What is the Most Effective Way to Teach Students to Reason Statistically?

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Although several applications of constructivist principles to classroom practice have been attempted and empirically evaluated (Brown & Campione, 1994; CTGV, 1990; Derry, Levin, Osana, & Jones, in press), not many studies have carefully compared the types of learning that emerge as a result of instruction grounded in different theories of learning. This paper describes an investigation that was designed to reveal the types of cognitive growth that emerge as a result of two different instructional treatments in the area of correlational reasoning. Middle-school students worked in small groups with trained adults who each administered one of two specific mentoring styles. One of the mentoring styles was based on the theory that knowledge is actively constructed by students as they engage in social and cognitive interactions with their peers. Mentors were trained to model good reasoning skills for the students by expressing their thoughts aloud. They voiced plausible hypotheses about correlational problems, asked pertinent questions, and encouraged students to collaborate in thinking correctly about relevant issues.

The other mentoring technique was based on Direct Instruction, a method that stems from the view that students learn through multiple recitations of explained facts and concepts. Careful task analyses lie at the heart of this approach; content is broken down into its component parts and placed in a "learning hierarchy" (Gagne & Briggs, 1979; Tarver, in press), which places the skills or facts in a logical sequence, and displays which skills are prerequisite to the learning of others. Mentors using this approach, therefore, used written scripts to explain concepts and demonstrate reasoning skills and subskills. Students were expected to repeatedly practice the skills that had been demonstrated and recite the facts and concepts that had been explained.

Two eighth-grade social science classes were used for this study. Students in each class were divided into small groups; a total of 12 groups were formed, half of which received the constructivist instruction, and the other half received Direct Instruction. Each group of students worked with one adult mentor over the course of a two-week period, for approximately 50 minutes each day. The learning objective for the students was to use ideas related to correlation and causation to correctly interpret newspaper articles, analyze arguments, and make reasoned decisions about social problems. All students were given a pre- and posttest measure that was designed to assess their ability to use correlation to reason effectively about complex, ill-structured problems. In addition, a random sample of 24 students was selected for one-on-one interviews. Transcripts were used to assess the amount of cognitive construction used to solve problems, the ability to integrate other statistical concepts into the reasoning process, the sophistication of the evidence used to support assertions, and the number of solution strategies attempted for a particular pair of interview tasks.

The results indicate that regardless of instructional style or ability, the students' level of reasoning skill was significantly higher on the posttest than on the pretest. No difference was detected on the pre-interview, but students receiving the constructivist mentoring style engaged in significantly more questioning, revising, clarifying, and elaborating than the Direct Instruction students on the post-interview. A significant treatment by time interaction was also found on the number of strategies measure. Qualitative analyses suggest that students' strategies for representing data was also dependent on the type of instruction received. There were no significant effects found in the ability to integrate other statistical concepts into the reasoning process or the sophistication of the evidence used in student arguments.

Overall, the results suggest that "there is more than one way to skin a cat": not only are eighth-graders able to use statistical concepts to reason through complex problems, but there exists more than one way for a teacher to guide students to this point. The cognitive processes that are used by students to arrive at a conclusion, construct an interpretation, make a decision, or analyze an argument, however, seems to differ according to the instruction received. A method founded in constructivist principles will yield more active "efforts after meaning" (Bartlett, 1932) than methods based on Direct Instruction theory. Thus, it is critical that teachers make a priori decisions about the types of cognitive processes they intend to cultivate in the classroom, and design learning environments accordingly.

References

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