The National Science Education Standards (NSES) outlined by the National Research Council (NRC) (1996) were designed to overhaul completely the educational system based on the belief that learning science required active student engagement. However, active was not operationally defined and, therefore, was open to different interpretations by teachers required to implement the new Standards. Therefore, we decided to compare the effects of three different instructional strategies perceived as requiring more or less active student engagement to determine whether they were equally effective for, or appreciated by, students.

Review of Pertinent Literature

Because many science teachers construe active involvement as learning through laboratory experiences, McComas (1991) specified criteria for excellence in laboratory instruction. He then used those criteria to identify nine high school science teachers who comprised the sample for a combined quantitative and qualitative study. Methods consisted of classroom observations, videotaping, on-site developed field notes, and in-depth interviews during which teacher behaviors were coded. In addition, measures of class and group engagement times and the amount of time and frequency of contact evidenced between the teacher and the laboratory groups were reported. Each exemplary teacher was represented by an extensive case study constructed from data provided by observations and verbatim transcripts of interview responses and teacher-student interactions. McComas then reported the following practices associated with exemplary laboratory teaching:

- Goals for using laboratory activities were well-established, central to instruction, and well-founded in pedagogical knowledge about students’ differences, constructivist principles, and the learning cycle.
- Laboratory work was used more frequently than twice the national average.
- Laboratory experiences frequently were used to introduce concepts rather than to confirm or reinforce an already-presented idea. Lessons initially were presented either tactually (manipulating items with hands while in the lab) or kinesthetically (making or doing things in the lab that required standing and moving) rather than through traditional lecture, discussion, reading, or chalk-board presentation.
- Open-ended activities with fewer teacher directives and more student choices were provided to encourage student thinking and enthusiasm.
- Teachers served as facilitators who circulated from group to group while interacting in ways...