The Future of Teaching and Learning Technologies

Howard Strauss
Princeton University, USA

INTRODUCTION

The evolution of a few critical technologies has the potential to change the way teaching and learning is done is the near future. Among those technologies are **biometrics**, global positioning systems and real mobile computing. Previously unthinkable paradigms for education are now—or soon will be—affordable, as Moore's Law slashes the cost of intelligent devices. This chapter presents some challenging ideas about how learning might be done in the future and what the future of colleges, classes and courses —if they still exist —might be.

Predicting the future accurately is at best difficult. Extrapolations from the present into the future are fraught with unpredictability. In 1958, a Boeing 707 320-B, the first United States (U.S.) commercial jet liner, cruised at 607 mph (Boeing, 2004). You'd expect that today, 46 years later, airplanes would fly much faster; yet the Boeing 747 and even the future 7e7 actually cruise a bit slower (Boeing, 2004). Spotting a trend doesn't necessarily mean it will continue.

HISTORICAL PERSPECTIVE

Classroom instruction has been done using some form of "talk and chalk" (Electronicstalk, 2001) for many centuries. If Ben Franklin returned to the present time, he would be totally baffled by a hospital operating room, an airport or even a cell phone. But if he entered most classrooms, where a professor stood in front of the class, chalk in hand, Franklin would know exactly what was going on. He might even be able to pick up the chalk and continue the lecture.

To date, the *talk and chalk* paradigm of a professor at the front of a classroom attempting to pour knowledge into the heads of students has changed little over the centuries. The blackboard may be a whiteboard or a screen, and the chalk may be a video source or PowerPoint slides, but given the great technological change in almost every other field – medicine, transportation, manufacturing, communication, agriculture and information processing, to name just a few – education has been remarkably immune to real change. Now that has the potential to change.

Universities have done some wonderful things with technology. Students apply to universities online, register online, browse library offerings online and use the Web as an invaluable resource for research and entertainment. And no university could operate as the business it is without the assistance of computing and information technology. In the classroom, video feeds, course management systems, e-mail and other technologies have taken away much of the drudgery of managing courses and bringing material to students. Yet, information technology has not done much to change the teaching and learning paradigm. Even distance learning is delivered as talk-and-chalk classrooms on a computer screen or TV.

Getting a real *paradigm shift* in teaching and learning has been prohibitively expensive. Even when it was realized that intelligent devices such as computers might have the potential to assist the teaching and learning process, the cost of doing so, the lack of sophisticated software and immobility of computers made progress extraordinarily slow. In 1945, the ENIAC, one of the first modern computers, weighed more than 30 tons and cost about $500,000 in 1946 dollars (McCartney, 1999).

MOORE'S LAW

In 1965, Gordon Moore, a cofounder of Intel, suggested that the density of *transistors* on a chip would double every year or so and that "the cost component is nearly inversely proportional to the number of components" (Moore, 1965).

This suggestion became known as Moore's Law and continues to more or less hold true through the present (Ross, 2003). In practice, the implication of this *Law* is that the cost of computing hardware halves about every 15 months. Random access memory (*RAM*), for example, which could be had for about $1.50 per megabyte in 2000, will likely cost one or two tenths of a cent in 2015. A *microprocessor*, which cost about 60 cents per megahertz of processing speed, is likely to cost about six hundredths of a cent per megahertz in 2015. And while Gordon Moore's *Law* did not apply to disk storage, its cost has at least halved every 18 months, so that a gigabyte of disk storage that cost about $7 in 2000 will likely cost 7 tenths of a cent in 2015.

One implication of these plunging prices is that computers will simply get very cheap, though Machrone's Law (Ross, 2003) suggests that the cost of computers will stay constant as people's desires for more powerful computers grow as fast as the density of components on a chip. Machrone has turned out to be wrong, as the cost of ever more-powerful PCs continues to plunge.

When computers were very expensive, it was important to maximize their use. Therefore, a great deal of effort was expended in ensuring that they had high utilization. One did not want a very expensive device sitting idle for very long. Computer designers also strove to make computers as general purpose as possible. Building a Swiss Army Knife-like device allowed the high cost of a computer to be justified by all the many functions it could do. But, in building any general-purpose device, there are compromises. Computers are no exception. The user interface and operating system of today's computers, for example, would be much simpler if they were designed only to do e-mail or Web browsing. Today, people use many sophisticated computers with no keyboards or conventional screens and that do not allow them to do e-mail or spreadsheets. There are several of these in cars that keep emissions down, prevent people from locking their brakes and even remember where their seat and steering wheel were positioned.

In 2015, adding 200MB of RAM, 10 GB of disk and a 1GHz processor to anything will add only about $1 to its cost. This means we will soon no longer have to build special-purpose computers – unless we want to. It also means that common devices – watches, cars, appliances, clothes and so forth – will include affordable intelligence; memory, software and processing power.

These devices will, of course, be continuously network connected. One can already see the ubiquitous nature of cell phones and the growing use of *Wi-Fi* (802.11) and Bluetooth to get a hint at what's on the horizon. WiMAX, also known as 802.16, for example (LaBrecque, 2004), has a range of 30 miles (compared to about 1000 feet for 802.11) and much higher bandwidth. These devices also are likely to include *GPS*. The Garmin iQue 3600 PDA (Garmin, 2004) already does this, and many more devices like this will soon follow.

BIOMETRICS

A very serious problem in the proliferation of intelligent devices is the need to make them secure to preserve privacy and the integrity of the device and the networks they are attached to. Traditionally, that has been done with an ID and password. As the number of systems and devices grow, the number of IDs and passwords one is required to remember also grows. To make passwords more secure, there is an increasing requirement to make them difficult to *crack*. Passwords that are difficult to crack are also difficult to remember. As a result, as the requirement for stronger passwords grows, so does the likelihood that they will be written down—often near the computer that is being protected—providing no security at all.

A password and ID is something a user knows. Other authentication schemes involve something a user owns, such as a magnetic stripe card or electronic gadget. Anything a user owns can be lost or stolen. Anything a user knows can be guessed or found recorded somewhere. A much better alternative is the use of biometrics—some characteristic of what a user is, such as a thumbprint, retinal pattern or facial feature. Since biometric authentication depends on something a user is, a user always has it with him or her, and it is difficult to impossible for it to be compromised. Also, it is safe to use a biometric for all systems and devices, so the need for multiple IDs and passwords is avoided (Strauss, 2003). The

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