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Educational Systems Design (ESD)

Educational technology is a broad field that encompasses both “hard” and “soft” technologies. Educational systems design is a “soft” educational technology that is grounded in systems philosophy, systems theory, and design theory and enhances the success of efforts to change our education systems. ESD provides a knowledge base that improves the chances of successful implementation of a change in education, improves the chances of long-term survival of the changes, and, most important, improves the chances that the changes will meet the needs of the social systems and individuals they serve.

Technology can be used to help educators do better what they are already doing, or it can be used to help them do things very differently—and potentially much better—than without it. ESD is an important soft technology for helping educators succeed at the latter.

Because most readers are familiar with instructional systems design (ISD), and because there are many similarities between ESD and ISD, it may be helpful to understand ESD by comparing and contrasting it to ISD. ESD is broader in scope than ISD, for ISD is a subset of ESD, but both encompass knowledge bases for “process” and “product” (means and ends). Furthermore, ESD has a foundation in systems thinking and design thinking, and it focuses on holistic transformation rather than piecemeal change. These four issues are discussed below.

The Scope of ESD

The major difference is that ESD is concerned with the entire education system, whereas ISD is only concerned with one part of it: the instructional subsystem. There are four subsystems in any educational or training system (Banathy 1991):

1. The learning experience subsystem, in which the learner processes information from his environment to produce new or modified cognitive structures;

2. The instructional subsystem, in which instructional designers and teachers use information about learning needs (gained through analysis activities), as well as administrative and governance input, to produce environments or opportunities for learners to learn;
3. The administrative subsystem, in which administrators use information about instructional needs, as well as governance input, to make decisions about resource allocation, including use of leadership; and
4. The governance subsystem, in which “owners” use their goals and values to produce policies and in other ways provide direction and resources for the educational enterprise in order to meet their needs (which usually include those of learners, teachers, and administrators).

ISD provides the knowledge base about designing the instructional subsystem, whereas ESD provides the knowledge base about designing the complete education system.

Process and Product Knowledge in ESD

Knowledge about the *process* of ISD is generally referred to as ISD models (such as those reviewed in Gustafson and Branch 1997), which focus on the activities in which people should engage in order to design a new instructional system. By contrast, knowledge about the *products* of ISD is generally referred to as instructional theories (such as those compiled by Reigeluth 1983, 1999), which focus on what the new instructional system should be like—what instructional methods it should use.

In a similar way, knowledge about the process of ESD is generally referred to as ESD models, or systemic change models, and focuses on the activities in which people should engage in order to design a fundamentally different educational or training enterprise or to fundamentally transform an existing one (see, e.g., Duffy, Rogerson, and Blick 1999; Jenlink et al. 1996, 1998). Knowledge about the products of ESD is generally referred to as comprehensive design and focuses on what features a fundamentally different kind of educational or training system should have in order to meet fundamentally different learning needs of the system it serves (see the vision offered by Reigeluth and Garfinkle 1994).

Foundations of ESD

A critical feature of ESD is its foundation in systems thinking and design thinking (design philosophy and design theory) (see, e.g., Banathy 1996, 155–171). Systems thinking, which includes systems philosophy, systems theory, and systems methodology (see, e.g., Ackoff 1981; Checkland 1981;

Churchman 1979; Hutchins 1996), is the centerpiece of the new sciences, which also include chaos theory, nonlinear science, and the science of complexity (Bohm 1983; Davis 1989; Wheatley 1992). Systems thinking focuses on understanding the mutually interdependent relationships (1) between a system and the larger systems of which they are a part (suprasystems); (2) between a system and its peer systems (other systems that are parts of the same suprasystem); and (3) among the many functions and components that comprise the new system. It also focuses on understanding the complex dynamics that govern the behavior of systems and strongly influence the effects of any changes made to a system (Senge 1990). Particularly relevant to ESD are the systems concepts of holism, self-organization, emergence, coevolution, and dynamical systems (Capra 1988; Michaels 1994).

Design thinking (Ackoff 1981; Checkland 1981; Cross 1984; Nadler 1981; Warfield 1990) informs process knowledge about how to design education systems. The fundamental activities of analysis, synthesis, and evaluation occur continuously throughout the design process. Simultaneity, recursion, and transcendence are important concepts, as are idealized design, values-based design, holistic design, continuous design, and ethical principles of design (e.g., stakeholders or users should design their own systems).

Piecemeal versus Systemic Change

To further understand the nature of ESD, it is helpful to think in terms of two basic kinds of change: piecemeal and systemic. Piecemeal change leaves the structure of a system unchanged. It often involves finding better ways to meet the same needs. In contrast, systemic change entails transforming the structure of a system, usually in response to new needs. For example, one may find that students' characteristics (such as their entering knowledge, learning styles, interests, and motivations) are more diverse than they used to be and that they have very different goals (such as college, vocational school, or immediate employment). To respond to these changed needs, an educator may decide to use customized, team-based, problem-based learning with continuous progress and to use advanced technology in new ways. Piecemeal change usually changes one part of a system in a way that is still compatible with the rest of the system, whereas systemic change entails such a fundamental change that it requires fundamental changes throughout the system, because the other parts of the system would not be compatible with the change.

Thus ESD is concerned with creating a new paradigm of education or training, as opposed to making changes within the existing paradigm. It recognizes that fundamental change in one aspect of a system requires fundamental changes in other aspects for it to be successful. In public ed-

ucation, it must eventually pervade all levels of the system: classroom, building, district, community, state government, and federal government. Similarly, in corporate training, it must eventually pervade all levels of the corporation. In this way, it can encompass not only the nature of the learning experiences and the instructional system but also the administrative and governance systems.

Such an approach to improvement is radical, not to mention difficult and risky. Thus it is important to address the rationale for such a radical change.

When and Why is ESD Needed?

Systems thinkers know that when a human-activity system (or societal system) changes in fundamental ways its subsystems must change in equally fundamental ways to survive. This is because each subsystem must meet one or more needs of its suprasystem in order for the suprasystem to continue to support it (Hutchins 1996). So if the suprasystems for education systems are undergoing systemic changes, only then do education systems need to undergo systemic change or risk becoming obsolete.

So are education's suprasystems changing dramatically? In the industrial age we needed minimally educated people (dropouts) who would be willing and able to endure the tedium of work on assembly lines. However, those line jobs have been rapidly disappearing. Just as the percentage of the workforce in agriculture dropped dramatically in the early stages of the industrial age, so the percentage in manufacturing has been declining dramatically over the past few decades. Even in manufacturing companies, a majority of the jobs today entail manipulating information rather than materials (Reich 1991). Just as the industrial age represented a predominance of manual labor with machinery, so the information age represents a predominance of "knowledge work" with information technology. This means that more people must be educated to higher levels, with a greater emphasis on preparing students to think, solve problems, assume responsibility and initiative, and work well in teams. These are dramatically different educational needs from those that our industrial age schools were designed to meet. While preparation for work is but one mission of schools, the civic and character-building missions have seen similarly dramatic changes in this age of terrorism, global conflict, drugs and violence, and corporate malfeasance. Thus it is evident that education's suprasystems are indeed changing dramatically.

The Knowledge Base of ESD

Given the need for ESD, what is its knowledge base like? It was mentioned earlier that it includes both process and product knowledge. Product knowledge is concerned with what a new system of education should be

like. This part of the knowledge base investigates the changing educational needs of the suprasystem (the community or organization to be served) and individual “clients” and explores the educational implications of those changes in needs. Process knowledge is concerned with how to design a new education system or how to help an existing one transform itself. This part of the knowledge base investigates the obstacles to systemic change and the activities that are most likely to lead to a successful change effort. These are discussed below.

Product Knowledge

Product knowledge is composed of (1) visions of different kinds of education systems and (2) linkages between each kind of education system and the characteristics and needs of the larger systems it serves. Consider, for example, the following analysis.

One thing educators know for certain is that different people learn at different rates. Yet our industrial age education systems present a fixed amount of content to a group of learners in a fixed amount of time, making it like a race to see who receives the A’s and who flunks out. By holding time constant, we force attainment of standards to vary. Our current systems are not designed for learning; they are designed for sorting, which was appropriate for industrial age needs. However, our information age society, with a predominance of knowledge work, requires all students to learn—that no child be left behind. If we are ever to meet this new educational need, we must stop holding time constant and instead hold attainments constant by allowing every student as much time as needed to master them.

However, switching from a time-based system to an attainment-based system means that we must switch from group-based progress to personalized progress. This in turn requires changing the role of the teacher to that of a coach or manager, rather than that of dispenser of knowledge to groups of learners who rotate from one teacher to another at the ring of a bell like so many little widgets on an assembly line. This requires that learning occur primarily from sources other than the teacher. Thus technology and other resources (including peers) must be used in dramatically different ways. Rather than focusing on technology integration—using technology to enhance what is currently being done in classrooms—we should focus on technology transformation—using technology to do things that were not possible before (Reigeluth and Joseph 2002). Furthermore, our assessment systems need to change from norm-referenced (comparing students with each other) to criterion-referenced (comparing student performance to a standard). One might envision an “inventory of attainments” replacing our current report cards and transcripts.

TABLE 1: Key Markers That Distinguish Industrial Age and Information Age Organizations

Industrial Age	Information Age
Standardization	Customization
Bureaucratic organization	Team-based organization
Centralized control	Autonomy with accountability
Adversarial relationships	Cooperative relationships
Autocratic decisionmaking	Shared decisionmaking
Compliance	Initiative
Conformity	Diversity
One-way communications	Networking
Compartmentalization	Synthesis and holism
Parts oriented	Process oriented
Planned obsolescence	Total quality
CEO or boss as "king"	Customer as "king"

SOURCE: Charles M. Reigeluth, ed. (1999), *Instructional Design Theories and Models, Volume 2: A New Paradigm of Instructional Theory* (Mahwah, NJ: Lawrence Erlbaum Associates).

To build product knowledge by investigating broader societal changes and exploring their educational implications, it is also helpful to look at the work of people like Daniel Bell (1973), Alvin Toffler (1980), and Robert Reich (1991), who have identified several massive changes that our society has undergone, from the agrarian age to the industrial age and now into what some call the information age. According to these and other scholars, there are "key markers" that characterize the emerging differences between information age organizations and their industrial age counterparts (see Table 1).

These key markers may provide insights as to core ideas that should guide the design of our new education systems (Banathy 1991). For example, changing from a system in which a group of thirty students must learn the same thing at the same time and rate, to a system in which each student takes as long as necessary to master a standard of attainment, clearly entails customization. Similarly, our current systems of education are also based on conformity and compliance. Students are typically expected to sit down, be quiet, and do what they are told. Their learning is directed by the teacher. But employers now want people who will take initiative to solve problems and who will bring diversity—especially diverse perspectives—to the workplace. Both of these enhance the ability of a team to solve prob-

lems and keep ahead of the competition. Communities and families also need people who will take initiative and honor diversity. The systems that education serves need diversity and initiative to be fostered by our education systems in the information age. Understanding these key markers can play a valuable role in building a sound product knowledge base in ESD.

So what product knowledge do we currently have? The New American Schools Development Corporation assumed as its mission to foster the development of “break the mold schools” as called for by President George H. W. Bush in 1990. This resulted in the development and implementation of seven comprehensive school designs, such as ATLAS, Co-NET, Modern Red Schoolhouse, and Roots and Wings. However, these designs have largely not arisen through a careful examination of the changing educational needs of society and a fundamental rethinking of teaching and learning processes to meet those new needs and thus have largely not “broken the mold” of the current school system. Furthermore, they have often not been implemented as intended and have not produced the desired improvements in student learning (Berends, Bodilly, and Kirby 2002). Nevertheless, these designs do represent “product” knowledge—guidance about what school systems should be like. Other more promising, though less thoroughly worked out, guidance can be found in a vision of brain-based learning systems (Caine and Caine 1997) and the vision of an information age education system (Reigeluth and Garfinkle 1994).

Process Knowledge

Process knowledge can focus on either how to design a new education system or how to help an existing one transform itself. This part of the knowledge base investigates the obstacles to systemic change and the activities that are most likely to lead to a successful change effort. The result is a set of principles and methods for systemic change (see Caine and Caine 1997; Duffy, Rogerson, and Blick 1999; and Jenlink et al. 1996).

There are many approaches to systemic change, none of which have been well-developed, researched, and validated. One approach is for “experts” to develop a comprehensive new system (product) and to have the leadership in a school district purchase the design, complete with implementation plans and assistance (process). This “invented elsewhere” approach has not been very successful for many reasons. One is that people don’t like to be changed. They are much more receptive to change when they are in control of it. Another is that systemic change requires people in a system to adopt different mental models about the system’s activities and structure for the change to be successful (Senge 1990, 2000). This approach overlooks this important principle of systemic change.

A second approach is for a school system to design and implement (process) its own new system (product). One variation of this approach is a

process in which all stakeholders (as opposed to a small group of leaders) are involved in, and are given ownership over, the change process and the nature of the new system. Another variation of this "invented here" approach is a process that entails just a few schools, rather than all the schools, in a district changing. A third variation is to create several autonomous schools within a building and initially change only one of those schools-within-a-school, as opposed to changing the whole school building. This approach has only recently begun to be tested but appears to be promising.

Regardless of such variation, some principles appear to have empirical support for the "invented here" approach. The following is a small sample of such principles (see Caine and Caine 1997; Duffy, Rogerson, and Blick 1999; Jenlink et al. 1996):

- Systemic change should not be undertaken unless the district is at a sufficient level of readiness for systemic change. Time can be spent helping to build such readiness.
- The school district's organizational design must be changed from a bureaucratic one to a participative and collaborative one early in the change process. This entails using principles of transformational leadership.
- A facilitator experienced in the process of systemic change should be used.
- Effort should be focused primarily on helping stakeholders (particularly those most responsible for implementing the new system) to evolve their thinking or mental models about education.
- The school district (including the community) must be the unit of change.
- Learning must be at the center of the change effort.
- Change must occur simultaneously in the core work process, internal social structure, and community relationships.
- Efforts should be made early to build political support for systemic change.
- The superintendent and teachers' association president must provide early advocacy for the change effort.
- A leadership team should be created to provide political support for the change effort.
- A school design team should be formed to lead the design work. It should be comprised of seven to nine people from all groups who will be affected by the change (teachers, parents, students).
- No one should be forced to change.

