Improving performance

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Introduction

Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources.

The term improving performance represents educational technology’s claim of offering the societal benefit of accomplishing a worthy goal in a superior fashion. What is that goal? Beyond just facilitating learning, educational technology claims to improve the performance of individual learners, of teachers and designers, and of organizations. This chapter discusses each of those goals in turn.

Please note that this chapter is not about “performance improvement” as it is conceived in business management theory or the field of human performance technology (HPT). In those venues, people view “performance improvement” as a process of using all available means to solve performance problems in organizations. Those means may include such as personnel selection, incentive programs, and organizational redesign in addition to training. This book and this chapter, on the other hand, are about educational interventions only. Therefore, this chapter deals only with the ways in which technology can enhance educational interventions in ways that improve human performance. At the end of the chapter, we discuss the broader
theory of HPT and show how educational technology and HPT interface with each other to form a powerful integrated concept.

Improving Individual Learner Performance

Educational technology extends individual learning into improved performance in several ways. First, the learning experiences are made more valuable by being focused on worthwhile goals, not just passing tests. Second, through technology the experiences can lead to deeper levels of understanding, beyond rote memory. Then they are made more valuable by being designed in ways that make the new knowledge and skill transferable. That is, the new learning is applicable to real-life situations, not simply left behind in the classroom. Through these means, learners become doers, with knowledge better connected to performance beyond the classroom setting.

More Valuable Learning

The Problem of Superficial Testing. In formal education, learning outcomes tend to be measured in terms of paper-and-pencil test results, whether teacher made or standardized. The formats of these achievement tests tend to be those that are most easily and reliably scored—true/false, multiple-choice, matching, and other such close-ended formats. A limitation of such instruments is that they are useful primarily for cognitive skills alone and especially cognitive skills of the lower levels—knowledge and comprehension as opposed to application, evaluation, and problem solving. Surveys of evaluation practices in corporate training indicate that in that sector, too, most paper-and-pencil instruments are used to measure outcomes rather than more authentic measures (Sugrue, 2003, p. 18). A problem arises if instructors then “teach to the test,” and they are often under considerable pressure to do so. If the test requires only lower level skills, instructors may teach only these skills.

Such narrowing and lowering of goals may have been taking place in the public schools of the United States since the national implementation of high-stakes testing in the years after 2001. According to Nichols and Berliner (2005), news sources reported that,

Teachers are forced to cut creative elements of their curriculum like art, creative writing, and hands-on activities to prepare students for the standardized tests. In some cases, when standardized tests focus on math and
reading skills, teachers abandon traditional subjects like social studies and science to drill students on test-taking skills. (p. iii)

In a national survey, teachers confirmed that the pressure of doing well on a standardized test seriously compromises their instructional practice (Pedulla et al., 2003).

*Multiple intelligences.* Meanwhile, more diverse types of knowledge, skills, and attitudes may be valuable for individual learners and for society. Howard Gardner (Gardner & Hatch, 1989), for example, suggested that there might be seven different types of intelligence, of which only two—linguistic and logical mathematical—are typically addressed in formal education. The other intelligences—musical, spatial, bodily kinesthetic, interpersonal, and intrapersonal—are addressed to some extent in the curricula of schools and colleges and to a greater extent in schools experimenting with curricula based on Gardner’s theory (Gardner & Hatch, 1989, p. 7). However, they usually are not addressed in the high-stakes tests that actually drive day-to-day teaching priorities. Consequently, references to learning outcomes in formal education tend to be equated with narrow, limited, and low-level knowledge.

*Domains and levels of objectives.* The best-known taxonomy of domains and levels of learning objectives is known as Bloom’s taxonomy. In its original form (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956), it proposed that educational objectives could be classified broadly into three domains—(a) cognitive, (b) affective, and (c) psychomotor. Each of these, in turn, could be subdivided into several levels, reflecting simpler and more complex skills within each domain.

The cognitive domain was viewed as basically hierarchical—from simple to complex—beginning with knowledge and proceeding to comprehension, application, analysis, synthesis, and evaluation. More recently, a team representing the original authors and publisher (Anderson & Krathwohl, 2001) suggested a revision of the cognitive categories into a two-dimensional matrix, reflecting current research and terminology. They renamed the categories as (a) remember, (b) understand, (c) apply, (d) analyze, (e) evaluate, and (f) create. On the second dimension, each of these levels may be applied to facts, concepts, procedures, or metacognitive knowledge.

The affective domain, dealing with attitudes and feelings, is organized according to the level of internalization of the attitude, starting with receiving and proceeding to the more deeply internalized levels of responding, valuing, organization, and characterization (Krathwohl, Bloom, & Masia, 1964).
The classification of objectives in the psychomotor domain is especially challenging since these tasks involve combinations of physical and mental skills. Simpson (1972) proposed that psychomotor skills can be organized according to their complexity, beginning with guided responses and proceeding to habitual mechanical skills, then to fluent combinations of skills, and eventually to the ability to adapt and originate new physical skills.

Romiszowski (1981) proposed that a major dimension of learned skills was missing from the traditional taxonomies—the interpersonal domain, one of the neglected domains later identified by Gardner and Hatch (1989). Romiszowski contended that not only were interpersonal skills not represented, but also they were very frequently the subject of training and education. In the school setting, teachers often aim to help students work better in groups as well as to interact productively with their peers in general. In the corporate world, supervisory and management training often dwells on human relationships. For example, the American Management Association (AMA, n.d.) offered over two dozen courses in this domain, related to assertiveness, leadership, communicating, managing emotions, listening, and negotiating. This “missing” domain has not yet been fleshed out in terms of an authoritative taxonomy but is recognized in textbooks on instructional design (Morrison, Ross, & Kemp, 2004) and instructional media utilization (Heinich, Molenda, & Russell, 1985).

During the programmed instruction era of the 1960s, Mager (1962) insisted that in order to be useful, objectives must not only clearly specify the domain and level of the skill but also the conditions under which the skill would be performed and the criterion or level of mastery required. The notion of precisely stated performance objectives was absorbed into the emerging doctrine of the systems approach to instructional design (ID). Systems approach models place a heavy emphasis on specifying learning objectives precisely, since a clear path of action cannot be chosen until the goal is set. On one hand, the practice of specifying objectives precisely can enrich education by offering a broad menu of targets at which to aim. However, on the other hand, it can lead to narrow and often low-level objectives being implemented. This latter tendency was noted in the programmed instruction era, when authors of programmed materials often found it convenient to achieve precision by specifying behaviors that were easy to observe and measure “answer correctly 90% of the questions on the post-test,” or “list five reasons.”

On the more positive side, many contemporary instructional design textbooks reflect quite a sophisticated view of types and levels of learning. Taking Morrison et al. (2004) as a sample of what is advocated in systematic ID models, we find that they referred to the cognitive, affec-
tive, psychomotor, and interpersonal domains, and within those domains describe multiple types and levels of skill. For each level in each domain, they provide a list of verbs representing indicators of each level. Although this elaboration of types and levels of learning does not necessarily match the breadth of Gardner’s (Gardner & Hatch, 1989) typology, it does provide a broad array of learning objectives. Therefore, one of the ways in which educational technology seeks to improve performance is through instructional design practices that lead planners to think about a wide range of learning outcomes and clarify what types of learning, at what levels, are desired. If such advice is followed, learners are more likely to experience learning activities and assessment methods that are appropriate for the wide range of human learning needs, not just those that are emphasized on standardized tests.

Surface Versus Deep Learning. Settling for verbal recall as the goal of instruction was a major problem that Edgar Dale (1946) was combating in the first modern textbook on audiovisual education. Dale contrasted “bookish learning” with “real learning,” by which he meant learning that was permanent, laden with emotional overtones, and ready to be applied to real-world problems. Therefore, this issue has a venerable and central place in the tradition of educational technology. Dale’s position is echoed by many other contemporary educators. It is at the heart of cognitivists’ “meaningful learning,” and much of the rhetoric of constructivism is aimed at replacing rote learning with learning that is situated in applied contexts.

The difference between rote knowledge and applicable knowledge is qualitative, according to the findings of neuroscience: “Overall, neuroscience research confirms the important role that experience plays in building the structure of the mind by modifying the structures of the brain . . . ” (Bransford, Brown, & Cocking, 1999). Weigel (2002) suggested the terms surface learning and deep learning to characterize these contrasting goals. Surface learning is represented in mere memorization of facts, treating material as unrelated bits of information, and carrying out procedures routinely without thought or strategy (p. 6). In deep learning, learners relate ideas to previous knowledge, look for underlying patterns, examine claims critically, and reflect on their own understandings (p. 6).

Weigel (2002) and others proposed that the venue in which deep learning can best take place is an inquiry-oriented community of learners. They suggested that such communities could be created through information technology. Using the workplace team as a paradigm, educators using local and Web-based networked computers, set up learning communities to allow learners to collaborate on realistic tasks. As they work in such problem-based and
task-based environments, they develop deep learning by proposing solutions, testing them, debating them with others, and arriving at a group synthesis.

*Transfer of Learning in Formal Education.* Technology can help learners not only to master higher-level skills, but also to apply new knowledge to novel situations, especially those outside the classroom—referred to as transfer of learning. Research on situated cognition suggested that what is learned in the classroom context tends to be confined to that setting unless learners have opportunities to practice the new skill in contexts that resemble the real world. Hard technology in the form of computer-based simulations offers a way to be immersed virtually in environments that would be impractical or even impossible to duplicate in reality.

Computer-based microworlds immerse learners in problems that are embedded in the complexities of reality. Some examples developed recently at the University of Missouri’s Center for Study of Problem Solving include computer-based simulations that allow learners to step into the shoes of a homeless single mother, design a new highway interchange, develop a new food product in an agribusiness lab, or play the role of a peacekeeper in a war-torn nation (http://csps.missouri.edu/pastprojects.php). Such immersive virtual environments add to the student experience by pushing academic learning into the realm of application.

*Transfer of Training in Corporate Settings.* In corporate training, there is a long-standing concern for the ability of trainees to put their newly acquired knowledge and skills to work in their everyday jobs, expressed in the term *transfer of training* (Baldwin & Ford, 1988). The systems approach to instructional design helps planners to focus on transfer of training, not just by activities that happen after instruction, but also those that happen before and during instruction,

- Before training: focus on transfer goals in the needs analysis; involve supervisors and trainees at the needs analysis stage; ask supervisors and trainees to develop a transfer plan together as a prerequisite for participation.
- During training: focus on application-oriented activities; incorporate visualization experiences into instruction; have participants develop individual transfer plans.
- After training: follow up with reaction surveys; observe and validate changed work behavior directly or through supervisors; conduct follow-up refresher or problem-solving workshops (Broad & Newstrom, 1992).
Therefore, individual learner performance in the classroom and in the workplace can be enhanced through soft technology, a systematic approach to ID, and through hard technology, the creation and use of immersive environments in which learners can practice and apply knowledge and skills in realistic settings.

Improving Performance of Teachers and Designers

Educational technology can improve the performance not only of learners but also of those who design and deliver instruction. It can reduce learning time and increase learning effectiveness, both of which enhance the productivity of instructors and designers. Equally importantly, educational technology can help create instruction that is more appealing and respectful of human values, thus aligning instructors and designers with their highest professional commitments.

Reducing Instructional Time

Early in the evolution of modern educational technology as behavioral psychologists were translating laboratory findings into real-world applications, they quickly came to appreciate the importance of articulating the goal of any instructional intervention. It is axiomatic in operant conditioning that the process starts by specifying the desired behavior. The formula for behavior modification is to specify the behavioral goal, observe the learner’s practice, and provide appropriate consequences for performance. Carried over into corporate training, precise performance objectives became the starting point of any design project (Mager, 1962). This, in turn, required close analysis of purported training needs to discriminate between objectives that were “nice to know” and those that were “need to know.”

Procedures for needs analysis and task analysis were refined to relentlessly weed out unnecessary training activity. In fact, many of the early triumphs of systematic instructional design were attributable to the reduction of learner time spent in unnecessary training. As Robert Mager (1977) put it in his keynote address at the ASTD national conference, “Since the objectives for this type of instruction are usually derived from a task or goal analysis, the instruction is more tightly tuned to the needs of the corporation than was previously the case” (p. 13). He went on to cite specific cases of dramatic reductions in instructional time: a broadcasting corporation’s course on transmitter maintenance reduced from four weeks to an average of two
weeks, self-paced, per person; an army typewriter-repair course reduced in length by 35%; an airline’s flight crew training reduced from 15 days to an average of 8; and the U.S. Air Force reducing instructional time between 10 and 25% per course over a range of over 1,000 courses. These time reduction achievements obviously yield great benefits to the organization, enhancing its performance, but they can be seen as enhancements to the performance of those who plan and deliver instruction—designers and teachers. The same number of staff can produce more and better instruction, instruction that is targeted to organizational needs.

Creating More Cost-Beneficial Instruction

Systematic instructional design allows ordinary planners to achieve extraordinary results. For novices, it can replace intuition and trial-and-error approaches with approaches that have been tested and refined. Beginning instructional designers can attain expert status more rapidly.

Instructional design can lead more reliably to effective learning, especially if the procedures include careful attention to selection of powerful instructional strategies. It can also arrive at that goal more efficiently. In the corporate setting, when trainees return to the job sooner as more skilled performers, the training function contributes to profits. When training is a profit center rather than a cost center, the instructional designer becomes a hero. Here we are discussing the benefits of increased productivity for teachers and designers; in the later section on “improving performance of organizations,” we will discuss the benefits for the organizations themselves.

In formal education, the growing demand for learner-centered, active learning means advance planning of new sorts of learning environments. The development of such environments requires a different approach than ordinary day-to-day ad hoc teaching. Educators who can apply a disciplined approach to instructional design are more valued professionals.

Creating More Humane Instruction

More Appealing Instruction. Instructional design theory aims at creating instruction that is appealing as well as being effective and efficient (Reigeluth, 1983, p. 20). Making this one of the major criteria for good instruction is justified by the expectation that learners are more likely to want to continue learning when the experience is appealing. If nothing else, being appealing
can at least increase time on task, which is consistently associated with improved learning.

What is appealing? This will vary from case to case, but in general instruction that has appeal has one or more of these qualities:

- Provides a challenge, evokes high expectations
- Has relevance and authenticity in terms of learners’ past experiences and future needs
- Employs humor or a playful element
- Holds attention through novelty
- Is engaging intellectually and emotionally
- Connects with learners’ own interests, goals
- Uses multiple forms of representation (e.g., audio and visual)

Keller (1987) referred to his ARCS Model as a method for improving the “motivational appeal” of instructional materials (p. 2), meaning materials that attract attention, are relevant to the learner, inspire the learner’s confidence, and provide satisfaction (p. 3).

Educational technology has a long history of concern for appealing instruction. Comenius (1592–1670), one of the major precursors of the field, created an impressive body of work about pedagogy, particularly advocating the use of sensory stimuli to enrich instruction. He opposed the punitive character of schools of his time, proposing instead to introduce children “to knowledge of the prime things that are in the world, by sport and merry pastime” (Comenius, 1657/1967). In the 19th century and early 20th century, Johann Herbart in Germany and William James and John Dewey in the United States developed educational theories that placed “interest” at the heart of the process.

The original rationale behind the audiovisual movement of the early 1900s was to escape the empty verbalism of lecture- and reading-based instruction by the use of films, audiovisual media, and other sensory experiences. For Dale (1946), the ideal was “rich experiences,” involving the senses in ways that are engaging and fresh: “The richest experiences are almost always personal adventures, in which the outcome has the appeal of the unpredictable” (p. 22).

Research by Csikszentmihalyi (1988) and others suggested a high correlation among positive emotional states, engagement, concentration, and enjoyment. Many of the instructional innovations inspired by cognitivist and constructivist theories—such as problem-based learning, cognitive apprenticeship, immersion in microworlds—have been designed to arouse interest as a key component in motivating learners to become deeply engaged with the material (Schiefele, 1991).
Respectful of Human Values. Humanism and technology are not contradictory concepts. Classrooms can be inhumane with or without technology, and technology can be used in ways that liberate people or constrain them. Many of the innovations advocated in educational technology have focused on advancing human values.

Programmed instruction, structured tutoring, direct instruction, and other design formats that sprang from behaviorist roots—which are often perceived as quite mechanistic—actually aimed to liberate learners from the tedium of large-group, passive instruction (Skinner, 1968). Being modular, lessons in these formats could be prescribed according to individual needs. Being paced according to individual progress, each learner receives a customized program. Being mastery based, learners’ confidence was built through experiencing success. Being based on operant conditioning, learners were constantly receiving feedback on their performance; in structured tutoring and direct instruction much of the feedback takes the form of social reinforcers (e.g., smiles and compliments).

More recently, constructivist and postmodernist theories make a strong claim to place humane values as the highest priority. The methods favored by constructivism place special emphasis on emotional and motivational features, and they often depend on technology-based experiences to attain these features. Immersive environments, such as computer-based microworlds and simulation games, provide a venue for “serious play” (Rieber, Smith, & Noah, 1998). Discovery activities based on exploration of Web resources are also favored. Besides stimulating curiosity, they put learners in control of the action, allowing them to determine the nature and sequence of the experience. Such environments require that individuals take ownership of their learning, which in part is intended to nurture lifelong interest in learning. Reflection activities during and after instruction are meant to help learners to become more conscious of the strategies they have followed so that they can grow in their ability to take control of their own learning processes.

Improving Performance of Organizations

Previous definitions have focused on the role of technology in improving individual learning to the exclusion of its role in improving the performance of organizations. Historically, technology has been adopted by organizations as a way to improve productivity—to reduce costs and/or increase output. This economic motive is certainly a major one for training programs in business and industry, but it has been less prominent in schools and universities. Given the enormous public benefit that could be achieved by increasing
the productivity of public educational institutions, we will review the issues of efficiency and effectiveness and some possible roles for technology in improving productivity in education.

Promoting Efficiency and Effectiveness

Efficiency in education is a delicate subject. It is easy to agree that human endeavors ought to be pursued efficiently, but it is more difficult to agree about the extension of this idea to education. The problem was posed clearly by Monk (2003):

Educators often feel ambivalent about the pursuit of efficiency in education. On the one hand, there is a basic belief that efficiency is a good and worthy goal; on the other hand, there is a sense of worry that efforts to improve efficiency will ultimately undermine what lies at the heart of high-quality education. Part of the difficulty stems from a misunderstanding about the meaning of efficiency as well as from the legacy of past, sometimes misguided, efforts to improve the efficiency of educational systems. (p. 700)

The pursuit of effective results is less controversial, but the concept of effectiveness is often intertwined with that of efficiency. We can begin to sort out these issues by examining the meanings of both concepts. Since both concepts are derived from economics, we begin with their meaning in economics.

Efficiency Defined. Economic efficiency is the production of goods and services in the least costly way. Its focus is on how an organization transforms inputs to outputs (McConnell & Brue, 2002). In the context of education and training, efficiency could be viewed as the design, development, and conduct of instruction in ways that use the least resources for the same or better results. Preserving and not wasting resources is necessary when resources are scarce, and in educational institutions, resources are typically limited. All organizations are better off when they leverage their available resources. By leveraging available resources, educational institutions benefit by being able to conduct more instruction with the same resources or the same instruction using fewer resources (thereby releasing funds for other functions of the organization). Further, if the institutions have rivals providing the same services, efficiency makes them more competitive.

Effectiveness Defined. Economic effectiveness is the production of goods and services that are valued by society and its members (Heilbroner & Thurow, 1998). In short, someone is willing to pay for them. In the context of educa-
tion, effectiveness has to do with the degree to which learners attain worthy learning goals; that is, the school, college, or training center prepares learners with knowledge, skills, and attitudes that are desired by their stakeholders.

From an economic perspective, efficiency is concerned with supply side factors while effectiveness focuses on demand side factors (Nas, 1996; Brinkerhoff & Dressler, 1990). From a systems perspective, efficiency is concerned with inputs and how they are processed while effectiveness is concerned with outputs. Often, efficiency is characterized as doing things right, and effectiveness is doing the right things (a formulation attributed to Peter F. Drucker). In the short term, effectiveness—doing the right thing—is more important than efficiency—doing things the right way (VSP, Inc., 2004). In the longer term, effectiveness and efficiency must go hand in hand. We need both. Instruction that is efficient is pointless if it misses the mark of producing desired knowledge, skills, or attitudes. Similarly, instruction that produces desired learning results but consumes excessive resources, is not timely, or does not affect the right people is also unproductive. It wastes scarce resources.

**Productivity Defined.** In simplest economic terms, productivity is output divided by input. An operation is productive to the extent that it is both efficient and effective—it produces desired results with the least necessary cost. As we will discuss, in education “desired results” may mean different things to different people. That is why it is so important to be clear about measurement: how costs are defined and measured and how outcomes are defined and measured. There is virtually unanimous agreement among economists that education, both elementary/secondary and postsecondary, has been declining in productivity over the past decade—costs constantly rising without any noticeable improvement—or even decline—in the attainments of students.

**What Inputs (for Efficiency) and Outcomes (for Effectiveness) to Measure?** Judgments about efficiency and effectiveness, and therefore productivity, depend heavily on how costs and benefits—human and monetary—are calculated. However, there is not a consensus among economists as to what factors should go into the equation of what economists refer to as “the production function” in education (Hanushek, 1986, p. 1149). First, what factors should be considered as inputs? Second, what takes place during the throughput, or the processing step? In other words, how is learning “produced?” Third, what factors should be measured to determine the success of education? Although these issues are better understood today and although the statistical methodologies continue to advance, economists and educators still have not reached consensus on the answers (Schwartz & Stiefel, 2001).
Input measures. Hanushek (1986) proposed that, for K–12 education, student achievement is a function of “the cumulative inputs of family, peers or other students, and schools and teachers. These inputs also interact with each other and with the innate abilities . . . of the student” (p. 1155). He broke down “school and teacher” factors into teachers’ educational level and experience, class size, facilities, instructional expenditures, and wealth of the community or school district.

These factors and the interactions among them are shown in Fig. 3.1 (and discussed in detail later in this chapter), which depicts the relationships according to research on factors associated with student academic learning. The noteworthy point seen in Fig. 3.1 is that some factors—such as aptitude, motivation, and instructional experiences—contribute more directly to learning than others, which are filtered through these more central factors. This helps to explain the failure of economic research and education research to find direct correlations between, for example, class size or teacher experience, and achievement test results (Hanushek, 1986, p. 1161, provided

Figure 3.1. Please supply caption.
a meta-analysis of 147 such studies). Class size does not cause learning. It may affect learning indirectly by influencing what instructional strategies are chosen by the teacher or by coloring the motivational atmosphere in the classroom. The same applies to the factor of teacher experience. Having a lot of experience does not cause learning. It may affect learning indirectly by influencing the teacher’s judgment in choosing instructional or motivational strategies.

Economic models for higher education differ from those for K–12 education because educational inputs and outputs are only a part of the total university enterprise: “Universities are a classic example of a multiple output firm, with outputs including research, housing, and entertainment (sports) in addition to education” (Bosworth, 2005, p. 70). Studies of instructional costs and benefits tend to be carried out at the departmental or course level. Such studies also tend to assume faculty expertise and student aptitude and motivation as constants, ignoring their contribution to the equation. Consequently, they focus on the factors of instructor time and hardware, software, and development costs. This conceptualization of the problem of improving efficiency lends itself well to the use of technology. The National Center for Academic Transformation (NCAT; http://www.thencat.org) sponsored a series of R&D projects to demonstrate that technology-assisted instruction can reduce the instructor time costs while maintaining quality (Twigg, 1999).

Beyond existing traditions in economics, questions plague the attempt to measure efficiency. Obviously, the instructor’s planning and teaching time is an important input in the equation. But what about the learner’s time? In cases where collaborative learning is emphasized, do you count the time spent by partners helping each other learn? In the case of peer tutoring, do you count the tutor’s time? If so, what value do you put on such time? And how do you count the learning benefits accruing to peer learners? Obviously, the cost of purchasing textbooks and other instructional materials should be counted, but what about the development costs for locally produced materials and systems? What amortization schedule should be used for equipment and materials?

Throughputs, or the “production” process. Although it is not made explicit in economic models of education, the instructor seems to be assumed the party who does the “production.” This is certainly the assumption when students are considered “customers.” When using this metaphor, the instructor is clearly viewed as performing a service for a client. However, as discussed in chapter 2, the contemporary view of the learning process considers the learner the producer. There is no learning without the willing and active participation of the learner. Rather than receiving a service, the learner is
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actually creating the product—his or her own learning gains—sometimes in collaboration with an instructor and sometimes without.

The instructor’s role is still large—providing the conditions (instructional and, especially, motivational) needed for successful learning—but not predominant. Thus, for an economic model to bear any resemblance to the reality of the situation, the learner must be viewed as at least the coproducer of learning gains. The throughput part of the model must include learners, and it must take into account their psychological traits (e.g., aptitude, developmental level, and personality) and psychological states (e.g., motivations and expectations), shown in Fig. 3.1.

Outcome measures. As thorny as the issues are for input and throughput variables, they are thornier for outcome measures. As Bosworth (2005) noted, “Medical care and education are two major examples of activities that raise challenging, and thus far unresolved, issues of how to measure output” (p. 68). What inputs cause learning and the factors involved in “producing” learning are empirical questions, which can be settled by research, but deciding on outcome measures is much more a matter of judgment, involving educational, social, and political values as well as economic analyses.

For example, in public schools in the United States in 2006, the reality is that, as a matter of public policy, outcomes measured in terms of standardized test scores heavily outweigh all other benefits in the cost-benefit equation. This is defended in terms of needing some sort of objective measure of outcomes. Others would argue that this is too narrow a measure and that other outcomes should be counted, for example,

- Student achievement in learning domains not included in standardized testing, such as social development, civic virtues, creative arts, health and athletics, and love of learning
- Student achievement in basic skills that are not measured on standardized tests, such as enjoyment of reading, critical thinking in science, application of math to everyday life, and the like
- A healthy learning environment, where each student has the opportunity to develop toward leading a successful and productive life
- A productive work environment for teachers, in which their efforts are rewarded and they are motivated to stay and grow

Because of their interests in efficiency and effectiveness, educational technologists have a special interest in making sure that both the processes and the outcomes are measured accurately. Thus, for example, when rich environments for active learning (REALs) are used to pursue deep learning and applied skills, it is paramount that the assessment be more than simple
paper-and-pencil tests. Simulations and portfolios are much more likely to give an accurate gauge of the attainment of those higher-level skills. In other words, you cannot be sure about effectiveness unless you measure accurately what the outputs are.

It is entirely possible for one instructional system to be more cost efficient than another based on one set of outcomes, but less cost effective based on another set of outcomes. Monk (2003) referred to this problem as “the legacy of past, sometimes misguided, efforts to improve the efficiency of educational systems.” Quality too often suffers when administrators focus narrowly on cutting costs. And the quality of outputs is often measured in intangibles, factors that are not as apparent as test scores.

For example, in teaching spelling, a structured tutoring program that has older students using flash cards to teach younger students to spell may result in 80% of the younger students spelling correctly 80% of weekly spelling test words 80% of the time. A computer-based program that teaches the same spelling words is purchased. Within a year, its costs are more than offset by replacing the hourly costs of the teacher aides that coordinated the peer-tutoring program. Further, the computer-based program results in 85% of the younger students spelling correctly 85% of the weekly spelling test words 85% of the time. This reduction in costs and improvement in outputs is technically more efficient. However, is it more effective? The answer is yes if the overall goal is improving spelling test scores of the younger students on weekly spelling tests. But what if there were unspoken goals?

In our hypothetical case, after one year the teachers begin to notice two phenomena. First, the younger students’ spelling in their written work, that is, spelling in context, had become problematic. When the teachers investigate, they are reminded by the younger students that in the peer tutoring program the older students often presented words in example sentences and in contexts often individualized to the experiences of the younger students. Second, the teachers of the older students report a drop in their spelling ability. The older students report that by teaching the younger students spelling, their spelling skills were kept sharp by practice and thinking about ways to help the younger students devise ways to remember the spelling of troublesome words. So we have increased efficiency but decreased effectiveness if the goal is for all students to apply good spelling to all their work. In other words, it is more cost efficient but less cost effective.

This “efficiency without effectiveness” has been the historical problem. Callahan (1962) eloquently told the story of the attempt to apply scientific management to American schools in the first decades of the 20th century and how quality, or effectiveness, was often sacrificed at the altar of business-
like procedures. Such episodes lead educators to be suspicious of appeals to efficiency. They know intuitively that schools, colleges, and other learning institutions have numerous goals, many of them unstated or intangible, and they are concerned about what unintended consequences may develop.

There will always be debate, in businesses and educational institutions, about what goals are worth pursuing and what indicators should be used to measure progress toward those goals. Educational technologists, as much as any other stakeholders, should be part of that conversation. Taking a systems view, they can help their institutions define and achieve worthy goals (outputs) with means (instructional processes) that are as efficient and effective as possible. They can point to research indicating that technology-based instructional processes can contribute to educational productivity. For example,

- Ellson's (1986) meta-analysis of comparison studies, seeking experimental treatments that were more than twice as productive as the control treatment (defined as learning an equivalent amount in half the time or at half the expense). Among the 125 studies that met this criterion, about 70% constituted some variation on programmed instruction, structured tutoring, or "programmed teaching," such as direct instruction. In the latter instructional configuration, an instructor—who could be a student or a paraprofessional—conducts structured lessons following a template developed and pretested by a qualified design team, thus making economical use of division of labor.

- Levin, Glass, and Meister's (1984) computer modeling of the costs and benefits of four instructional treatments that made claims to cost effectiveness: lowering class size, tutoring programs, computer-assisted instruction (CAI), and increased instructional time. Peer tutoring (soft technology) had by far the largest effect size, with CAI second. The other interventions yielded negligible benefits per dollar spent.

- In the first decade after Keller's (1987) invention of personalized system of instruction (PSI), described in chapter 2, some 75 comparison studies, mostly at the college level, had been published. A meta-analysis (Kulik, J. A., Kulik, C. L., & Smith, 1976) showed that the typical PSI student scored at the 75th percentile on a standardized test compared with the 50th percentile for the control treatment—one of the largest advantages for any experimental treatment in all of educational research.
Organizational Learning

The very survival of organizations is contingent on their abilities to learn and adapt to changing conditions. In contemporary management theory, organizational learning is regarded as more than just the sum of the knowledge and skills of an organization’s individual members. In addition to this, organizations may have institutionalized processes for collecting, interpreting, storing, and disseminating knowledge. In the following sections we will discuss, first, individual learning in organizations, and, second, group learning by organizations.

Individual Learning in Organizations. As information and communication technologies (ICT) have grown in mass penetration and advanced in capability, more instructional functions can be mediated through technology. At the same time, economic pressures have motivated organizations to consider changing the way they conduct education and training.

ICT or “hard” technologies have proven capable of many economies related to education. In particular, they can deliver instructional materials cheaply over long distances, and they can do routine operations such as record-keeping less expensively and more reliably than human operators can. Perhaps more importantly from a learning standpoint, they can bring individuals and small groups together in conversation, thus enabling collaborative work as well as reflection on that work. By capitalizing on such advances in carrying out education and training, the productivity of the organization can improve: Learners spend less time in training and become expert performers more rapidly.

“Soft” technologies offer a new paradigm for organizing the work of education. This new paradigm starts with adopting some of the innovations of the industrial revolution—division of labor, specialization of function, and team organization. Corporations and distance education institutions have used this new work paradigm to create and offer online modules and courses at very competitive prices; the courses vary in instructional quality, but most are at least comparable to average residential courses; some are comparable to the best of traditional courses. Such new “technological” ways of working offer productivity improvements, sometimes dramatic.

Technology in business. For profit-making organizations, the role of technology has long been clear: technology is adopted primarily to replace costly human labor with cheaper means of production. Technologies that are more pervasive, such as information technology, tend to have even greater potential for transformational change. By the 1990s, corporations were experienc-
ing competitive pressures not only from companies in their own country but also from companies in neighboring countries and countries many time zones and oceans distant. Globalization was gaining momentum. Consequently, pressure for cost cutting pushed American companies to find ways to do business with fewer employees. It was called “downsizing.” Hence, businesses invested millions of dollars in computer systems, which they expected to recoup in the form of reduced costs of generating the products and services they sell. By the beginning of the 21st century, these investments were clearly paying off and many business processes had been transformed fundamentally.

Technology in K–12 education. What role technology should play in educational institutions has not been as clear. The administrative functions that schools and colleges share with businesses have been subjected to a good deal of automation—payrolls, recording of grades, enrollment figures, bus routes, financial records, and the like. However, the core function, providing education, has not been as radically affected.

A number of compelling cases of exemplary use of technology in schools have gained visibility from time to time, but few have persisted and expanded beyond the experimental stage. One prominent current example is Project CHILD, an elementary school model (described in chapter 5) that has been implemented and sustained in dozens of schools since 1995 (Butzin, 2005). This curricular plan exemplifies soft technology in the sense that it was systematically designed based on research and rigorous evaluation, and it also makes exemplary use of hard technology, employing computer-based activities as one of its pillars. Project CHILD has been recognized by a taxpayer group in Florida as an exemplary model of cost effectiveness (Florida TaxWatch, 2005). Unfortunately, for every school making exemplary use of technology to improve cost effectiveness, there are a hundred that do not.

There are many reasons that schools lag behind other sectors in their uses of technology in their core functions. First, the teaching-learning process is complex and highly intertwined with human feelings, such as altruism, submission, passionate interest in one’s subject matter, and mutual trust and respect. It is not simple or easy to automate such a process, or even parts of the process. Second, key organizational decision makers have a stake in making and keeping the teaching-learning process labor intensive. As Heinich (1984) pointed out, this is reflected most clearly in the tendency of teachers’ unions to protect jobs by opposing policies that might reduce the labor intensiveness of teaching (pp. 77–78). Third, most elementary and secondary schools in the United States are public institutions operated by local districts and funded largely by state appropriations. They have had, to a great extent,
a monopoly position. There have been few competitors (nonpublic schools) within their local area and fewer from beyond. For most “customers,” the only way to exercise choice is to physically uproot and relocate the whole family to a new location. So competitive pressure is largely lacking—or at least it has been in the past. Virtual schools may be changing the competitive environment.

Virtual schools. Distance education approaches first developed in higher education are now appearing at the elementary/secondary level in the form of virtual schools. For-profit ventures offer online courses aimed primarily at home schooling households. This puts competitive pressure on the public schools, which need to maintain their daily attendance rates in order to continue receiving state per-pupil allocations. Thus, public schools are pushing to implement online distance education programs. Online delivery is also an answer for hard-to-serve students, such as full-time workers, pregnant and young mothers, disciplinary force-outs, students with health problems, and others who are not well served by the regular schools.

Thus educational technology may help improve the organizational performance of schools by providing the communications capability (hard technology) and the courseware design (soft technology) to allow schools to expand their reach to changing audiences.

Technology in higher education. In higher education this issue has risen in visibility as distance education has migrated to an Internet-based platform. Educational institutions are able to reach distant audiences at little additional cost, compared with the costs of residential or television-based instruction. Many potential “customers” for higher education view educational services as a commodity that can be purchased from any one of many vendors, regardless of location. This is particularly true for nontraditional college students—adults with families and jobs. For such students, residential education involves many indirect costs—in terms of time, money, and aggravation—that can be avoided by working toward a degree online. This is not to say that the online option is necessarily superior in other ways, only that it can reduce cost and increase convenience. Experience to date suggests that it requires an exceptional degree of commitment for students to complete a program at a distance. In a relatively short period of time, a host of new distance education institutions, many of them for-profit, have sprung up and taken root. The largest, University of Phoenix, has become the largest private university in the United States, with over 200,000 students in its online and face-to-face courses. Although residential campuses still offer unique advantages and a ready supply of students, the competitive heat is rising.
It may not be competition, strictly speaking, that is driving interest in technology in higher education. Rather, administrators now have a concrete image of an alternative approach to education. They see that distance education institutions are able to offer education at much lower prices because of the way they are employing technology. Interestingly, it is not hard technology that gives such distance institutions an advantage (residential institutions have lots of hard technology, too) but rather soft technology. This was articulated clearly by Sir John Daniel, then Vice-Chancellor of the British Open University:

The most important thing to understand about using distance education for university-level teaching and learning that is both intellectually powerful and competitively cost-effective is that you must concentrate on getting the soft technologies right. . . . These soft technologies are simply the working practices that underpin the rest of today’s modern industrial and service economy: division of labour, specialisation, teamwork and project management [italics added]. (Daniel, 1999)

Division of labor and specialization refer to “unbundling” the various functions performed by instructors: instructional designer, developer, subject-matter expert, lecturer, discussion leader, evaluator, remediator, and adviser. By forming a team of specialists in these different functions each job can be done more expertly, a course can be designed, and the team can move on to the next course, thus industrializing the process. A well-designed course can be largely self-instructional, leaving the tutorial function to low-paid paraprofessionals working the phones in a cubicle somewhere. So far, this soft technology approach has been confined mainly to distance only operations, but administrators at traditional universities are taking note. There are examples of this approach being applied at traditional universities. One notable case is the Math Emporium at Virginia Tech University (http://www.emporium.vt.edu), a large computer center encompassing a dozen core mathematics courses, all of which are available on demand in a self-instructional format.

Group Learning by Organizations. Argyris (1977) drew attention to the problem of people’s ignoring or hiding errors in organizations. He proposed and later elaborated (Argyris & Schön, 1978) a distinction between single-loop learning—the detection of error in a particular case—and double-loop learning—when errors are detected and corrected in ways that alter the organization’s future capabilities. Senge (1990) extended the concept of double-loop learning further, to generative learning—a posture of ongoing experimentation and feedback, critically examining the organization’s actions and policies.
The idea underlying these concepts is that organizations themselves can learn, that is, they can become smarter in dealing with the challenges they face. If organizations do not actually have brains, how can they learn? Popper and Lipshitz (2000) proposed that organizations can build organizational learning mechanisms (OLM), “institutionalized structural and procedural arrangements that allow organizations to learn non-vicariously, that is, to collect, analyse, store, disseminate, and use systematically information that is relevant to their and their members’ performance” (p. 185).

Technology, both hard and soft, can contribute significantly to building OLMs. ICT can provide powerful means for storing, retrieving, and sharing knowledge. Audio and video conferences, Internet discussion forums, and groupware such as Lotus Notes enable a dynamic and growing organizational memory. Of course, the hard technology only works effectively when it is combined with the soft technologies of man-made policies and practices in a synergistic whole (Goodman & Darr, 1998).

The ultimate goal, proposed by Senge (1990) is the evolution of learning organizations—schools, colleges, and businesses “in which you cannot not learn because learning is so insinuated into the fabric of life” (p. 9). Learning organizations would be ideal environments for both individual learning in organizations and group learning by organizations.

A Systems Perspective on Organizational Performance

A powerful way to visualize the influences of technology within organizations is to adopt a systems view. Organizations of all types can be viewed as complex enterprises of interconnected parts that in ideal circumstances work in harmony to effectively convert numerous types of inputs to valued outputs: valued in the sense that individuals and other organizations are willing to use or support them. People are central to organizations. They work alone and in teams to create a work environment and culture that enables them to contribute to the generation of valued goods and services. The effectiveness of an organization as a whole depends to a great extent upon the effectiveness of the work that people perform individually and in teams as members of the organization’s component parts.

Moreover, organizations do not exist in vacuums. They exist within a larger environment, or suprasystem, that places pressures, constraints, and expectations upon it. Other organizations provide its inputs and consume its outputs. The marketplace, natural forces, and governments regulate both directly and indirectly an organization’s inputs, processes, and outputs. These forces, external to the organization, constitute its environment. An effective organization, through ongoing feedback from its external environ-
ment and back-and-forth feedback among its internal parts, continually calibrates and adjusts its inputs, processes, and outputs to achieve its overall goals and objectives in timely and cost effective ways.

Organizations, as complex systems, behave systemically. The parts are not independent or freestanding. As such, interventions must look beyond simple cause-and-effect relationships and recognize that a cause and its effect cannot be isolated or separated from its context. Systemic problem solving is a matter of holism over reductionism (Douglas & Wykowski, 1999; Hallbom & Hallbom, 2005).

Systems theory has been a key theory in educational technology since the 1960s, particularly through the early work of Bela Banathy (1968). It rose to greater prominence in the 1980s and 1990s as more and more American educators publicly acknowledged the need for systemic change. These calls ultimately led to the creation of the New American Schools Development Corporation (NASDC) as part of a national government initiative to develop new, whole-school designs for American schools, which functioned from 1992 through 1995.

The essence of the systems view is to step back and note the factors that surround and influence events in the classroom. Only by first seeing the classroom in its larger context can one restructure the environment to be more supportive of more powerful instructional strategies. The model shown in Fig. 3.1 is intended to provide this systemic perspective. The elements of the model and the interconnections among them are based on generalizations gleaned from meta-analyses of the educational research, especially those reported by Walberg (1984).

**Direct Influences on Learning** The core of the model shows three influences that directly affect student academic learning. They are derived primarily from Walberg’s (1984) overall conclusion that “the major causal influences flow from aptitudes, instruction, and the psychological environment to learning” (p. 21). The direct influences are,

- **Aptitude**—relatively permanent psychological traits, including intelligence(s), maturation level, personality, and “learning style” (which has been defined in many different ways)
- **Effort**—often characterized as amount of invested mental effort (AIME) or how hard the learner is working on learning task
- **Instruction**—the amount and quality of teaching-learning activities in which the learner is involved

The relative importance of these three factors is hotly debated among educators, under the rubric of the “nature-nurture” debate. Some psychologists
have proposed that up to 90% of the variability in learning stems from aptitude factors; most would agree that aptitude is responsible for at least half of the variability. Effort may be the next most important. There is ample evidence that if students have high aptitude and/or motivation to invest a lot of mental effort, almost any instructional treatment will succeed.

However, to the extent that learners have lower aptitude or are less highly motivated, better designed instruction and longer engagement in it can improve the amount learned, retained, and applied.

Second-Level Influences on Learning. Many of the forces that consistently show a causal relationship to learning actually impact learners indirectly, that is, they affect aptitude, effort, or instruction rather than affecting learning directly. As shown in Fig. 3.1, effort is especially affected by second-level influences. First, effort depends on the learner’s psychological state, especially the motivations and expectations that are salient at the time of instruction. Second, effort can be affected by peer influences. Third, the media and methods selected in the instructional process can arouse effort.

Walberg (1984) found two aspects of instruction to be critical—time on task and the “quality” of the educational experience, which is represented by method and media in the diagram. The combination of methods and media provide the structure of the learning environment as well as the teaching-learning activities that are employed.

Walberg (1984) identified the classroom social setting as an important influence, defining it as “the cohesiveness, satisfaction, goal direction, and related social-psychological properties or climate of the classroom group perceived by students” (p. 24). This is indicated in Fig. 3.1 by the dotted line encompassing the classroom environment. Given the right climate, teachers are more likely to offer higher quality instruction and students are more likely to feel motivated to invest effort and activate their innate aptitudes.

Peer influences can act both inside and outside the classroom, hence this element is shown as straddling the boundary of the classroom in the diagram.

Third-Level Influences on Learning. Some of the other factors identified by Walberg (1984) as critical are represented in the diagram as third-level influences; that is, they do not influence learning directly, but indirectly, through some of the second-level forces. Chief among the third-level influences is home and family. This category includes a number of factors deemed very important by Walberg:

- A good home environment increases supervised homework and reduces the time spent watching television (p. 24). Since the time
of Walberg’s analysis recreational uses of the computer may be displacing television as the chief competitor for children’s attention.

- The “curriculum of the home” promotes achievement in several ways, through informed parent-child conversations about school, encouraging leisure reading, deferring immediate gratifications in favor of longer-term goals, expressions of affection and interest in the child’s activities, and other intangible psychological supports. Taken together, the home and family environment “is twice as predictive of academic learning as socio-economic status” (p. 25).

Mass media play a third-level role also, in that they help create a culture (just as they are also shaped by the culture) that may support or inhibit healthy psychological states, including motivation and expectations. They have an influence on peer groups’ attitudes toward school also.

Surrounding all these influences—home and family, classroom, school, mass media, and peers—is the overall socio-cultural/political environment, both local and national. Within the United States, there are many subcultures, each of which exerts different influences on the forces within it, ultimately promoting or undermining the forces that affect academic achievement.

Only through a systemic lens of this sort can educators fully understand the interplay of the forces that actually impact the quality of learning. If schools or other organizations are to become learning communities, they must incorporate structures and policies that will be supportive of, not hostile to, the goal of facilitating learning. Educational technology, by nature devoted to a systemic view of problem situations, helps organizations improve performance by identifying the elements of the system, understanding the linkages among those elements, and treating root causes rather than mere symptoms.

Improving Performance of Organizations: Beyond Learning

Organizations can promote the productivity of the people within them by helping them gain new knowledge, skills, and attitudes, but they can also promote productivity by changing the conditions within the organization so that people can accomplish more, with or without additional instruction. For example, they can provide people with better tools, give them better working conditions, motivate them better, or provide job aids. Noninstructional interventions are often pursued under the label of “performance improvement” or “human performance improvement.” Those that entail changes in organizational structure are commonly seen as “organizational development” efforts. All of these would fall outside the field of educational tech-
nology. Those who advocate a systemic approach toward the total process of instructional and noninstructional performance improvement prefer the label of “HPT.”

**Human Performance Technology (HPT)**

Evolving since the 1970s as a separate field, HPT embraces the viewpoint that organizational effectiveness can be advanced by employing a wide range of interventions, including, but not limited to, instruction. Deficiencies in performance may be caused partly by ignorance, but more often there are problems of motivating people or giving them the tools needed to do the job, or even selecting people who are better suited to the demands of the job.

Therefore HPT pursues “…the systematic and systemic identification and removal of barriers to individual and organizational performance” (International Society for Performance Improvement, 2005). As a concept and field of practice it is comparable to educational technology. Like many instructional designers, performance technologists advocate systematic processes of analysis, selection, design, development, implementation, and evaluation to cost effectively influence human behavior and accomplishment (Harless, as cited in Geis, 1986). The difference is that performance technologists consider instruction to be just one of many possible interventions to improve performance in the workplace. This viewpoint was summarized in Pershing’s (2006) definition of HPT as “the study and ethical practice of improving productivity in organizations by designing and developing effective interventions that are results-oriented, comprehensive, and systemic” (p. 6).

The systematic ID approach and the HPT approach are quite compatible with each other. A visual model that shows how the two concepts dovetail is shown in Fig. 3.2.

The strategic impact model (Molenda & Pershing, 2004) begins by emphasizing strategic alignment, showing how needs of the organization are derived through strategic planning. Then performance analysis determines where there are deficiencies in the organization. Next, these deficiencies are examined as to their causes (cause analysis). Ignorance, or lack of skill/knowledge, is only one of the possible classes of performance deficiencies, so instruction is only one of several possible solutions.

The steps in solving instructional problems are shown on the right side of the model. Other causes of deficiencies—low motivation, poor working conditions, lack of information, and poor organizational structure—can be addressed by other sorts of interventions, shown on the left side of the model.
All the interventions needed in a given case will pass through processes of analysis, design, development, and production (with evaluation and revision accompanying each of those stages) before they are brought together in a coordinated implementation. The model also represents the requirement of change management at each step along the way in order to increase the odds that the interventions will be accepted by the people in the system and incorporated into the organizational culture.

Summary

Educational technology can claim to improve the performance of individual learners, of teachers and designers, and of organizations as a whole.
To begin with, the educational experience is more likely to lead to improved performance because the instructional design doctrine of educational technology advocates the selection of objectives that fully represent the types and levels of capability to be learned. Further, educational technology has a commitment to promoting “deep learning,” learning that is based on rich experience and that can be applied in real world contexts. Transfer of learning is promoted by learner immersion in microworlds, virtual environments in which learners have the opportunity to experience the consequences of decisions. In the corporate setting, the systems approach recommends activities before, during, and after training that make it more likely that workers will use their new skills on the job.

Teachers and instructional designers’ performance is improved by the systems approach, which helps focus on high-value objectives, weeding out irrelevancies, thus reducing instructional time, which conserves the resources of educators. Systematic development processes also tend to yield more effective learning results, further enhancing productivity. Educational technologists are also sensitive to the need to make instruction appealing and humane. The innovations they advocate, from programmed instruction to constructivist learning environments have been tools to free learners from passive, lock-step teaching, to provide more exciting and involving learning experiences.

Productivity has been declining in the education sector. To improve productivity requires defining and improving both efficiency and effectiveness. Technology has the potential to improve both efficiency and effectiveness. Learning processes within organizations can be improved through hard and soft technologies, to the overall benefit of the organization. ICT can reduce the time and cost of distributing materials as well as all sorts of administrative tasks. Soft technologies, especially modern work processes, can help improve organizational performance by unbundling the many functions associated with instruction and reorganizing those functions more rationally. Distance education universities have achieved enormous economies of scale this way, and some traditional universities have restructured programs to make them more learner centered and more efficient. To accomplish this restructuring, a systemic view is necessary, a view that is synonymous with educational technology.

Beyond improving learning, organizations can solve people problems that are larger than just those of lack of knowledge or skills. The umbrella of HPT provides a framework for combining instructional interventions with motivational, ergonomic, environmental, organizational, and other interventions into coordinated initiatives that can dramatically improve productivity.
3. IMPROVING PERFORMANCE

References


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Q3]AU: Please supply full reference for “McConnell & Brue, 2002” or delete this citation from the text.

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