



# INNOVATION ABSTRACTS

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## SPATIAL REASONING: A PREDICTOR FOR SUCCESS IN PHYSICS EDUCATION

A recent study of Albert Einstein's brain by Canadian scientist Sandra Witelson of McMaster University in Hamilton, Ontario, has found that his parietal lobe, a region of the brain's cerebral cortex, is 15% wider than that of the normal human brain. Her research also discovered that Einstein's brain had no parietal operculum—which allowed for the expansion of the parietal lobe. Other than these distinguishing features, Albert Einstein's brain is quite normal.

Scientists know that the brain's parietal lobe processes spatial reasoning—the ability to visualize, perceive, and mentally rotate three-dimensional images—and abstract thought. Einstein relied on these abilities to visualize space, time, and distance to develop his theories of relativity. Damage to the parietal lobes causes abnormalities in left-right orientation and map reading, and affects one's ability to do math, and ability to stay oriented in familiar places.

Research conducted at Rutgers University and Camden County College helped clarify the nature of the relationship between visual-spatial abilities and achievement in physics courses, and the influence visual-spatial abilities have on the high attrition rate in many introductory college-level physics courses. Findings suggested that spatial reasoning was important to success in college physics.

This research included three sections of introductory college-level physics ( $S=136$ ) and one section of non-science liberal arts ( $S=52$ ). Students received pre- and post-measures of visual-spatial ability in the areas of perception, orientation, and visualization. The greatest increases in visual-spatial abilities occurred in an experimental section that received spatial skills intervention—specifically, test items that utilized graphical form and were related to laboratory work. Substantial gains in visual-spatial ability were registered by control physics sections, also. These increases suggested that

taking introductory physics improves visual-spatial abilities and that science teachers should balance laboratory experiments that depend on computer software with those that demand physical performance. Although students who withdrew from the course during this study demonstrated mathematics skills comparable to those who completed the course, their scores on spatial tests were appreciably lower.

Courses frequently cover an extensive range of subject matter and present content in an abstract and quantitative form—a characteristic of science courses, in general, and of introductory college-level physics, in particular. In these courses, the dropout and failure rates are uncommonly high. College physics courses rely heavily on drawings, diagrams, and graphs to present and analyze physical phenomena. The visual-spatial abilities of students exposed to spatial skills intervention, as well as those successfully completing a laboratory-based physics course, improved. Increases were realized in areas of perception, orientation, and visualization—the same skills that Einstein used to develop his theories of relativity.

Students' organization and analysis skills, and their skill in generating abstractions, must be developed. The processes associated with spatial-visual thought appear to be related closely to those involved in data analysis, as well as to those utilized in abstract representation. Elementary school educators should test for and develop spatial abilities in the early grades, followed by laboratory experiences to enhance them.

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## COLLABORATION FOR CRITICAL THINKING

As I looked for ways to revamp my English I and II composition courses, I decided to throw out everything and start over. I chose six essays for each unit covering a different writing style. The first three were discussed in class; the discussions were divided into introductions and challenges. For example, I introduced an essay, "Sticks and Stones and Sports Team Names" (Estrada), by asking students to list three names used in Iowa that may be construed as racist. They created a lengthy list, including Hawkeye, Redskin, Brave, and Chickasaw. At this point we only had a list. I asked the class to respond to the following questions: How can an ethnic name be a slur and paradoxically admiring? What does the term "political correctness" mean? Have demeaning names "hurt" you at any time? What question would you like to ask the author?

Then, I divided the class into groups of five students each, let them work on their questions for 20 minutes, and then had them return for a group discussion. The students developed some personal responses to the essay that they could incorporate into their own writing. This procedure was followed in the next two class meetings as the class worked on a common essay.

The work produced for the second assignment was presented by student groups. Each group had an hour to convey the writing sense and style of an essay to the class. One group wrote 8-10 questions and asked the class for verbal responses; then chose a video clip that reflected the essence of the essay, a song that captured the essay's theme, and a work of art that conveyed the concept of the essay.

This group was discussing the essay "Sex Education in Our Schools" (Kuhn) and began with questions, including: When did you learn about sex? How did you learn about sex? What responsibility does the public school system have in teaching sex? What formal institutions (i.e., school, church) and what informal institutions (i.e., peers) are our sex education sources and teachers? After a 15-25 minute discussion on these questions and others asked by the audience, the group moved onto the film clips, an hilarious scene from *Varsity Blues* in which the high school sex education instructor is trying to be blunt and open in a humorous way about sex-ed terms and the human anatomy, not realizing that a number of male students were in the audience the previous night at the strip club where she moonlighted. This clip raised several questions. The students then turned to the song "Contact" from the

musical *Rent*, which dealt with sex as a means of ownership. It produced a lively debate from emotional and political perspectives about how sex-ed should be taught. The group chose Goya's *The Naked Maja* to contrast sex as depicted in art in early centuries with sex in this millennium.

Then the group returned to the thesis of the essay, discussed how each of their presentations might be controversial today, and described parallel controversies in sex-ed programs. The presentation ended with each person in the group commenting on the essay and how current sex-ed programs mirrored or differed from the proposal in the essay. I assigned a group grade for each project, with the stipulation that if I felt a student was not participating sufficiently, I would adjust the grade.

Most preparation for presentations occurred in class; however, what could not be finished in class was completed when the group could arrange to meet. The results have developed critical thinking and are invigorating, challenging, student-centered, never boring, and a great way to realize the impact of the written word.

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