Constructivism Criticism

I have no quarrel with Jose Mestre's assertion, in his September 1991 article (page 56), that the transmission model of learning, in which teachers talk and students listen, doesn't work very well. The constructivist model does seem more attractive: At least the teachers are talking with, and not just to, the students.

The transmission model provides no motivation for the students and is antithetical to science in that it resorts to dogma. The teacher as source of all knowledge imparts the Truth to students by virtue of authority. It is not surprising that students learning through this mode would have difficulty with any kind of science developed since Galileo!

If the transmission model is analogous to the science of Aristotle as practiced in the Dark Ages, the constructivist improvement is analogous to the Socratic method. It appears to require the teacher as authority too, although a more engaging and benevolent one. Under this model the teacher can guide students through misconceptions to understanding. While this sounds enticing, it seems designed to help students solve problems. In fact, it appears from Mestre's article that being able to solve physics problems is the sole measure of success as viewed by learning theorists.

One of the reasons students have trouble with solving physics problems is that they have had very few of the kinds of real-world experiences that the problems discuss. Giving students an opportunity to discover for themselves the properties of the physical universe would go far toward motivating an interest in the subject.

Hands-on experience with physical phenomena is much more important than transmitting physics facts or instilling physics concepts. A week at San Francisco's Exploratorium would probably do more for a student's education than two years of science classes. For students who have witnessed diverse phenomena, the principles of physics will have a force that they can't have as abstractions standing alone.

Pre-college physics needs to focus on instilling an interest in the subject through participative experiences with physical phenomena in which students discover physical properties for themselves, without the "answers" being provided. Teachers, in this model, would help students formulate questions and explore with

them how experiments could help provide answers.

What is not required for pre-college physics? We do not need teachers who have, think they have or think they ought to have all the answers. We do not need science curriculums that seek to convey a wide range of physical principles. We do not need to develop pre-college physics programs that strive to turn out students who can readily solve textbook physics problems. With the right sort of pre-college education, principles and problem solving will come readily later, at the college level.

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I greatly enjoyed reading the excellent article by Jose Mestre on introductory physics teaching using the constructivist approach.

With superb teachers, more students would gain insight under that new system. However, in the real world, average teachers frequently would not have sufficient background to focus the interactive questions of the constructivist classroom on precisely the important aspects of the problems. I fear that the best students might then be hampered in their stumblings toward insight, while the lesser students would not be helped anyway. Let us remember the "new math" of a few years ago.

Given the bleak picture Mestre paints of the traditional approach, how were so many of us able to gain insight? When I think back on how my cohorts and I learned science from the traditional approach, I find that the presentations were indeed dry, absolutist and so on. But after a while some students suddenly noticed the underlying patterns, said "Aha!" and made it—they became "Scientists." The rest just fumbled along.

In the absence of a preponderance of superb teachers, perhaps the maximum overall good might be served by continuing the present system. Yes, do encourage those teachers who are insightful and resourceful enough to use different systems, such as constructivism, to do so. But the attempt to force it on everyone could, I believe, result in a situation worse than the present one.

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How Do Students Get Misconceptions?

In his article "Learning and Instruction in Pre-College Physical Science" (September 1991, page 56) Jose P. Mestre discusses in detail overcoming common misconceptions students have about physics. He illustrates several examples of such misconceptions in his figure 1, whose caption states, "Traditional instruction based on the 'transmission model' is often inadequate to overcome misconceptions." He does not point out, however, that many of our students' misconceptions have probably been *acquired*, in the course of successful "learning" by the traditional methods, from incorrect and misleading presentations in textbooks.

Mestre gives the example of students' believing that a ball shot through a level, spirally shaped tube will continue on a spiral path after emerging from the tube. This does not seem to be an unreasonable conclusion for students who have learned from their high school physics books that Newton's first law "states that a *net unbalanced force is needed to change the state of motion of an object*," to quote *Physics: Principles and Problems*, by Paul W. Zitzewitz and James T. Murphy (Merrill, Columbus, Ohio, 1990). The "state of motion" of the ball, after all, was clearly described as coming through the spiral tube.

The discussion leading to the above statement of Newton's law is not very illuminating either. The students are told to "consider an object that has no net force on it. If it is at rest, it will remain at rest. *If* it is moving at constant speed in a straight line, it will continue to do so [italics added]." It does not appear unreasonable that the students extrapolate such statements to "If it is in spiral motion, it will continue to move in a spiral." Why does the almost sensible statement have the restriction "*If* the object is moving at constant speed . . ."? There should be no concern with the details of the motion before the forceless motion is considered. Nowhere is there any indication that the forceless motion is a continuation of the *instantaneous* velocity of the object at the instant when forces on the object ceased. All the examples deal with initially constant velocity. It is a big step for the students to develop such generalizations on their own after they have seen so many confusing, although not incorrect, expositions.

Another of Mestre's examples of misconceptions concerns the explanation some students give for why, when two different kinds of light bulbs are connected in series to a battery, one is lit and the other is not. These students believe that the electricity gets