story Problem Pretest
    - High levels of inter-scorer agreement ranging from 87% to 95%
  - 40-minute scripted lesson taught in groups of 3-6 students
    - 56% of lessons were independently observed; 100% treatment fidelity
  - Story Problem Posttest
    - High levels of inter-scorer agreement ranging from 91% to 96%

Results

- Main Analyses:
  - Independent Activity: No significant differences among conditions ($p = .16$)
  - Pre- to Posttest Performance: Significant learning gains ($p < .001$) in conditions MG/DG/IA, M/DG/IA, and M/M/IA. See Figure 1.
    - M/DG/IA was significantly different from MG/DG/IA ($p <. 05$) and MG/MG/IA ($p < .001$); and M/M/IA was significantly different from MG/MG/IA ($p < .01$). See Figure 1.

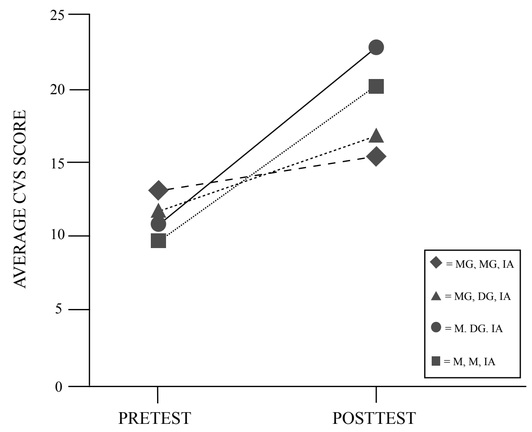

Figure 1. Pre- and posttest average scores for transfer of CVS knowledge for each of the four experimental conditions.

- Exploratory Analyses: See Figure 2

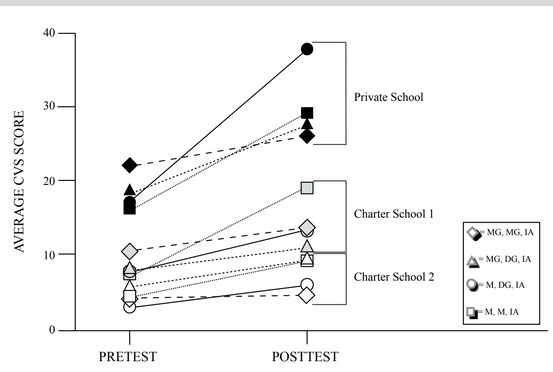

Figure 2. Pre- and posttest average scores for transfer of CVS knowledge for each of the four experimental conditions at the three schools.

Discussion

Though the four forms of active learning produced equivalent learning gains on the independent activity, there were significant differences in transfer across conditions. On the measure of transfer, the strongest condition was M/DG/IA and the weakest condition was MG/MG/IA.

The gap that existed between charter school students' pretest scores and their private school peers' pretest scores was not closed through even the most intensive form of instruction.

Future studies should be conducted on the array of active learning implementations. Researchers should also investigate ways to close the gap between students from low and high SES backgrounds.

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