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Minds and Machines: the Art of Teaching in the Digital Age

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I need to begin with a few words about my topic. When, several months ago, I was asked for a title for today's talk I adopted a strategy which has turned out to be a little dangerous. I knew that I needed to talk about teaching and I have been interested for some time in instructional uses of computers and also in the general area of artificial intelligence. Not really having any idea of what I would actually say, I opted for something which I hoped would suggest a substantive issue and provide plenty of room to maneuver. Hence the title of today's presentation: "Minds and Machines: the Art of Teaching in the Digital Age."

In fact, of course, I am trapped. I now need to say something about minds and machines. And even if I did know a lot about these subjects, most of you did not come here to listen to that talk, but rather to one about teaching. So now I also need to somehow make a connection between all of these things. I'll try.

Let me start with something safe, an assertion firmly believed by almost everyone but a few unrepentant computer hackers and a several thousand philosophers: "Minds are not machines."

This simple assertion has the advantage of using both the terms I need to discuss. Moreover, as you have all already guessed, it leads quite naturally to the issue of the use of computers in teaching. Good teaching, as we all know, has everything to do with minds and almost nothing to do with machines. The machines which were to have transformed teaching in the past—various audio/visual devices, language labs, speed-readers and so-on—may have made marginal contributions; but none of them has been "revolutionary." And now we have the computer and the claim that this new machine will revolutionize teaching. We've all been around for a while and we've heard these sorts of things before; and we have reason to be doubtful.

Now, in fact, I think that it is quite true that minds are not machines. But what I would like to suggest today is that there are two important senses in which, despite the persistence of the "machine" label, computers are not really machines either. Moreover, it turns out that each of these non-machine-like characteristics can be expected to impact the art of teaching.

The first sense in which a computer is unlike any other machine is that it is not a special-purpose device. Other machines are built for specific uses and can perform unrelated tasks only by re-building the machine itself. Charles Babbage's proposal to build the "analytical engine" in the 1830s is usually said to mark the historical origin of the modern computer precisely because it was to be a device which could perform an unlimited range of mathematical and logical calculations without a need to rearrange its parts. This characteristic puts the computer in a class of its own among machines. In fact, as Alan Turing demonstrated in 1936, a computer is a "universal machine." In the abstract model presented by Turing, this meant that there could be a single device

"universal machine" has already presented an answer to the question "Will the computer revolutionize education?"

If we mean by "revolution" the displacement of traditional modes of activity, as the industrial revolution displaced the traditional hand-crafts, the answer is by now obvious, even trivial. The traditional modes of delivery for educational services, including direct instruction, will be largely displaced by digital technology. The form of this displacement will vary widely but it is now apparent, for instance, that just as the computer replaced the typewriter, so will e-mail render student mailboxes largely obsolete, multimedia presentation software will displace "chalk and talk" and the Internet will increasingly challenge the library as a first source for information of all kinds. Recently the "Campus Computing Project," for instance, reported that 44% of college classes now use e-mail, 33% include Internet resources as part of the syllabus and 22% of college courses use Web pages for class materials and resources (Grene 1998).

In this respect, educational institutions are simply the recipients of the effects of the computer revolution in general. And I think by now all of us in higher education can see that it has become utterly pointless to debate the merits of an active engagement with digital technology. The ivy on the walls of academe is not nearly thick enough to hold off the digital revolution.

What will this digital assault demand of us as educators? With respect to this aspect of the computer revolution, I think that the answer is "Not much." Faculty, like everyone else, will need to develop basic "computer literacy" i.e. they will need to learn how to use the computer for tasks they can no longer avoid. Paper-less campuses do have obvious implications for a faculty member's command of basic e-mail, for instance. But we don't really have to worry very much about these kinds of uses. They will arrive and we will respond and, most of the time, we will continue about our research and teaching in the ways in which we were trained.

The more interesting challenges are to be found in a second sense of the computer revolution in higher education. This, too, is firmly rooted in the nature of the machine itself, or more to the point, in the second sense in which a computer is unlike any other machine.

It was Turing's convincing demonstration of the existence of the universal machine which provided the theoretical foundation for modern computing; but Turing's insights did not stop there. Unlike nearly all of his contemporaries he saw the computer not as a device for performing mathematical calculations but rather as a way to embody virtually any process of thought. Turing was convinced that computers would one day think and not just in one or a few senses of thinking but in all the ways in which humans can be said to think. His machine, in short, was not only to be universal in that a single machine could imitate any other. It was also to be a universal logic machine, able to duplicate any process of thought we might conceive.

Turing's insights and proposals (especially his so-called "Turing Test") continue to play a central role in the debate on the possibilities of machine intelligence. They are also more broadly applicable, however. They serve to remind us the computer is also not "mechanical" in the logic it must follow; in fact computers can be programmed to behave as if they are not programmed at all.1 As Turing could see half a century ago, in theory at least, what we can do with a computer is limited only by our own imagination. And this brings us to the second sense of the computer revolution in education. It is one thing to be over-run by a technology which renders past practices inefficient or ineffective (as we all inevitably will be). It is quite another to recognize in the new technologies opportunities to energize and transform past practice; and the unparalleled flexibility and reach of the computer are proving to be a powerful stimulant to the imaginations of teachers and students alike the world over.

In fact the computer is so little a "machine" i.e. it is so "non-mechanical" that it can readily serve as a sort of natural ally for creative minds in search of new strategies to engage other minds.

I know that what I have said thus far appears a bit "philosophical" and that this is often taken as the very opposite of "practical." Those of us drawn to the study of philosophy probably

have ourselves to blame for this; we so enjoy our play in the world of ideas that we sometimes forget to come home. But in fact the identification and exploration of the foundations of thought and action which is the work of philosophy is exactly the opposite of impractical. We conduct these inquiries in order to understand and, sometimes, to transform our practice. And I think that this is the case also with our thinking about the foundations of computing and their relationship to the practice of teaching. Our awareness of the nature of computers and the likely character of the revolution they entail does offer educators guidance as they re-think the practice of teaching.

What I would like to do in the time I have left is to build on our recognition of the non-mechanical properties of computers in order to explore with you some possible directions for the new teaching strategies implicit in the digital revolution. We live in the midst of technological transformations which are both exciting and quite overwhelming; and I should say at the outset that I am well aware of the limited reach of my own efforts to "jump over my own shadow," i.e. to escape the conceptual bonds that come with my own training and some twenty-odd years of teaching experience. Just as the first products of the printing press included printed facsimiles of illuminated manuscripts and the first films were "photo-plays," we may expect that many of our efforts to apply the new technologies to teaching will have less to do with their inherent potential than with our own habits of mind. But we can try to imagine.

To this point, I've tried to say a little about minds and machines and, in particular the mind-like properties of computers. Now, in the hope of completing the connections I so boldly anticipated in my title, I need to turn to teaching.

There are many different approaches to teaching and I certainly would not propose a single formula to cover them all. Still, I think that most of us can agree that in our teaching we hope to do at least three things: first and foremost we seek to engage our students, to capture their interest and stimulate their involvement with the subject. Second, we aim to empower our students, to develop those skills of analysis, synthesis and critical assessment essential to full understanding. Third, we strive to encourage an active exploration of our subjects, one which takes students beyond what they have already been told or shown and into the realm of personally meaningful research.

Our challenge is to think of ways in which digital technologies can support and possibly transform our efforts in each of these areas. To give you a sense of the direction that I think such reflection might take I'd like to share with you work which some of us have been doing for an introductory humanities course. The application I am going to show you is not technically sophisticated; many of my colleagues at the University have produced much more advanced instructional software. But the story of the development, use and extension of this simple instructional application will, I hope, help us to think a bit about the relationships between the art of teaching and digital technology. The application is called "Exploring 'Fra Lippo Lippi'" and it is used in an introductory humanities course which I teach with an historian, Jack Resch.

"Fra Lippo Lippi," a poem by the English poet, Robert Browning, is an engaging, delightful portrait of an Italian painter of the early Renaissance. Or at least Jack and I think that it is engaging and delightful. Our students seldom saw it as we did; in fact, it generally left them cold. Our "traditional" attempts to resuscitate the poem, study guide and questions to prepare for class discussion, did help, but not enough. Our students continued to care little for the poem. This was all the more perplexing in light of Browning's portrayal of Lippi's art and life. Lippi had been a free-spirit who cared little for the dictates of the church of his day. Neither the love of natural beauty displayed in his art, nor his love of the beautiful Lucrezia, a sister in the Carmelite order, found favor with his ecclesiastical superiors. Browning's poem captured the imaginative independence of the artist and served as well to nicely introduce important elements of the transition from Medieval to Renaissance art. Here was a creative rebel with a joy for life and a contempt for authority—just right, one would think for students in all times, even for the students of "Generation X."

The poem, in short, had great intrinsic merit, effectively introduced important course content and should have been of interest to our students. We needed a way to get them engaged

and digital technology has given us the tools we need.

In this particular instance it requires very little imagination to see how new tools can facilitate the traditional goal of student engagement. "Fra Lippo Lippi" was a natural candidate for an interactive, multimedia lab exercise. The poem was about art, but most versions do not include images. The poem itself, while quite interesting once it is understood, contained references which would be obscure to most students and which they seldom looked up. Poetry itself was not readily accessible to many of our students, often because they failed to slow down, listen to the poem and absorb its meaning. Finally, specific sections of the poem contained important insights relating to specific course content but students seldom noticed them or stopped to consider their significance.

With ideas and materials suggested by Jack, Karla Vogel and I designed an application in which the text of the poem is supplemented with audio readings and comments; hyperlinks to definitions, explanations and related material; works of art by Lippi and other artists cited in the poem; and on-line discussion questions.

We have asked for student assessments of the application each time it has been used and the results are encouraging. In fact students have spontaneously cited each of the effects for which we had hoped:

> I had little to no understanding of Fra Lippo Lippi after two readings. After a short time with the multimedia I became engrossed both with the story and the beauty of the work that I hadn't seen before.
>
> Hearing your voice helped give me a sense of how to read it. Almost like I caught the rhythm. Also [being] given a specific idea for focus while reading helps me a lot.

This was very helpful. The first time I read it in the book I did not understand it very well. But the application made me a more active reader. Its footnotes and artwork contributed greatly to my understanding.

And even more to the point, the "classroom conversation" about Browning, Lippi and the artistic innovations of the Italian Renaissance has improved with our use of the lab exercise.

"Exploring Fra Lippo Lippi" works well as far as it goes which, of course, is not nearly far enough. I suspect that all of you who have built instructional software yourselves, or simply thought about it a little, are already squirming in your seats with suggestions for revisions or extensions. Let me share with you some of the ideas that we have for "Exploring 'Fra Lippo Lippi'" and in the process let me also share some of my thinking on what these ideas have to say about the connections between minds, machines and the art of teaching.

If we return for just a moment to those common objectives of teaching it will be clear that the computer as an ally of minds engaging minds, i.e. as a tool for teachers, has much more to offer to the understanding of Browning's poem.

The first objective of "Exploring 'Fra Lippo Lippi'" was to more fully engage students and thus improve the quality of our common discussion in class. A common claim in defense of multimedia instruction is that "if you're stimulated with audio you will have about a 20 percent retention rate, audio-visual is up to 30 percent, and in interactive multimedia . . . . the retention rate is as high as 60 percent." Whatever the literal truth of this assertion, it does effectively point to the advantages of learning which can draw on multiple sensory experiences and which promotes active engagement by the learner.

"Exploring 'Fra Lippo Lippi'" does contain some modest steps in these directions. The use of audio to complement reading of the poem has been more appealing, and helpful, to students than we had anticipated. And, of course, our use of images was intended from the beginning to add

meaningful visual associations to the text. But, again, the multimedia computer allows us to present virtually any kind of information and to interact with users in an endless variety of ways. Having these tools available leads rather naturally to reflection on the particular challenges our students face in mastering course content and possible ways of addressing them. Thus, as a single simple illustration, one of the challenges which we know students face in our course is placing the various individuals, works and historical events we discuss in a meaningful framework. Was it Giotto or Masaccio who came first? And why would it matter, i.e. what significant developments are tied to each artist?

One common approach to this problem made possible by the multimedia computer is the interactive time-line. The time-line itself provides an orientation to the relationships in question in graphical/textual format. We can obviously go beyond this however and address some of what we know about different learning styles and the effects of a multiple-sensory learning environment and interactivity. We can include images of key works, explanations of these in both textual and auditory form (including reminders or anticipations of items from class discussion) and we can give students things to do to make it more likely that they will retain this information. Thus our current plans include the construction of such a framework with hyperlinks to brief summaries of key information on each artist, auditory reminders of key lecture points, images of relevant art works, and movable icons to test and reinforce this understanding by allowing students to arrange the time-line themselves.

We also seek to empower our students. We foster the development of skills of analysis and critical assessment, for instance, skills which we expect them to take with them and to use long after the course is ended.

There are many ways in which we might do this but let me focus on just one. Skills of analysis and critical assessment evolve and are applied differently in different disciplines. To understand a poem, it is helpful to understand at least a little about poetry but there is very little in our course which speaks to the nature of poetry much less to the specific features of Browning's work as a poem. One of the reasons for this is the limitation of time faced by all teachers. "Humanities I" is already very tightly packed and it is difficult to add further information to our current lecture/discussion schedule.

Only a small step is needed, however, to see that digital technology promises to radically transform this sense of instruction as contact hours enclosed within four walls during fixed times of the day or night. A presentation on the nature of poetry cannot be squeezed into class time without squeezing out something else; but it would make a natural extension to this particular application which students use outside of class.

It might be objected that if the time for this is not available in class, it may well not be available outside of class either. There are only so many hours in the day and it is clearly unrealistic to think that a lab exercise can simply be indefinitely extended to include more and more course content, content which, as in the past, may not find its way into class activities.

But of course this objection misses the mark and it misses because it is based on the traditional model of teacher and student. We are frequently told that digital technology will transform the teacher-student relationship with the result that teachers will be less a source of information than facilitators of student efforts to locate and assess that information. And this is a very simple illustration of something like that transformation. Not all students will make use of the information added to "Exploring Fra Lippo Lippi." What we seek to do is to make relevant information available and to do so in ways which encourage its use. At the very least this models the process of interdisciplinary study and research which is at the core of the course. Given the powerful interactive capacities and attractions of the computer, at its best, such an approach should draw students to issues and insights they might never have found on their own and which could never be adequately explored in our limited time together in class.

In this process faculty will sometimes serve as guides, pointing students to useful

resources. At other times they will use the technology to, in effect, project themselves beyond the classroom. There is already a hint of this possibility in another of the student reactions to "Exploring 'Fra Lippo Lippi:'"

> I wouldn't have been able to understand the poem without the program. It gave almost a one-on-one with Dr. Savage.

A "one-on-one" was not an objective of our first efforts with this application; but it is, once again, fairly easy to imagine additions which could extend this sense of communication with course instructors on key points of course content.

Turning to the third of the basic agreements I think we have as teachers, we seek to encourage an independent exploration of our subjects, an exploration which promotes breadth of knowledge and depth of understanding. The computer can assist us in this in a number of ways.

First, and most obviously, the continually expanding capacity of computers encourages us to think in terms of offering direct access to large amounts of related information. "Exploring 'Fra Lippo Lippi'" sought to engage students, to make the poem itself more interesting and meaningful by providing, for instance, basic information about the artists mentioned in the poem and images of their works. But the poem was also intended as a point of departure for understanding major developments in Renaissance art. Additional information on the artists, their works and their significance would be a natural extension of the application.

Computer access to information is not limited, of course, to what we ourselves add directly to the application. The Web now contains a variety of rich resources on Renaissance art, for instance. Providing links to these sites is another way to encourage exploration and this, too, would be a natural extension of "Exploring 'Fra Lippo Lippi'."

These are more or less apparent ways of taking advantage of the interactive capabilities of computers to make related information available at the points at which it is likely that students might make use of it. And, of course, there are many others—we may be able to direct students to on-line journals, conferences or listservs in support of scholarly examinations of course materials, for instance.

Our experiments with this simple application have provided one way of reflecting on some of the instructional potential of the new tools of the digital age; but I now need to return to my title and to some of the broader implications of minds, machines and the art of teaching.

I claimed above that the computer is a natural ally for minds seeking to engage other minds. We started "Exploring 'Fra Lippo Lippi'" with the intent of drawing our students more deeply into the give and take of what we hope will be a dynamic, personally meaningful "classroom conversation." We started, in short, with something that the computer revolution has not changed: the striving for engagement of mind with mind which is the very core of the art of teaching. Whatever we accomplish beyond this in the development of intellectual skills and mastery of content all derives from that engagement.

There is, finally, something else which can only follow from active engagement and this, too, concerns an educational objective which is unchanged by the computer revolution. A student who becomes deeply engaged in his or her studies does not simply acquire knowledge; such students are literally transformed. And it is this personal transformation which is the real goal of the art of teaching. As Joseph Weizenbaum once put it, "Something should constantly be happening to every citizen of the university; each should leave its halls having become someone other than he [or she] who entered in the morning" (Weizenbaum 278).

Witnessing this transformation is one of the great satisfactions in the life of the teacher. We see it as we compare the student standing before us at graduation with the person we met in that first, tentative year of higher education. We see it also at the end of each semester as we read the

papers or exams or listen to the presentations of students who found more to engage their imaginations than perhaps they expected at the beginning of a course and whose powers of understanding, expression and self-confidence have grown accordingly. These moments remind us that in the final analysis the goal of education is not the filling of minds but the development of persons.

Such transformations do not come easily and they do not happen in isolation. Learning in the digital age will continue to demand great effort, and a great deal of reflection on the part of students and faculty alike.

And this brings us finally to the caution which must accompany any endorsement of the instructional uses of computers. We have seen that a computer is unlike any other machine in its unparalleled flexibility. Computers, in theory at least, are extraordinarily malleable. But there is no reason to believe that all the minds which shape the machine, for instance, the programmers and software developers and vendors, will necessarily understand the art of teaching. They may, from time to time, turn to the more superficial and indeed "machine-like" properties of the computer, its regularity, ready availability and efficiency for instance, and propose "revolutionary" uses which have little to do with the hard work, and extraordinary rewards, of higher education.

Faculty who suspect that Web surfing is not really a substitute for academic research and that the possibilities for painless learning through "edutainment" amount to a sort of virtual alchemy are quite correct. The digital age has indeed provided us with unprecedented tools and extraordinary promise; but that promise does not lie ready-made within the computer—it will only be realized by faculty themselves, that is by minds shaping machines to support the shared goals underlying the art of teaching.

Note

1. Here I am thinking, for instance, of "connectionist" architectures in which digital computers simulate neural networks. The outcomes of the operations of such systems are not the result of an explicit set of instructions in an ordered series of steps as in more traditional programming.

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