Comments on D2: EFFECTIVE LEARNING ENVIRONMENTS FOR COMPUTER SUPPORTED INSTRUCTION IN THE PHYSICS CLASSROOM AND LABORATORY *(Ronald K. Thornton)*

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Perhaps the most important message in this chapter is that technology by itself can seldom improve physics teaching and learning. Any use of technological advances need to be embedded in a pedagogy that is appropriate for the context in which one is teaching and consistent with contemporary research on how students learn physics. My view is that there is no "right way" to teach any topic in physics. A teacher's approach must include consideration of the local context, the students' backgrounds, the teacher's facilities, and the resources that are available. By including these variables with the results of physics education research, a teacher can design a curriculum that will be effective for his or her students and be fun and interesting to teach.

As Thornton points out computer technology can support such curricula in significant ways. The use of various data collection techniques which he describes have been particularly valuable as shown by the research which he describes. Certainly, real-time data collection provides the students with a quick way learn how the physics of the textbooks is related to the world around them. They can collect much data in a short time, run an experiment multiple times and see results with a variety of different representations quickly. These representations can range from simple tables of numbers to physical or mathematical models to a variety of visual results such as graphs (Figure 1). Because each student may find a different representation communicates best with him/her, this aspect of the computer support can be important.

An aspect that is implicit in the chapter is that the type of computer is relatively unimportant. Because the focus is on the pedagogy, a teacher can incorporate sensors from any distributor of such equipment with almost any computer. The types of applications that Thornton describes could equally well be run on Windows or Macintosh as well as some handheld devices. A teacher can be successful with the resources that are available to him or her.

This message needs to be communicated to future teachers as well. At the University they may learn to incorporate computer support for their pedagogy by using brand X sensors with the W operating system. They should be able to relatively easily move to brand Y sensors with the M operating system if that is available at their schools. The learning curve will not be zero as one changes technologies. However, again, because pedagogy is the important issue, technology change is relatively straight forward.

Thornton followed the example of physics education research in preparing this chapter. He wisely limited the scope and presented a few ideas in some depth. Of course, when one takes that approach, one necessarily omits many approaches that could have been included (or put in another chapter). Some of those uses of technology are included in other chapters in this volume. Others can also be utilized in effective pedagogical use of technology. For example, Visualization of abstract concepts such as quantum physics and kinetic theory and using video to both collect data and visualize physical models are two important areas. Much has been written about these applications elsewhere so they need not be repeated here.

Finally, any instructor who is working with teachers at any level should not overlook the ways in which technology can change teaching. Many times school and university instructors have told me that they wanted to include computers in their teaching because they felt it was the modern thing to do. I usually refer them to ideas such as those presented in this chapter. The result is frequently that they not only incorporate technology in the classroom but change the way they teach. That is the ultimate value of contemporary technology in the teaching and learning of physics. I wonder if we will be able to apply this lesson to Web-based social networking next.