Inquiry-based Instruction for Elementary Physics: Hi-Tech and Low-Tech

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I will discuss a new elementary physics course based on guided inquiry methods of instruction, which was developed and taught for eight consecutive semesters at Southeastern Louisiana University. Both hi-tech and low-tech approaches were used, and student learning was carefully assessed with various techniques. While significant learning gains were documented in several areas, student difficulties in learning certain concepts were stubbornly persistent.

I have been engaged in ongoing development of an inquiry-based elementary physics course targeted at education majors and other non-technical students. In this course, issues related to student preconceptions (as determined by pre-testing) were investigated by students through guided "mini-research projects." These projects were carried out by the students working cooperatively in small groups. Discussions centered around each group's results led to a systematic summing up by the instructor to provide perspective. During course delivery, ongoing testing and other assessment guided the pacing and depth of the topical coverage. Among the issues I have investigated is the question of just how severely the breadth of topical coverage had to be reduced from conventional levels, in order to ensure student mastery of the targeted concepts.

It was found necessary to drastically restrict the number of topics covered; ultimately, the course developed a narrow focus on force and motion. "Low-tech" methods of stopwatch timing and hand-plotted graphs were used to introduce students to graphical analysis and interpretation of data. This was later supplemented with "hi-tech" techniques utilizing microcomputer-based laboratory equipment, with real-time computerized graphical display of data acquired through ultrasonic motion sensors. Overall student subjective response to the course was very positive. Students who were previously frightened of mathematics and physical science found the course enjoyable and valuable. The number of elementary education majors taking physics courses at Southeastern Louisiana University was increased from zero to more than 20 per year.

Various forms of assessment documented substantial learning gains in graphing skills, graphical analysis of motion, understanding of kinematics concepts, and scientific reasoning ability. However, student difficulties in the understanding of acceleration and of the relationship between force and motion persisted despite all efforts to overcome them. Extensive interviews carried out with students after completion of the course, as well as written diagnostic assessment instruments, all pointed to the very great difficulty of guiding students toward mastery of certain fundamental, though somewhat abstract, physical concepts.