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CONFESSIONS OF A MODERN LUDDITE: A CRITIQUE OF COMPUTER-BASED INSTRUCTION

by

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The Original Luddites

Mention of the shire of Nottingham usually evokes the image of Robin Hood, who supposedly stole from the rich and gave to the poor. The legend of Robin Hood can be traced back to a series of English ballads that first appeared in the 14th century. However, attempts to trace this legend back to a historical figure who lived at the time of Richard I have failed the test of history.

In 1811, Nottingham gave birth to another mythical figure — Ned Ludd. Although the existence of "King Ludd" is questionable, the agrarian revolt associated with those who claimed to be his followers was real and the "Luddite" movement spread rapidly through northern England. By 1813, the Ludds represented a serious enough threat to justify a series of trials in Yorkshire that resulted in hangings and transportations. (Most of those transported were undoubtedly sent to Australia because the American Revolution had forced the British to find another dumping ground for their "criminals.") The Luddite movement resurfaced in 1816, during the depression that followed the Napoleonic Wars, but a combination of vigorous repression and economic recovery led to its demise in 1817.

The implications of laborers rising up to challenge the process of industrialization lasted long after the collapse of the Luddite movement. In 1830, "The Society for the Diffusion of Useful Knowledge" felt compelled to publish an eight-page pamphlet entitled "An Address to the Labourers, on the Subject of Destroying Machinery," the full text of which can be obtained by contacting the author. This pamphlet reflected conventional wisdom among proponents of the industrial revolution at the time, and, after surreptitious replacement of a few words here and there, reflects conventional wisdom among proponents of the information highway that is supposed to transform society at the turn of the 21st century, the way the industrial revolution changed society at the turn of the 19th century. A small portion of this pamphlet is reproduced below.

> You appear to have contracted a great dislike to the use of what are termed Machines .... You have never well considered the Reason of your dislike. You merely state, that Machines are hurtful to the Labourer ... Upon these grounds, you proceed to destroy them.

> The word *Machine* seems to convey to your minds, some contrivance necessarily attended with mischief to the Poor; whereas in truth, the word Machine means the same as Tool or Instrument ...
>
> Man ... begins, as soon as he feels ... the necessity of finding food, to look about for tools ... to assist him in cultivating the soil ... He first invents the most simple tools; the hoe, the spade, the rake, the axe, the flail, ...
>
> As men ... extend their knowledge further, they contrive other machines, ... the wheel, the cart, the plough — all of which are intended and used to ease his toil and abridge his labour. If these instruments did not produce this effect, men would reject them as useless and unprofitable. ...
>
> In following the course you are now pursuing, you are driving men back to their savage state, when they lived upon acorns and roots, and had no machines nor tools at all, a great demand for labour, and very little to eat.

The Luddite Legacy

In these more enlightened times, we no longer hang opponents of technical revolutions — or even transport them to foreign lands — because all we have to do is whisper the accusation: *Luddite!* Thus branded, these individuals automatically become ignorant, naive, backward, destructive people, who are opposed to "progress," which is presumed to lead both inevitably and invariably to a better society.

Modern usage of the term "Luddite," however, is inconsistent with the insight provided by historians who have studied this movement. Contrary to popular belief, the Luddites did not go about blindly destroying machines in a vain attempt to preserve their jobs. They were a well-organized and disciplined group — with enormous popular support — that carefully selected their targets. It was not the new technology to which they objected, but the societal changes that were being imposed on them from above by proponents of this technology. It was not the threat to full employment that concerned them, but the threat to the traditional wages a laborer could earn. They did not ask for a return to old fashioned work, but to "full fashioned work at the old fashion'd price."

Luddites in The Age of Computers

It would be a mistake to conclude from either the title or contents of this article that the author is opposed to computers. The first thing he does when he walks into his office — after turning on the lights — is to turn on a computer. It would also be a mistake to presume that, by labeling himself a modern Luddite, the author wishes to destroy the computers in our school and universities, or even remove them from the classroom. There is abundant evidence that computers *can* play a role in teaching and learning. Like his predecessors, this Luddite would like to concentrate on certain carefully selected targets, to remind the reader that any critical analysis of computer-based instruction would conclude that its use does not *necessarily* improve the teaching/learning environment.

Tales of Failure

Stories of the successful introduction of computer-based instruction are so numerous they need not be referenced. But what about tales of failure? An objective witness who perused the literature of computer-based instruction (CBI), or who attended one of the meetings at which its proponents delivered papers, would be amazed by the frequency with which instructors complain that "95% (or more) of the software that is out there is [expletive deleted]."

Because few people want to be associated with stories of failure, the author will transform case histories of "less than successful use" of computers into a series of questions that both authors of CBI programs and potential users of these programs might consider. Before we turn to these questions, however, we might consider an example of a "less than successful use" of computer-based instruction that has appeared in the literature.

Should Instructional Equipment Carry a Warning Label?

Our example is a study[1] that examined the implications of teaching organic chemistry with a liquid-crystal display device hooked to a Macintosh computer. The material from a year-long organic chemistry course was presented to the students using HyperCard to drive a liquid-crystal display screen. The lecturer did much more than transform material that would normally be written on the blackboard into a HyperCard environment, he took advantage of the potential of this software to increase the variety and frequency with which graphics and simulations were presented. Because students were unable to take notes and watch simultaneously, selected screens from the computer windows were distributed as notes to which students added key points. The computer materials were also available to students in a computer laboratory, or for copying for home study. Although all software was launched from HyperCard, eight other software packages (Molecular Editor, PC Model, Microsoft Excel, Chem 3D, ChemDraw, VideoWorks, ChemConnection, and HMO) were used.

A control group was taught by classic techniques. Both lecturers shared similar teaching philosophy and standards. The same textbook was used in both sections, pacing was similar, and the final exam was the same.

Students in the experimental section took very few notes, but they listened and watched intently. Class participation (questions, comments, discussion) was unusually high, of better quality and more stimulating than the lecturer had experienced in thirty years of teaching organic chemistry. Students were impressed with the course and believed that

[1] Joseph Casanova and Sally L. Casanova, *Educom Review*, **1991**, Spring, 31-39.

they had a good understanding of the subject, particularly the visual representations of molecular structure. But there was a problem with the students' performance on the exams. There was a striking difference between the experimental and control section, for example, on the final exam given at the end of the first quarter. The average score for the 30 students in the control group was 125 out of 200, whereas the average score on the same exam for the 29 students in the experimental group was only 88 out of 200. When the test questions were sorted into categories, the experimental section was found to have done worse on all categories of test items, even those topics that were judged to be visually intensive and potentially better understood with the techniques employed in the experimental section.

The instructor of the experiment group concluded that the "electronic blackboard" allows for the presentation of substantially more information in a given period of time, but students may have trouble absorbing the added information. He also noted that students in the experimental section had to invest more time in the course, and the professor had to invest at least three to four times the normal amount of time in order to prepare each classroom presentation. In summary, he concluded:

> ... the electronic blackboard is extremely labor-intensive, logistically complex, and conducive to enhanced learning only if skillfully used. Its introduction into the lecture has more profound consequences than it would first appear, and a warning label should limit its use to those tasks it does best.

Questions For Authors And Implementors of Cbi

Analysis of case histories of problems that arose when CBI programs have been implemented led the author to raise the following questions.

- *Does the program teach skills that you value?* In each field of science one can find examples of beautiful programs on which students could spend several hours developing certain skills that would earn them less than 1% of the number of points in the course. If they do this, however, they will have less time to spend developing other skills, which might be more likely to make them successful in the course. When choosing (or designing) software it is useful to remember that it carries a hidden message to students, who believe that we wouldn't have spent all this money on computers unless the content of the programs we assigned was important.
- *Does the program teach skills with which your students have difficulty?* It is common to come across experiments done to evaluate CBI programs in which only modest changes in student performance were observed because the students did reasonably well on the test questions even before they used the program.
- *Do we need a computer to deliver instruction?* The computer has revolutionized the development of instructional materials, but that doesn't mean the computer also has to be used to deliver this instruction. Proponents of CBI would argue that the computer does a better job of presenting instructional materials to students. But it

does so at a cost to both the instructor and the student. For the instructor, funds spent on purchasing computers to deliver instruction aren't available for upgrading laboratory equipment. For the students, a computer-generated handout has the advantage that it can be studied whenever and wherever the student chooses; it doesn't require a special trip to the computer lab.

- *Are the computers being used to do something that requires a computer?* Although the speed and power of the computers used for instruction has increased at an almost frightening rate in the last 10 years, the price of these computers has been remarkably stable. Their cost can be justified when they are used to do something that can best be done with a computer, such as collecting real-time data, doing extensive calculations, manipulating massive data bases, storing and retrieving information, and so on. All too often, however, these computers are being used to deliver instruction that could be presented almost as well with a two- or three-page copy of a computer-generated handout at a cost that is about five orders of magnitude smaller.
- *Are the computers being used to do things you would use a computer to do?* There are 50 faculty and more than 300 graduate students in the Department of Chemistry at Purdue. Virtually all of them use computers. Some use them to collect, store, or manipulate data. Others use them for molecular modeling or other calculations. They use the Internet for e-mail and the Web to gain access to rapidly changing information. Almost everyone uses them for word processing, and many will admit using them to play games. But none of them use the computer the way CBI programs ask students to use the computer — to learn conceptually difficult material. Perhaps the optimum way of using computers with students is to use them as productivity tools, the way we use them.
- *Do the students have difficulty navigating through a CBI program?* Studies of student use of CBI programs suggest that students often get lost, or disoriented, while navigating their way through the program. This isn't surprising because the author has watched a number of individuals get lost while demonstrating software they have written. Navigation problems are often the result of programs that try to do too much. Because they can link many topics, developers of software programs often believe that they should link these topics.
- *Is the program a first draft or a finished product?* Because of the time and effort that goes into writing a CBI program, they often have a stronger resemblance to the first draft of a textbook being considered for publication than they do to the third or fourth edition of a popular text.
- *Does the program feature things that can be done or things that should be done?* Imagine that you had a choice between software packages. One randomly selected an organic compound from among a number of examples stored in its memory, displayed the structure to the student, asked for the correct IUPAC name for the compound, and then told the students whether they were right or wrong. The other allowed the student to enter virtually any compound they could imagine, allowed them to propose a name for the compound, analyzed the structure to determine the IUPAC-approved name for the compound, and then analyzed the student's answer to determine whether (or where) errors had been made. Which would you buy, the

one that does something that can be done or the one that does something that is worth doing? Suppose that you could buy a program on organic substitution reactions that allowed the student to choose the substrate for the reaction, the entering group that attacks this substrate, the temperature of the reaction, and the solvent in which the reaction is run. The program then analyzed this information and helped the student decide whether the reaction was more likely to involve substitution or elimination. If it was likely to be a substitution reaction, whether it was S_N1 or S_N2. If it was more likely to be an elimination reaction, whether E_1 or E_2. If the reaction proceeded through a carbocation intermediate, whether or not it undergoes rearrangement. And, if it undergoes rearrangement, what the most likely product would be. This would be a program that does what should be done, not merely what can be done, and it is one that the author would gladly purchase.

- *Are the students using computers because they want to, or because they have to?* The author is familiar with a variety of programs that represent excellent supplements to a course. Some are particularly useful for weak students, struggling with the course. Others provide a challenge to strong students, who might otherwise be bored with certain topics in the course. But these programs aren't equally successful when they are required of all students in the course.
- *Does the program increase the students' understanding of course content or their familiarity with computers?* Several years ago, we used a popular spreadsheet program to create a series of templates that guided students through the calculations associated with four general chemistry laboratory experiments. Although the student response to these spreadsheets was favorable, they had no effect on the students' performance on hour exams on questions related to the laboratory or on students' retention of information. The most significant effect of this experiment was on the students' ability to use a spreadsheet program, which wasn't one of the goals of the course.

Conclusion

Hippocrates (460-377 *B.C.*) is the source of several famous quotes, including: Ars longa, vita brevis (Art is long; life is brief), but he is most famous for *The Physician's Oath*, which includes the notion that "I will use treatment to help the sick ... but never with a view to injury and wrong doing. ... to help the sick, and ... abstain from all intentional wrong-doing and harm." When implementing computer-based instruction, we should strive, above all else, to ensure that we don't interfere with the students' progress through our course. This can only be achieved by recognizing that any change in an instructional environment will have both positive and negative effects. By reflecting on what happens when we make changes in our course, we should be able to find ways to maximize the positive effects and minimize the negative effects of these changes.