A revolution is 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’s been developing over the past 100 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,” and “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 in over-extended periods of time. Teachers carefully structure the problems so that in the course of solution, students naturally pass through and acquire all topics of relevance. The students might not even notice 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; curriculum is structured around the basic topics of literacy, history, social studies, science, and mathematics. For each 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 the first day of class, on through university education. The new approach, termed “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 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 articles in this special section are exciting and filled with potential.

**Dimensions of Instruction**

In analyzing this special section, 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 or the skills the students have acquired.

**Viability.** 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, and integration into existing classroom activities are all critical to widespread viability outside pilot classrooms.

The articles presented reflect a broad spectrum of approaches for both the style of teaching and the use of technology. This is appropriate. 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, so even traditional approaches have their place.

For example, the lecture and textbook are still the most commonly used way of presenting a large array of material rapidly and efficiently. Rote learning and drill-and-practice are valuable in transforming understanding into automated skill, making the information and procedures available without conscious effort, but are weak in motivation (engagement) and in providing conceptual aids to understanding.

Learner-centered, problem-driven approaches to education—the primary focus of the following arti-
Articles—are most effective in engagement, motivation, and, through their problem-driven format, in providing a solid conceptual understanding.

Two articles illustrate the compelling use of intelligent multimedia simulations. These studies excite the imaginations of students by giving them the chance to play the role of a professional on the job: journalism students preparing TV news stories (Schank and Kass); and medical students practicing cardiac resuscitation (Woolf). These systems provide practice on skills needed by real professionals on the job.

Two articles focus on the role of new collaboration tools to engage learners in understanding scientific phenomena (Edelson et al.; Linn; Scardamalia and Bereiter). In these studies, students work with others while exploring new means of communication and information access. Collaborating with peers on real-world projects is both fun and valuable; it provides practice on important interpersonal and formal reasoning skills.

Two articles provide perspectives on construction tool kits. These tools support learning design and model-building skills. (Eden et al., and Kafai). The thing that is motivating about these examples is the use of complex problems in an open-ended design space, but the complexity itself poses a problem. The way to avoid the initial complexity is through a technique known as “scaffolding,” in which one starts gradually with simpler cases and builds up to the full level of complexity. Three articles address the importance of scaffolding in a range of content areas: engineering design (Guzdial et al.), object-oriented programming (Rosson and Carroll); and modeling of ecosystems (Jackson et al.).

Conclusion
How well do these articles 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 is the primary advantage of problem-driven, learner-centered education.

The dimensions of effectiveness and viability were not the focus of these articles so it is not surprising that it is in these areas that they are limited. Assessment of effectiveness is limited to the opinions of students and teachers. These off-hand, noncritical assessments are one component of effectiveness, of available systems, which is a measure of viability, and still others discuss the need for better tools or software component infrastructure for building and distributing educational software.

Technology is certainly a catalyst for change, helping to bring about the new revolution in education. Technology can also be a barometer of that change, providing a perspective on what is working and what is not. Learners are just one of the stakeholders in the current education system. For the revolution to succeed, the needs of all stakeholders must be addressed, or they may very well remain opponents to change. Learner-centered design addresses the need for learner engagement, but other stakeholders need designs that 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.