Published: *Computers & Education* 31, 1 (1998), 25-39
An International Journal by Elsevier

Relate-Create-Donate:

A teaching/learning philosophy for the cyber-generation

Ben Shneiderman ben@cs.umd.edu

Professor, Department of Computer Science

Head, Human-Computer Interaction Laboratory

University of Maryland

College Park, MD 20742

Draft November 23, 1997

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.

George Leonard

Education and Ecstasy, 1968

1. Introduction

Memorable educational experiences are enriching, joyful, and transformational. They enrich students with increased knowledge and skills, provide them with a satisfying sense of accomplishment, and reshape their expectations. Students are driven by intense motivation that propels them to solve challenging

problems and fills them with the thrill of accomplishment. They are proud of what they have done, have a clearer sense of who they are, and are ready to take greater responsibility for their education.

Creating an environment that engages students is no easy feat. A teacher's lecture can be memorable, but meaningful challenges from teachers and interactions among students are usually more influential (Csikszentmihalyi, 1993). Engaging experiences are often generated by an individual or team project that leads to a satisfying outcome. Enthusiasm is often high in class plays, orchestral performances, debate team tournaments, and science fair projects. This essay proposes an adaptable educational philosophy that integrates technology to create collaborative team experiences based on ambitious, authentic, service-oriented projects.

In reflecting on my experiences and my observations of students over 25 years, I have come to value student activities and team project strategies for an increasing share of my teaching. As I joined others who were also shifting from the proverbial "sage on the stage" to the "guide on the side," I developed a still greater appreciation of the opportunities for teaching/learning any subject in an environment that is rich in computing and communications technology (Shneiderman, 1989, 1992, 1998; Shneiderman et al., 1995). My experience and examples are largely in a university setting, but I believe that variations on the proposed philosophy are applicable to most settings and ages.

Educational philosophies evolve in response to the needs of each era and in harmony with available technology. The ancient Greek image of the teacher facing a single student while sitting on opposite ends of a log seems quaint and appealing, although inadequate in a modern context. The common practice of medieval students' copying manuscripts or compiling mathematical tables is now seen as insufficiently creative. The industrial age teacher standing in front of classroom with rows and columns of separated desks seems orderly, but possibly too rigid. Mid-century scenarios of computer-based instruction or TV-based lecturing have never been fully realized but they are still useful supplements. As technology evolves, teachers, students, administrators, and parents busily re-negotiate to shift the methods and goals of education.

Academe requires students to acquire facts, information, knowledge, and wisdom, but a holistic view also includes the preparation for participation in family, community, work, and national structures. Additional goals could be personal growth, self-actualization, communication skills, and increased capacity for learning, critical thinking, and creative problem-solving.

To respond to these goals, teachers need a guiding philosophy that they can adapt to their personal style, course contents, student population, and available technology. I propose a three-component philosophy called Relate-Create-Donate which stresses:

1) Relate: work in collaborative teams

2) Create: develop ambitious projects

3) Donate: produce results that are meaningful to someone outside the classroom.

The Relate component emphasizes team efforts to develop communication, planning, management and social skills. The modern workplace demands proficiency in these skills, yet students are often taught to work on their own. Research on collaborative learning indicates that in the process of collaboration students are forced to clarify and verbalize their problems, thereby facilitating problem solution and anchoring/assimilating/accommodating novel information in the student's ideational structure (Ausubel, 1968). Collaboration has dangers, but when managed well, it generates intense motivation from many students, encourages learning from peers, and reduces drop out rates.

The Create component points to a fusion between learning and creative work. In creating substantial and appropriate individual and team projects, students will learn many things that serve the goals of education. Similarly, learning is useless if it does not prepare a student to be creative. Successful students create to learn, and learn to create.

The Donate component stresses the benefits of having authentic, service-oriented projects that will be meaningful and useful to someone outside the classroom. Having an outside "customer" generates intense motivation, helps clarify goals, and provides training for future professional work. Outside customers might be employers for student's who have part-time jobs, managers at volunteer organizations or campus groups, curators at local museums, or administrators at nearby schools. If possible, I would give a grade based on the amount of societal benefit produced during the semester.

Any definition of a teaching philosophy is merely a starting point for teachers, who adopt, adapt, and apply it in their own creative way. Variations on the Relate-Create-Donate philosophy have existed for thousands of years as indicated by the ancient Chinese proverb:

I hear and I forget

I see and I remember

I do and I understand

or by Sophocles's quote:

One must learn by doing the thing

For though you think you know it

You have no certainty until you try.

John Dewey (1916) developed the notion of authentic projects early in this century. Later, Piaget's expression of active learning and cognitive stages of child development influenced many, including Papert (1980), who described computer-based learning environments for mathematics that were tied to LOGO programming. Vygotsky (1986) emphasized the social contexts for learning, stimulating many discussions of collaborative methods (Kohn, 1986; Davidson and Worsham, 1990; Slavin, 1990; Soloway et al., 1996).

The case for student activities was boldly stated by Wees (1971):

"whatever knowledge children gain they create themselves;

whatever character they develop they create themselves"

in his aptly titled book *Nobody Can Teach Anybody Anything* (1971). His strong statement about the necessity for students to create their own learning experiences left a deep impression on me.

National reports on education from respected sources have shifted to emphasizing active learning, inquiry, and team projects (Figure 1 and 2) (NIE, 1984; AAHE, 1987). A report on national science education (NAS, 1996) emphasized that:

"Learning is something students do, not something that is done to them (p. 20)

...inquiry into authentic questions generated from student experiences is the central

strategy for teaching science." (p. 31)

An even stronger position was taken in a 1997 Presidential Report (PCAST, 1997):

> "Basic skills are learned not in isolation, but in the course of undertaking
>
> (often on a collaborative basis) higher-level "real-world" tasks...
>
> The student assumes a central role as the active architect of his or her
>
> own knowledge and skills, rather than passively absorbing information
>
> proffered by the teacher."

This essay attempts to show how knowledgeable teachers can apply educational technology to create active collaborative learning experiences. Section 2 of this essay clarifies the role of teachers and educational technology designers. Section 3 explores the three components of Relate-Create-Donate and Section 4 describes the many remaining challenges.

2. Teaching and Technology

The historical path of technology in education is filled with controversy. Even books and paper faced resistance because they reduced human memory skills. Although they are powerful tools in fostering learning, their contents and usage are shaped by prevailing philosophies of education. We can only guess how long it took for the first grammar or arithmetic textbooks to appear. Some proponents must have argued that textbook-assisted instruction meant that students could learn on their own, but teachers still played a key role in challenging, guiding, and evaluating student performance. Paper and books changed the content of education because memorization of key dynastic leaders or a few medicinal plants gave way to consulting extensive royal histories or detailed pharmacological tables. Powerful technologies change our expectations and curricula.

Paper has an even more potent role than as a store house of knowledge. It achieves remarkable power when it is a blank sheet that invites student creativity. But the transformational insight that students should be more than copiers took centuries to emerge, and must have been difficult to promote. Contemporary educational philosophies and teachers assume that students should write as well as read.

Listening to radio and records, or watching TV and videotapes have been proposed as educational panaceas, but they too have become only components for constructing a pedagogical framework. These are largely passive media, with limited capability for students to be creative, unless educators shift their focus to student generation of these media. Advocates of more interactive approaches oversold computer-based instruction, and promoters of "intelligent tutoring systems" still portray them as having the potential to solve educational problems.

Some technology cheerleaders and national leaders focus on installing computers in classrooms as a measure of success in transforming education. However, even if there were one computer available for each student, with appropriate software and network access, there is no assurance that education would improve. The technology alone can never be a solution, but in the hands of a knowledgeable teacher, appropriately designed technology can become a useful tool. The World Wide Web cannot be a solution to educational needs unless the creative component is included. We have to do more than teach kids to surf the net, we have to teach them to make waves.

Two guiding questions shape my philosophy of technology use in education:

What is the role of the knowledgeable teacher?

> Knowledgeable teachers provide challenge, guidance, and evaluation. They build a motivating and supportive environment while attending to the diverse needs of each student. Creating a trusting relationship between the teacher and each student begins with the first encounter. The successful teacher conveys enthusiasm for and competence in the subject and the process of instruction, earning trust by presenting the right level of challenges for each individual and team. As the relationships mature through constructive guidance and thoughtful evaluations, students joyfully seek greater challenges, eagerly pursue proficiency in the subject, and willingly take greater responsibility for their education.

What is an appropriate design for educational technology?

> Appropriate design for educational technology supports the teacher-student relationship by enabling teachers to propose more ambitious challenges, tailor guidance to individual student and team needs, and give more detailed evaluations. Educational technologies may include domain-dependent drill-and-practice,

> tutorials, or specialized software, but my orientation is towards generic tools for creative work such as word processors, spreadsheets, database systems, and statistics packages plus network access for email and digital library resources. Integrated classroom tools should also support collaborative processes, advising, and evaluation. (Norman, 1997).

Training knowledgeable teachers and developing appropriate designs are substantial challenges. This essay cannot cover these topics in depth, but the next section reports on how Relate-Create-Donate works in realistic educational settings and discusses some remaining challenges.

3. Applying Relate-Create-Donate

3.1 Relate: Collaborative teams

Extensive descriptions of collaborative teaching methods reveal the rich set of possibilities available to teachers (Davidson, 1990; Millis, 1990). Collaborations can be as simple as a two-minute in-class exercise involving pairs of students or as elaborate as a two-year project-oriented curriculum involving dozens of students. Collaborative team projects have the potential to raise motivation, reduce drop-out rates, and develop job-related skills, but collaborative methods are not commonly used. Most teachers have little experience with collaborative methods and team management, since they were likely to have been trained by lecture methods. Lectures can be effective, and technology can help improve them with presentation software and online demonstrations, but more active teaching strategies with collaborative teams offer appealing possibilities.

Term-length or shorter team projects done outside the classroom seem more acceptable to teachers, maybe because they minimally disrupt a lecture-oriented course plan. Students who work together on substantial team projects learn a great deal about project management, leadership styles, and efficient use of time. They often need to be trained in making a modular work plan, setting schedules, reviewing each other's work, and resolving differences. College-level collaborative projects are typically organized around half-hour meetings, separated by 2-10 hours of individual work. Adding class reports from project teams is an appealing way to give students a chance to develop presentation skills. Team sizes typically range from 2-6 students. As the team size grows, more attention should be paid to management strategies.

Teachers are more familiar with in-class collaborations for laboratory science and studio art classes, but these methods can be effective in any discipline. Math students can work on problems, English students can write or review each other's poems, and computer science students can compose or debug a program (McConnell, 1996). In-class collaborations may take 2-120 minutes and often take longer than anticipated because of the high degree of student engagement. Pairs of students are easy to arrange, but getting 3-10 students to work together during class takes creative planning and flexible seating arrangements.

In many situations, groups of two students per computer produces superior educational outcomes than one or three. Pairs of students verbalize potential solutions; typically, one student deals with the computer while the other focuses on the problem. Regularly switching roles ensures balanced learning. In my experience, the variance in problem solution time is smaller with pairs than with individual use of computers. High variance in problem solving times is disruptive, because the quick students are eager to move along, while others need more time. Verbalization by pairs overcomes hurdles and reduces the discouraging situation of individual students who cannot solve a problem even after 15-20 minutes.

Computer-rich networked classrooms enable a variety of collaborations (Shneiderman et al., 1995). Students can create on their computers and show to the whole class for discussion with a large-screen projector or by copying to every student's computer. By rapidly reviewing student work, everyone can see the range of good to bad work and can sharpen their reviewing skills. With appropriate software, classroom brainstorming among dozens of students can, within minutes, produce an amazing variety of comments, which can then be discussed or saved for review. Anonymous inputs encourage diverse and creative suggestions. Rapid class voting on brainstorm results or on any list of alternatives typically leads to a spirited discussion (Alavi, 1994).

Collaborative methods may be novel for teachers and for students, so some resistance is likely and it may take a teacher several attempts to create successful collaborative projects. Students need experience and guidance in working together. Often they are busy with other courses, extra-curricular activities, jobs, and family responsibilities; and then they must add the complexities of arranging team meetings on a tight commuting schedule. Teams often meet briefly before and after class, coordinate through email discussions, and occasionally hold longer meetings. But by working in teams

students learn efficient time management and realistic expectations of how long each task takes.

Email is a fundamental collaborative tool, and its low cost plus high payoff should make it useful in almost every course. Similarly listservs, newsgroups, or bulletin boards should be established automatically for every course, even before the first face-to-face meeting. These tools are wonderful for sending hints on assignments to an entire class or messages to individual students commenting on their work, especially when the next class is 3-4 days away. Students can also initiate questions at any time to the entire class, to individual students, or to the teacher. This 24-hour classroom approach has the potential for creating an intense environment that may be overwhelming to some students and teachers. I have learned to advise students about how to manage their time and to set expectations of what level of effort I expect. Similarly, I have developed personal guidelines about how often I will respond to email questions and how to steer students to appropriate resources to solve their problems (for example, computer center staff for technical problems or teaching assistants for many class-related questions).

Experience is accumulating in many disciplines and educational settings, but many questions remain open: What size team in optimal? Should team membership be assigned or should students be able to chose their partners? Is uniform skill and motivation helpful? How does a teacher intervene when a team member consistently fails to perform? Should grades be assigned individually or to the team?

Research on collaborative teaching/learning continues with the promise of deeper understanding and refined guidance for teachers. Improved collaborative software should facilitate easier management and guidance, even for larger teams.

3.2 Create: Ambitious projects

Teacher regularly wrestle with the formulation of homework assignments, but often they start with a favored textbook from which they can assign readings and problems for each student to work on individually. The formulation of team projects and in-class collaborations challenges many instructors, especially since textbooks provide only modest help.

Computers and the World Wide Web have opened new possibilities for resources and for projects. Access to digital libraries with remarkable primary resources expands the opportunities for students to perform research projects in many domains. The Library of Congress's American Memory (a project of the National Digital Library program, http://www.loc.gov) offers collections of Mathew Brady's Civil War photos, Calvin Coolidge's archives, Walt Whitman's poems, and dozens of other collections, that could serve as a basis for innovative projects in many disciplines. Similarly, the resources of NASA, the Bureau of Census, or hundreds of other U. S. government agencies as well as international resources are stimulating teachers to assign more ambitious class projects.

The World Wide Web also offers novel opportunities. A natural project for students is to produce an online textbook or encyclopedia for their course. With a class of 10-100 students, this becomes a major effort with an editorial board to develop an outline, specify an audience, produce a style guide, manage assignments, and arrange internal reviews. Twenty-four students in my graduate seminar on Virtual Reality produced a wonderful resource - EVE (Encyclopedia of Virtual Environments) that continues to be maintained by the University of Washington's Human Interface Technology Lab (Figure 3) (http://www.hitl.washington.edu/scivw/EVE). The idea has been repeated at the undergraduate level and in the elementary school level in which a fifth grade class produced a database on the animals of Africa for third graders.

Another use of the Web is to publish student projects, making them available for anyone. Students may be anxious that their work will be so visible, but it does seem to push them along to polish their projects more than in the past. A second, unanticipated benefit was that students can learn from each other as portions of projects became available several weeks before the final due date. While I always write evaluations for projects, this year I asked students to read one other project and send an email note to the authors and to me with one paragraph describing what they liked about the project and one paragraph making constructive suggestions for improving the online presentation. I graded these comments and gave the students one week to make changes before I announced the website (Students HCI Online Research Experiments - SHORE) to several newsgroups and listservs (Figure 4) (http://otal.umd.edu/SHORE). Students are proud of their accomplishments and each has an impressive product to include in a job interview portfolio. Revised versions of several papers have been published in professional journals, conference proceedings, and online magazines.

In-class projects range from simple questions with factual or open-ended answers to design projects that may involve teams working across several class meetings. Careful use of class time dictates thoughtful choice of challenges and constructive discussions that are beneficial to many students.

3.3 Donate: Service-oriented authentic projects

The rewards of doing good by helping others are especially sweet when you are also helping yourself. This can be the case when students work on service-oriented authentic projects for clients outside the classroom. Students have skills that can be highly beneficial in many situations, and students benefit by having an actual client whose needs can promote advanced learning (Jacoby, 1996).

Over the years my students have worked on campus related projects such as developing scheduling systems for the bus service and television station, keeping records for the scuba club, designing a student ride board, organizing carpools, and creating an accounting system for the physics department. Off campus software projects have included donor and volunteer list management for a major charity, scheduling for a county recreation office, information management for a day-care center, and many more. Other students projects have also developed a guide to science education software for parents of junior high school children, a hypermedia guide to computer viruses, and a plan for computer usage in a local high school.

One of my favorite projects focused on helping elderly residents in a nearby retirement facility. The students read the literature to learn what was known about elder's learning and using a variety of software products. Then they made several visits to the retirement facility to try different training strategies. Their final report, citing the literature and relevant software, was written with recommendations for the director of the retirement facility.

Sometimes I receive requests for my students to work on specific projects, but most students find their own projects. Their sources include their part-time jobs, hobbies, or student organizations and often their parents or siblings. Naturally, my students find computer-related projects, but faculty in archaeology, journalism, business, biology, and other areas have reported success in finding service-oriented authentic projects.

Clients's expectations should be kept modest and they must recognize the students as volunteers in an academic setting. In my experience the clients have been satisfied with the experience because it gave them new ideas and often a prototype for a future project. Approximately one in ten projects results in operational systems that are used or serve as the basis for an immediate development effort.

The State of Maryland requires 75 hours of community service for high school graduation. I think this noble requirement should serve as a model and inspire a similar plan at the college level. Students are highly motivated by having a real client and they are proud of their accomplishments. They also have an ambitious project in their portfolio when they go on job interviews.

4. Remaining challenges for Relate-Create-Donate

The philosophy of Relate-Create-Donate is still fresh and needs refinements to suit diverse settings. A central problem is how to deal with the resistance to change, especially among teachers, but also among administrators and occasionally among students. Teachers are often unfamiliar with the variety of short and long-term collaborations so they are unsure about what to do. They may also hesitate because of bad experiences or negative expectations. A gentle start is advisable with a simple in-class exercise or a limited team project out of class.

In-class presentations are another easy approach; students can present solutions to homework problems or lecture on some component of the course. Assigning pairs of students to make the presentation helps them polish their presentation and deals with the possibility that one student may be absent on the presentation day. Student anxiety is often high during a first experience in speaking before the class and I struggle to keep myself from jumping in with a clearer explanation or example. By the time students make their second presentation they have seen other presentations, so the quality of slides and examples regularly exceeds what I might produce, given my time constraints. Student feedback and grading on presentations leads to rapid increases in quality.

Teachers and administrators may also resist collaborative methods because of the new role for teachers, concerns about adequate coverage of the required curriculum, and difficulties in giving individual grades. The image of the teacher as the "sage on the stage" is strong, so it may be initially uncomfortable

to be the "guide on the side." When I first assigned an in-class discussion topic for pairs to work on for three minutes, I felt uncertain about what I was to do. But as the buzz of spirited conversation grew louder and was difficult to suppress after time was up, I began to appreciate the power of collaborative methods. Teachers are expected to "cover the material" in their lectures and are gratified by the process, although the result may be merely that they obscure the topic. Lecturers have little assurance that students are learning anything. With in-class presentations and collaborations student engagement is at least more visible: students may be uncovering or discovering the material for themselves. But a smooth presentation or lively conversation may not ensure deep learning. Traditional tests and individual homework assignments can be merged happily with occasional or regular collaborative methods to enable teachers to assess students.

Most students readily take to collaborative methods, but there are often one or two students in a class who request to work alone. They allege heavy work or family burdens, but ironically they often argue that they would be willing to take on the responsibility of doing the entire project on their own. Computer science students (and professionals) rank high on introversion scales, so their resistance is understandable. I do require team participation and indicate the importance of learning to work with others as a natural part of software engineering or user interface projects. Some students prefer a more traditional lecture-oriented course with short textbook homework problems, but for each of these students, there are others who report that team-oriented projects have changed their lives and that it was the most influential course in their education. The thankful letters I get from students, even ten years later, are especially gratifying.

Another challenge for sympathetic readers is to get the necessary support within their educational communities. Successful teachers need sympathetic administrators who provide resources and reward achievements, compatible colleagues who are helpful in discussing problems, and infrastructure staff to provide and maintain the technology. Increasing attention to educational issues and educational technology research from the U. S. National Science Foundation is helping to expand efforts at many institutions.

5. Conclusion

This essay proposes an adaptable teaching/learning philosophy that applies advanced technology, but is based on new roles for teachers and collaborations among students. The Relate-Create-Donate philosophy is a starting point for teachers and administrators. It is based on:

1) Relate: work in collaborative team

2) Create: develop ambitious projects

3) Donate: produce results that are meaningful to someone outside the classroom.

Relate-Create-Donate must be interpreted, evaluated, and refined, but I believe that properly designed computing and communication technology can support collaboration among students, access to peers and mentors, construction of sophisticated results, and service-oriented authentic projects. There are many reasons for resistance or concern about this philosophy, but the opportunities for faculty and students may be substantial. Learning can become a joyous joint venture/adventure that prepares students for effective participation in communities, for successful employment, and for personal fulfillment.

Acknowledgments: I greatly appreciate comments on drafts from Neil Davidson, Jim Greenberg, Thom Haller, Barbara Jacoby, Delia Neuman, and Jennifer Preece.

References

Alavi, Maryam, 1994. Computer mediated collaborative learning: An empirical evaluation, *MIS Quarterly 18*, 2 (June 1994), 159-173.

Ausubel, David, 1968. *Educational Psychology: A Cognitive Approach*, Holt, Rinehart and Winston, New York.

American Association for Higher Education, 1987. Principles for Good Practice in Undergraduate Education.

Csikszentmihalyi, Mihalyi, 1996. *Creativity: Flow and the Psychology of Discovery and Invention*, HarperPerennial, New York.

Davidson, Neil and Worsham, Toni, 1992. *Enhancing Thinking Through Cooperative Learning*, Teachers College Press, Columbia University, New York.

Dewey, John, 1916. *Democracy and Education*, MacMillan, New York.

Jacoby, Barbara and Associates, 1996. *Service-Learning in Higher Education*, Jossey-Bass Publishers, San Francisco, CA.

Kohn, Alfie, 1986. *No Contest*, Houghton Miflin Company, Boston, MA.

Leonard, George B., 1968. *Education and Ecstasy*, Dell Publishing Co., New York, NY.

McConnell, Jeffrey J., 1996. Active Learning and its use in Computer Science, *ACM SIGCSE Bulletin 28*, Special Issue, 52-54.

Millis, Barbara J., 1990. Helping faculty build learning communities through cooperative groups, In Hilsen, L. (Editor), *To Improve the Academy: Resources for Student Faculty and Institutional Development, 10*, New Forums Press, Stillwater, OK, pp. 43-58.

National Academy of Sciences/National Research Council, 1996. Report on National Science Education Standards, Washington, DC.

National Institute of Education, 1984. *Involvement in Learning: Realizing the Potential of American Higher Education*, Final Report of the Study Group on the Conditions of Excellence in American Higher Education.

Norman, Kent, 1997. *Teaching in the Switched On Classroom: An Introduction to Electronic Education and HyperCourseware* (http://lap.umd.edu/SOC/sochome.html).

Papert, Seymour, 1980. *Mindstorms: Children, Computers, and Powerful Ideas*, Basic Books, Inc., New York, NY.

Piaget, Jean, 1964. Cognitive development in children: the Piaget papers, In R. E. Ripple and V. N. Rockcastle (Editors), *Piaget rediscovered: a report of the conference on cognitive studies and curriculum development,* Ithaca School of Education, Cornell University, pp. 6-48.

President's Committee of Advisors on Science and Technology, Panel on Educational Technology, 1997. *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States*, Washington, DC.

Shneiderman, Ben, 1989. My Star Wars Plan: A Strategic Education Initiative, *The Computing Teacher 16*, (7), p. 5.

Shneiderman, B., 1992. Education by Engagement and Construction: A Strategic Education Initiative for the multimedia renewal of American education, In Barrett, E. (Editor), *Sociomedia: Hypermedia, Multimedia and the Social Construction of Knowledge*, MIT Press, Cambridge, MA, 13-26.

Shneiderman, Ben, 1998. *Designing the User Interface: Strategies for Effective Human-Computer Interaction: Third Edition*, Addison-Wesley Publ. Co., Reading, MA.

Shneiderman, B., Alavi, M., Norman, K., and Borkowski, E. Y., 1995. Windows of opportunity in electronic classrooms, *Communications of the ACM 38*, 11 (November 1995), 19-24.

Slavin, Robert, 1990. *Cooperative Learning: Theory, Research, and Practice*, Prentice-Hall, Englewood Cliffs, NJ.

Soloway, Elliot, Jackson, Shari L., Klein, Jonathan, Quintana, Chris, Reed, James, Spitulnik, Jeff, Stratford, Steven J., Studer, Scott, Jul, Susanne, Eng, Jim and Scala, Nancy, 1996. Learning Theory in Practice: Case Studies of Learner-Centered Design, *Proc. ACM CHI'96 Conference*, ACM, New York.

Vygotsky, L., 1986. *Thought and Language*, MIT Press, Cambridge, MA.

Wees, W. R., 1971. *Nobody Can Teach Anybody Anything*, Doubleday Canada, Toronto, Ontario.

Principles for Good Practice in Undergraduate Education

- Encourage Student-Faculty Contact

- Encourage Cooperation Among Students

- Encourage Active Learning

- Give Prompt Feedback

- Emphasize Time on Task

- Communicate High Expectations

- Respect Diverse Talents and Ways of Learning

Figure 1: Seven principles from the American Association for Higher Education (1987)

Conditions for Excellence in Undergraduate Education

1) Student Involvement

"Active modes of teaching require that students be inquirers -

creators, as well as receivers of knowledge."

- involving students in faculty research projects

- encouraging internships

- organizing small discussion groups

- requiring in-class presentations and debates

- developing simulations

- creating opportunities for individual learning projects

2) High Expectations

3) Assessment and Feedback

Figure 2: Summary from Involvement in Learning: Realizing the Potential of American Higher Education Final Report of the Study Group on the Conditions of Excellence in American Higher Education (National Institute of Education, 1984)

Figure 3: The Encyclopedia of Virtual Environments (http://www.hitl.washington.edu/scivw/EVE)

Figure 4: Students HCI Online Research Experiments - SHORE) (http://otal.umd.edu/SHORE).