Learner-Centered Education

Donald A. Norman
James C. Spohrer

Apple Computer Inc.

(Special Note: This paper is a draft of the preface to an upcoming special issue of the *Communications of the ACM* devoted to learner-centered education. It includes references to specific papers that will be contained in the issue.)

There is a revolution taking place in education, one that deals with the philosophy of how one teaches, of the relationship between teacher and student, of the way in which a classroom is structured, and the nature of curriculum. At the heart is a powerful pedagogy, one that has been developing over the past hundred years. It embraces social issues, the culture of the classroom, life-long learning concerns, and perhaps both last and least, technology.

The basic issues can be described through such key words as "constructivism," "learner-centered," "problem-based." At the heart is the idea that people learn best when engrossed in the topic, motivated to seek out new knowledge and skills because they need them in order to solve the problem at hand. The goal is active exploration, construction, and learning rather than the passivity of lecture attendance and textbook reading. The major theme is one of focusing education around a set of realistic, intrinsically-motivating problems. Students work to solve these problems, often in groups, often over extended periods of time. Teachers carefully structure the problems so that in the course of solution, the students naturally pass through and acquire all topics of relevance. The students might not even notice that they are undergoing instruction and learning, for the education occurs naturally in the course of activity. This short description obviously simplifies the issues and the variety of approaches, but it does capture the major driving forces.

In the past, the focus has been on the content: the curriculum is structured around the basic topics of literacy, history, social studies, science, and mathematics. For each content area, content area experts divide the topics into small, manageable bundles, each then taught according to a prescribed lesson plan. This framework governs most of the world's teaching from kindergarten through university. The term "learner-centered" is somewhat akin to the "user-centered" focus of modern interface design. Here, the focus is on the needs, skills, and interests of the learner. Learner-centered is often accompanied by a problem-based approach, where the problems are picked so as to fit the interests and needs of the learners. The focus is on the learner and authentic problems rather than on the structured analysis of the curriculum content--though both are clearly necessary.

The philosophy is not new, but the current applications are. At the heart of the change are new technologies that enable many of the constructive ideas to be carried out. The computer provides a powerful enabling technology for ideas that have been around for the past century. Some schools have practiced this philosophy with such tools as chalkboards, index cards, and video tape. In moving these ideas into software, it is necessary to start somewhere, to show success and progress on simple problems before solving the larger ones. In this vein, the papers in this issue are exciting and filled with potential.

Dimensions of Instruction

In analyzing the papers of this special issue, we find it useful to evaluate them along three dimensions: Engagement, effectiveness, and viability.

Engagement

An engaged student is a motivated student. Motivation, which correlates well with time on task, can make more of a difference between success and failure than any other factor. One of the powers of computer-based instruction is the capability to engage by providing rapid, compelling interaction and feedback to the student. Interactive multimedia technology can help motivate learners by providing information in a form that is concrete and perceptually easy to process. Engagement is also mediated by the choice of topic, and one of the major themes of problem-based education is to use the problem as the primary motivating force.

Effectiveness

The major concern of traditional teaching methods is effectiveness: how much do students learn? After all, if there is no learning of the topics of concern, then no matter how engaged, no matter how viable, the method is of little value. With the new style of education the traditional measures of effectiveness--test scores--are not necessarily appropriate. Traditional tests measure declarative knowledge: learned recitations and applications to small problems. They do not necessarily address depth of understanding nor the skills that the students have acquired.

Viability

So, the demonstration is compelling, engaging, effective. But is it viable? Perhaps it is a toy problem that won't scale to real curriculum needs, or large numbers of students, or diverse content areas, or to everyday teachers and students rather than hand-picked ones. Perhaps the technology really won't support the practice, or the cost is prohibitive. What about the social and cultural infrastructure required to make it work?

Authoring tools, design tools, component software standards, improved distribution infrastructure, integration into existing classroom activities are all critical to widespread viability outside pilot classrooms. Without proper tools, the cost of development remains prohibitively high and prevents smaller organizations and communities from developing custom solutions. Without component software and distribution mechanisms, too many resources are spent developing redundant capabilities rather than leveraging off the efforts of others. Without an integration plan, the new systems must compete for classroom time and attention with more entrenched approaches to the same material.

The Papers

The papers in this issue reflect a broad spectrum of approaches for both the style of teaching and the use of technology. This is appropriate, for if one thing is certain about teaching and learning, it is that the wide diversity in individual differences for learning and the very broad range of topic matters that need to be learned require a wide range of approaches. For teaching and learning, as with most complex phenomena, there is no silver bullet, no single method that will immediately prove superior, solving the problems of instruction across all domains, across all types of students. In fact, different students and different materials require different approaches.

The lecture and textbook are still the most effective ways of presenting a large array of material rapidly and efficiently. After all, they have been with us for several thousand years: this is the way that most of us were trained. Nonetheless, these traditional methods are weakest in the areas of engagement and the ability to provide individual assistance. Of course, good lecturers provide important components of motivation and engagement and problem sessions in small groups provide an opportunity for individual assistance and guidance. But skilled instructors are rare and individual or small-group instruction expensive, so that although these methods can work in ideal situations, the ideal is seldom available.

Rote learning and drill-and-practice are still essential to transform understanding into automated skill, making the information and procedures available to the mind without conscious effort. This is of essential importance for the basic knowledge and operations of a discipline, whether it be a motor skill such as driving or sports, or an intellectual one, such as mathematics, language, or literature. Traditionally, rote learning is weakest in motivation (engagement) and in providing conceptual aids to understanding. However, even drill and practice does not have to be boring, as evidenced by some of the edutainment software that is now available. Note that computer-based training can be extremely effective in coaching, motivating, and guiding drill-and-practice. This is where much of the early effort in computer-based instruction focused, and although this is not the domain of the papers in this issue, these tools should not be forgotten: we will forever require them.

Problem-driven approaches to education, such as are the primary focus of the papers in this special issue, are most effective in engagement, motivation, and, through their problem-driven format, in providing a solid conceptual understanding. But because any single problem requires considerable time to allow the students to discover and work through the critical components, this approach is weakest in covering a wide range of materials and in establishing the ability to use the skills automatically, without cognitive effort. These aspects of education are best left to the textbook, the lecture, and drill and practice.

Most of the papers in this issue reflect the new revolution in education, the "computer-as-tool," where the computer provides tools for constructing problem solutions, for exploring information spaces, for collaborating among other students and teachers, and for simulations of the phenomena under study. Here, the human teacher acts as the coach and guide with the computer acting to facilitate authentic problem solving, social interaction, access to information (e.g., through a network browser), and simulations of phenomena.

Challenging professions can excite the imaginations of learners. For example, imagine producing TV news stories that may shape the opinions of millions of viewers or working in a hospital emergency room to save the lives of critically ill patients. Two papers illustrate the compelling use of intelligent multimedia simulations and tool kits in authentic, complex domains: journalism students preparing TV news stories (Schank & Kass), and medical students practicing cardiac resuscitation (Woolf).

Collaborating with peers on real world projects is not only a lot of fun for some students, but also provides practice on an important constellation of personal interaction and formal reasoning skills. Three papers focus on the role of new collaborative media to engage learners in understanding scientific phenomena (Edelson, Pea & Gomez; Linn; Scardemalia).

Designing and creating interesting artifacts--building things that others may use or view is a powerful motivator for some. Six papers provide perspectives on construction kits and tools to support learning through design. Artifacts that learners create range from kid created educational games (Kafai), all manner of microworlds from grid-based biological, physical, and social simulations to collaborative text-based virtual worlds known as MUDS (Eden, Eisenberg, Fischer & Repenning; Smith, Cypher & Schmucker; Resnick, Martin & Bruckman), even Lego-based robots and beautiful 3D paper sculptures (Guzdial, Carlson, Rappin & Turns; Rosson & Carroll).

Six papers examine the importance of exploratory environments and modeling tool kits to support learners who build and/or analyze models of mathematical or scientific phenomena all the while motivated by a set of engaging challenges (Jackson, Stratford, Krajcik & Soloway; Cappo & Darling; Roschelle & Kaput; Horowitz, Neumann & Joyce Schwartz; Guzdial, Carlson, Rappin & Turns; Judah Schwartz).

Conclusions

How well do these papers fare on our three dimensions of instruction--engagement, effectiveness, and viability? On the whole, their primary strength is that of engagement, not surprisingly, for this the primary advantage of problem-driven, learner-centered education.

The dimensions of effectiveness and viability were not the focus of these papers, so it is not surprising that it is in these areas that they are weakest. Assessment of effectiveness is limited to the opinions of students and teachers. These off-hand, non-critical assessments are one component of effectiveness, of course, but will pass muster neither with education professionals nor school boards--nor should they. Conventional assessment, with its reliance upon the answering of questions in a rigidly controlled examination format is not necessarily the answer. But we need better evaluation than that of asking students and teachers if they liked the approach: the dangers and biases of these assessment methods are well known.

Viability is the most difficult dimension to assess, for nothing short of the development of complete curricula and test deployment in school systems will suffice to answer this question. It is going to be very difficult to examine viability, for it depends upon social cultural, and political issues as much as in evidence of engagement and effectiveness. There will be major challenges in deploying any new pedagogy in the reality of the public schools system or modern university.

Technology is certainly a catalyst for change, helping to bring about the new revolution in education. Technology is also a barometer of that change, providing a perspective on what is working and what is not. Learners are just one of the stockholders in the current education system. For the revolution to succeed, the needs of all stockholders must to be addressed, or they will remain opponents to change. Learner-centered design addresses the need for learner engagement, but other stockholders need designs which address the issues of effectiveness and viability. In sum, the work reported here is tentative, tantalizing, and incomplete. But the studies promise great things for the future through a motivating, engaging approach to the problem of learning.

The Authors

Donald A. Norman is Vice president of Advanced Technology at Apple Computer and professor emeritus in the Department of Cognitive Science, University of California, San Diego. He is the author of The design of everyday things and Things that make us smart.

James C. Spohrer is Program Manager and Principal Scientist for Authoring Tools in Apple's Advanced Technology Group.

Donald A. Norman
Advanced Technology Group
Apple Computer, Inc. MS 301-4D
1 Infinite Loop
Cupertino, CA 95014 USA

Phone: +1 408 862-5515
Fax: +1 408 255-7045
E-mail: dnorman@apple.com

James C. Spohrer