Education by Engagement and Construction: A Strategic Education Initiative for a Multimedia Renewal of American Education

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We can renew American education by offering students the opportunity to develop skills, experiences, and values they need to become successful individuals, workers, family members, and societal contributors. They can have fun while learning and gain satisfaction from meaningful accomplishments. The Strategic Education Initiative is a five year, $100 billion plan to help transform American education, provide powerful tools for teachers, promote advanced technology, and make schools more meaningful.

Dynamic multimedia, novel user interfaces, powerful computing facilities, and international networks can empower teachers and students in remarkable ways. These technologies can support teachers in fostering student engagement with peers and outsiders, and construction of projects that contribute to a better world. These approaches also promote each student's self-worth while learning the subject material. I believe that as teacher effectiveness increases and learning becomes interactive, creation generates satisfaction, process and product become entwined, and cooperation builds community.

Introduction

Government leaders, corporate executives, think-tank gurus, and academic social commentators have expressed their concerns over the decline of American education. This negative attention seems to engage journalists and media moguls, while corporate public relations staff churn out the good news about how the business community is already doing its fair share. Cover stories in Fortune, Newsweek, and Business Week are helpful in focusing attention, but they are not the solution.
Renewing American education is a difficult job, but it must be done to preserve a productive and competitive economy, to enrich the life of each citizen; and to create a vital, safe, healthy, and meaningful society. This article is a call to action from two directions: a top-down, long-term national plan for a Strategic Education Initiative and a bottom-up local idea that each teacher can begin to apply immediately. There are many other directions, levels, and paths by which change can be pursued, but this article concentrates on the two stated directions.

These directions are oriented around the computing technologies of multimedia workstations, high-speed networks, and vast hypermedia databases of text, images, video, sound, music, maps, etc. There is always a danger of trying to solve social problems with technology, but I hope I have avoided the obvious pitfalls. The United States has a history of successfully blending social visions with technology. In the 19th century, immigration and western expansion were coupled with the development of canals and railroads, while the the 20th century highways and airports were the focus of major federal initiatives. It seems possible that computing technology and data highways might be the analogous paths for the 21st century.

Part I: My Star Wars Plan: A National Strategic Education Initiative

A major national commitment to education would engage the energy and enthusiasm of most Americans, just as the space program did during its glory days of the 1960s and 1970s. During that time science and engineering Ph.D. production soared while lower school children were entranced by manned travel to the moon, color photos of the whole earth, and pursuit of Martian life forms. The drop-off in support for spaceflight had a strong relationship to the corresponding drop-off in graduate science study. Further cuts in education programs and a failure to create compelling national goals in science and technology (the superconducting super-collider is too remote from most people's concerns or comprehension) have contributed to the decline.

Therefore I propose a bold national Strategic Education Initiative (SEI) (Shneiderman, 1989), patterned on the concept of the Strategic Defense Initiative (SDI) or the Strategic Computing Initiative (SCI). The SDI was quickly labelled the Star Wars Plan because of the space-based battle station imagery reminiscent of the George Lucas movies. Mine is also a Star Wars Plan but it is linked to the image of Luke Skywalker’s wise and gentle teacher Obi-Wan Kenobi (played by Alec Guinness) rather than to the terrifying Darth Vader. Instead of 1,000 space-based battle stations, I propose at least 10,000,000 school-based edu-stations, enough to have one for every five students, plus appropriate teacher training and software.

The focus of the Strategic Education Initiative would be on teacher-oriented tools for educational computing, including hardware, software, networks, teacher training, and research. The goal would be to invigorate education in a dramatic way by spending $100 billion over a five-year period. The impact would be to help teachers to empower students with a sense of their own capabilities in this emerging multimedia and networked world (Soloway, 1991). If the SEI is effective, students would be prepared with necessary skills for work and for responsible membership in multiple communities.

Beyond the benefits of training for millions of teachers, major spin-offs would include the stimulation of user interface research, refinement of educational evaluation, expansion of computer hardware manufacturing, development of software tools, and the growth of the whole computing industry. Improvements would be applicable to many fields beyond educational computing, such as home and office automation, medical informatics, image processing, tele-operation, scientific data analysis, engineering workstations, desktop publishing, and library information services.

Undoubtedly, the investment, impact, and ideas of the Strategic Education Initiative would lead to improving U.S. competitiveness internationally. At a time when the U.S. dominance of the computing industry is being vigorously challenged, these benefits to competitiveness could be helpful by stimulating user interface research and development (Shneiderman, 1987).

The draft budget in figure 1.1 is a rough estimate that would have to be refined and detailed, but the essential notion is to provide schools with funds to acquire and apply hardware, networks, software, training, etc. Leading universities would have larger amounts to conduct research,
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Figure 1.1
Draft budget for 5 years

evaluate projects, and develop advanced prototypes that could be applied by others. Regional partnerships among colleges of various sizes could share specialized resources (such as image databases or MIDI music synthesizers) and disseminate ideas, curricula, software, etc. High schools and lower schools would receive lesser amounts, but volume purchases would enable acquisition of adequate numbers of sufficiently powerful educational workstations. Collaboration with universities and regional research centers would provide access to emerging research results.

As a rough estimate, the price of a networked multimedia personal computer for high schools and lower schools should fall to under $1000 within five years, assuming high volume production runs. More powerful workstations at the university level might still be in the $5000 to $10,000 range, but the average cost per student workstation should be well below $5,000.

Construction of a high-speed National Data Highway to permit remote computing, communication, collaboration, and image access is a viable goal, although it will certainly take more than five years to complete (Carlitz, 1991). Allocation of $20 billion would get this project off to a fine start. The current High Performance Computing Initiative (Senate Bill 272, 102nd Congress) is a step in this direction, but it is likely to provide only about $1 billion. The construction of an online Library of Congress is another major goal that will take more than five years, but $10 billion should get this project going. The current Library of Congress public access online catalog could be made available nationally within five years; getting the texts and images online will take several decades. This goal may sound grand or even extreme, but it also seems inevitable and only a matter of our deciding when it should happen.

Such a utopian vision and such a large expenditure should be seriously questioned and challenged. There are complex and difficult administrative, legal, economic, and social hurdles that need to be overcome, but the benefits seem to be enormous. The cost may seem incredible in an age when school budgets are being trimmed and university salaries are declining, but $100 billion over five years would be much less than 1% of the GNP, about 2% of the federal budget, and less than 10% of the Defense Department budget. Strategies for business participation and state and local control to ensure diversity must be developed. However, if the SEI is successful the payoff might be several times the investment in terms of economic productivity and reduced unemployment costs.

A strong commitment to education is a vote of confidence in the future and a gift to our children. I say "let's do it!" But more than hardware or software we need to inspire teachers and children. For this I propose, in part II, a new vision of what education might become.

Part II: The Local Idea: Education by Engagement and Construction

Imagine that a national leader emerges who brings about the Strategic Education Initiative and sees to it that all the financial, legal, administrative, and technical problems are solved. Imagine that every school, college, and university has enough computing workstations to allow teachers and students essentially unlimited access to software, databases, networks, and electronic mail. Now the question becomes: How do we restructure education?

The old world of education often consisted of listening to lectures, memorizing facts, using drill and practice to acquire skills, and accessing information in books to complete worksheets. More facts meant higher grades and was somehow better. This theme was suggested by the Cultural Literacy movement of Hirsch (Hirsch, Kett, and Trefil, 1988), who claimed that there were 5,000 key concepts that every informed citizen should master. While there are undoubtedly facts, phrases, and names that are important to learn, the emphasis seems wrong. This approach may have been suited to the industrial age of assembly line productivity, but in the third wave (Toffler, 1980, 1990) electronic age of the global village (McLuhan, 1964) a new vision seems necessary. Content is
certainly important, standards are vital, but current educational approaches are failing.

Businesses have learned, some more quickly than others, that mere numbers of workers is not a correlate of productivity and that fragmented assembly line thinking is archaic. A few well-trained workers who function as an effective team are more valuable than dozens or even hundreds of less competent and poorly organized individuals. Leaders of successful companies understand that creative solutions, flexible plans, and competent relationship skills are key ingredients for modern organizations. When corporate placement officers call me for a reference on a student they ask whether the candidate works well with others, handles responsibilities, accepts guidance, and is a self-starter. They want to know about process and whether the candidate has been a producer.

To educate students for the modern world of rapid change and teamwork we need to give teachers appropriate tools to increase their effectiveness (Shackelford, 1990) and related tools for students to exercise their creative powers. Computing a correlation coefficient is an archaic skill when computers do that task, but understanding how to present a statistical report on cancer causes to a teenage smoker is a modern challenge. Teachers can make a difference by restructuring the school experience away from individual fact acquisition towards team-building experiences with project-oriented processes that address the stated educational goals of school districts and university curriculum committees.

Defining Engagement

The theme I have chosen to represent this new environment is “Education by Engagement and Construction.” By engagement, I mean to convey interaction with people. Engagement has two complementary components: students use the world as a rich resource for learning experiences, and students attempt to produce some positive impact on the world. The purpose of learning is not to store facts in the student’s head, but to engage with people. So instead of the isolationist goal of learning Spanish grammar, the engagement goal is to give a guided tour of your school to someone in Spanish. Instead of memorizing the order of succession of the kings and queens of France prior to the revolution, the goal is to explain to classmates the background of Charles Dickens’s Tale of Two Cities.

An important part of engagement is information gathering from people outside of the school environment. Instead of limiting research to books in a library, students should interview, in person or by phone, appropriate personalities. Imagine how a report on World War II would be enriched by an interview with a D-day participant in a retirement home. An economics report becomes more real after a discussion with a local banker, a political science project becomes livelier after an interview with a local or state politician, and biology becomes more meaningful after a visit with a hospital lab technician. The experience of speaking to adults at work should be educational, the process can improve social and communication skills, and the discussions are potentially illuminating for everyone involved.

The second aspect of engagement is the cooperation among students to complete projects. By working in teams, students can take on more ambitious projects and they must make their plans explicit in order to collaborate. Engagement with fellow students can help make learning more lively and more effective as a model for the future world of work, family, and community.

Now imagine the rich environment of computers and networks created by the Strategic Education Initiative. The engagement can transpire over the networks. Bulletin boards can provide sources of information and contacts for personal encounters. Networks can enable students working on similar projects at different schools to collaborate. For example, approximately 10,000 elementary school children were involved in a project to collect and exchange acid rain data. High school students in the U.S. were paired with Russian students for e-mail exchanges. Hundreds of sixth graders simultaneously measured the length of a shadow and exchanged data in an attempt to measure the diameter of the earth.

Electronic mail enables contact with key figures in many fields. For example, students in my graduate seminar on user interface design did the common task of reading research journal papers and critiquing them, but the task took on heightened interest when they were required to send their critiques to the authors by e-mail. The discussions seemed deeper, the usual offhand attacks became softened in tone but sharpened in insight. The replies and contact with leading professionals gave my students a sense of importance and maturity. Similarly, I offered my e-mail address
to Prof. Chris Borgman at UCLA who was using one of my books for her user interface course. When her students sent me comments on my book, I replied with my reactions, and saved their insights as input for my current revision. My undergraduates were delighted that they could contact students and professors at other universities for a comparison of university computing policies and for a study of uses of computer supported classrooms.

Defining Construction

The second part of my theme is construction, by which I mean that students create a product from their collaboration. This may not seem so different from current expectations of writing a computer program or a term paper. But when coupled with the engagement theme, I mean constructing something of importance to someone else. Instead of having database management students write the same safe class project, I have had students prepare database management programs for the University’s bus service, generate a scheduling program for a local TV station, prepare an online information retrieval program for a nearby suicide hotline, or develop record keeping software for a student Scuba Club.

Instead of writing a term paper on uses of computers by the elderly, two of my students in a Computers and Society course conducted computing classes for elderly residents of a local apartment complex. Then the students prepared a report for the director of the complex, with a copy for me to grade. Several teams of students worked with their high schools or elementary schools to suggest ways to improve the use of computers. Another student wrote computer programs to manage lists of volunteers and contributors for a local soup kitchen that serves homeless people. One student challenged the University’s legal policy about student access and privacy rights with respect to their accounts. Another student wrote a handbook about educational software for parents of deaf children, while another pair of students prepared a hypertext guide to coping with computer software viruses. Computer tools enable construction of ambitious projects; there is a special sense of pride when students produce an animated hypertext, laser-printed report, or collect/disseminate data through networks.

In addition to these semester-long projects, there are many opportunities for short-term construction projects ranging from the traditional programming exercise done as a team project to class presentations by students on normal lecture material. Requiring a team of two students to present a topic to the entire class can make it appealing for the whole class, and the designated students will be likely to take their responsibility seriously. In programming classes, it is possible to require students to read each other’s computer programs and to share the grade 80% to the author and 20% to the reviewer. Code reading has been shown to be effective in professional and student environments. Having students read each other’s written reports is a key technique in the emerging collaborative education movement and a well-established idea for professionals. Turning work into a communal experience is made more practical by the presence of word processors/text editors because making suggested revisions has become easy.

Cooperative Groups in General Studies

College-level computer science has been my academic domain, so it might seem that these notions are only suitable for that age group and subject. However, I feel that Engagement and Construction are appropriate at most ages and in most fields. In fact, related ideas have been proposed by many reports on education during the past decade. The Final Report of the Study Group on the Conditions of Excellence in American Higher Education, National Institute of Education wrote that “active modes of teaching require that students be inquirers—creators, as well as receivers of knowledge.” That report also stressed projects, internships, discussion groups, collaborations, simulations, and presentations (figure 1.2). Similarly, the Principles for Good Practice in Undergraduate Education presented by the American Association for Higher Education (figure 1.3) pushed for cooperation among students and active learning projects. Multiple strategies for cooperative learning groups have been carefully developed and evaluated (Millis, 1990) and software to support cooperation has become a hot topic (Ellis, Gibbs, and Rein, 1991).
The concepts of exploration and creation are also well-established in the education literature from John Dewey to Seymour Papert (1980). Piaget wrote that “knowledge is not a copy of reality. To know an object, to know an event is not simply to look at it and make a mental copy, or image, of it. To know an object is to act on it. To know is to modify, to transform the object, and to understand the process of transformation, and as a consequence to understand the way the object is constructed” (1964). The phrase “discovery learning” conveys the key notion that “whatever knowledge children gain they create themselves; whatever character they develop they create themselves,” as Wees wrote in his aptly titled book Nobody Can Teach Anybody Anything (1971).

The pleasure of learning can be a powerful attraction, if teachers and students arrive with positive expectations. Furthermore, education can provide a constructive sense of community where respect for individual differences and diversity flourishes. To promote the experience of cooperation, facilitated by computer networks, rather than competition (Eisler, 1987; Cohn, 1986), partnerships, team projects, class workshops are recommended.

Summary

I believe that renewing American education can be a positive experience for teachers, students, and parents. Much creativity is needed to implement Education by Engagement and Construction (figure 1.4), but my explorations and reports from colleagues are encouraging. There are many problems such as how to scale up small class projects to lecture sections with hundreds of students, how to preserve the breadth of content coverage that is currently required by many school districts, and how to evaluate and grade students.

More problems await us, but the process of change is engaging, and the chance to construct a vigorous educational environment is alluring. As George Leonard (1968) wrote, “Ways can be worked out to provide a new apprenticeship for living, appropriate to a technological age of constant change . . . What then is the purpose, the goal of education? A large part of the answer may well be what men of this civilization have longest feared and most desired: the achievement of moments of ecstasy.”
1) Students want to:
   Create
   Engage
   Explore
   Discover
   Communicate
   Help
   Build
   Participate

2) And construct products by:
   Writing (poems, plays, essay, novels, newspapers)
   Drawing (pictures, logos, portraits, birthday cards)
   Composing (music, songs, operas, hypermedia)
   Designing (buildings, maps, games, animations, family tree)
   Planning (class trips, vacations, parties, elections)

3) Teachers should promote:
   Engaging in the world (lobbying a Senator)
   Helping where needed (teaching computing to the elderly)
   Caring for others (raising funds for the homeless)
   Communicating ideas (writing to a newspaper editor)
   Organizing events (preparing a bake sale)

4) Multimedia technologies can empower students:
   Enable students to create multimedia reports
   Encourage media supported class presentations
   Develop communication through electronic mail
   Provide experience in searching databases
   Explore information networks
   Promote use of word processing, drawing, spreadsheets, ...

5) Project orientation enhances engagement:
   Help an elementary school to improve computer use
   Teach elderly word processing
   Find or develop aids for a handicapped person
   Revise university policy on information protection
   Improve university administration, registration, ...
   Evaluate and suggest improvement to ATMs, library systems, voicemail, ...
   Write guide for parents about kids' software
   Review workplace practices for computer users

Figure 1.4
Outline of education by engagement and construction

Acknowledgments

I appreciate the thoughtful comments made on drafts of this paper by Jim Greenberg, John Kohl, Delia Neuman, Anthony Norcio, Kent Norman, Catherine Plaisant, and Sherry Turkle. I am also grateful to Teresa Ehling, Michael Sims, and Lorrie LeJeune of the MIT Press for their invaluable help in the production of this volume. My thanks also go to Ed Barrett who had the courage to organize this innovative conference.

References