Comprehensive Systems Design: A New Educational Technology

Edited by

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Springer-Verlag
Berlin Heidelberg New York London Paris Tokyo
Hong Kong Barcelona Budapest
Published in cooperation with NATO Scientific Affairs Division

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A Systems View of Restructuring Education

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Abstract: Education is viewed more broadly than schools only. An educational system consists of four basic kinds of components: teachers, students, content and contexts. Six types of diadic relationships exist among these four components, as well as those between an educational system and its environment. To restructure an educational system is to change one or more of these seven basic relationships. Extant examples of these relationships are described, which are followed by examples of how they might be changed. Since form follows function and function follows aim, communities should begin by addressing the content component. Once content aims are clarified, then each community should ask: Who are the teachers, who are the students, and what are the contexts needed to bring about those aims?

Keywords: educational system, general systems theory, educational relationships, community

Should We Restructure Schools or Educational Systems?

Schools are one way that education can occur, but not necessarily the only way or even the best way. To limit ourselves to making changes in the structure of schooling will not solve current problems in education *if* those problems are due in part to conditions beyond the schools themselves. It makes more sense to consider education, and more specifically educational systems.

Education consists of teachers, students, content and contexts [1, 2]. Simply, for it to be education there must be a *teacher* who intends to guide, a *student* who intends to learn, *content*--that which is to be learned, and a *context*--the immediate setting necessary to support the guidance and learning. Education does not occur in a vacuum, however. It occurs in an *environment* that consists of a surrounding community and its culture. Nowadays communities exist within states and nations. The reasoning behind this notion of education is as follows:

1. Education does not occur without a teacher. The teacher is the one who guides or leads. To guide does not necessarily mean to instruct directly (e.g., to present information, give feedback, demonstrate, evaluate student learning). For example, in a Montessori classroom students often interact with, and learn by means of, the curriculum materials and context. Direct instruction from a Montessori teacher occurs relatively infrequently [3].

2. Education cannot occur without a student, one who intends to learn, to follow a guide. According to Steiner, if a student does not intend to learn, but nonetheless follows unwillingly, it is not education [1]. Furthermore, students should not be confused with learners. Learning can occur without guidance, such as trial-and-error learning. Learning can occur by accident as well. Such learners are not students. Rather, in education students try to learn under the guidance of a teacher.

3. Education cannot occur without content. The content is what is to be learned, that with which students interact as they construct their personal understandings, values and beliefs in their attempts to learn. The content is that which is shared between successive generations of conscious beings, which cannot be shared by physical procreation. The content is the substance of psychical procreation. The content need not be constrained to typical subjects such as reading, writing and arithmetic, or history, physics and geography.

4. Education cannot occur without a context that supports teaching and learning activities. Education is bound in time and space. It occurs in a setting that may include persons other than teachers and students, as well as places and things. The context need not be schools or school districts, however. Education can occur at home, for example, where parents teach their children how to cook. Education can also occur in the streets where a gang leader instructs a member on how to hot-wire a car in order to steal it. Education can occur in a church, for example, where a pastor attempts to bring a person to believe certain religious tenets.

5. Finally, education normally occurs within an environment that is *beyond* the immediate context for guidance and learning. There is a surrounding society and culture, of which education is one vital enterprise, but not the only one. A local community normally constitutes part of the environment of education, and that community exists within a state or nation.

Thus, education is not viewed narrowly as the which occurs in public or private schools, but in its most fundamental sense. This is the *epitome* of education. This view of education is essentially that put forth by Elizabeth Steiner and George Maccia [1, 2].

Structure of Educational Systems

From general systems theory, a system is defined by Ludwig von Bertalanffy [4] as "elements standing in interaction," or more precisely as a group of two or more components with at least one affect relation that has information [2].

When we refer to the organization or structure of something we are concerned with the nature of the parts or elements and how they are connected to each other, or fit together to make a whole. Given the epitome of education, it follows that an educational system consists of four

basic kinds of elements or components (*A-F*). The seventh kind of relationship is that between the educational system and its environment (*G*). See Figure 1.

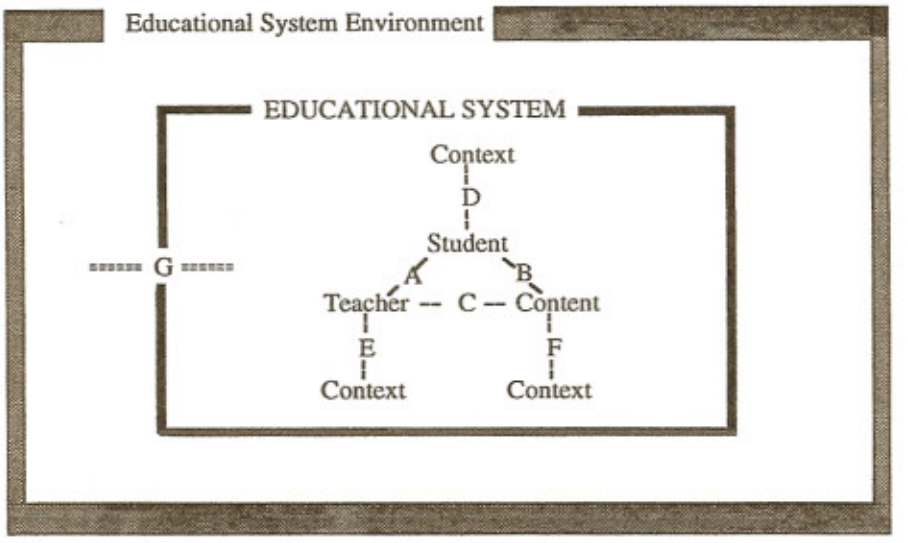

Figure 1: The Seven Fundamental Relationships in an Educational System

Therefore, *when we refer to restructuring education, we should be concerned with changes in properties of one or more types of components and one or more of the seven basic relationships in every educational system.* This is the guiding conceptual model that I propose for thinking about restructuring education. It is important to note that when I refer to an educational system, I mean it in terms of the essence of education, not necessarily in the sense of *existing* school systems, such as those typical in the U.S. today. A school district consisting of school buildings containing classrooms with teachers and students is merely one way that an educational system can be physically structured and organized.

Some Examples of the Seven Basic Relationships in Education

If we adopt the systems model proposed in Figure 1, this can serve as a conceptual framework for organizing our thinking about typical examples of relationships in current educational systems. In the subsequent section we will consider examples of significant *changes* in these relationships--i. e., restructuring.

A. Teacher ⇄ Student Relationships. Typical kinds of current relationships between teachers and students include:

- teachers present information aurally and visually to groups of students;
- teachers often assign the same readings and exercises to an entire group of students;
- teachers grade student homework and tests, and provide feedback on their learning progress;
- teachers supervise student seat work when not directing group activities in the classroom;
- teachers verbally answer student questions;
- teachers seldom individualize instruction because it is impractical under current conditions;
- teachers discipline students who misbehave;
- students ask teachers questions when they do not understand or they get stuck on some learning task;
- students listen to and watch teacher lectures and demonstrations;
- teachers frequently decide when and how long students are to learn various parts of the curriculum;
- most communication between students and teachers is face-to-face and to a lesser extent by writing on paper;
- teachers and students typically spend a limited amount of time together in a teaching-leaning relationship, usually an academic year (9 - 10 months) in most public schools.

B. Student ⇄ Content Relationships. Examples include:

- students too often find subject matter to be meaningless, apparently disconnected with real purpose in life;
- student interaction with content is often passive (e.g., reading, watching and listening);
- students frequently deal with content which is in abstract or symbolic form (i.e., written/spoken words), and less often with content which is in iconic, representational or concrete form;
- students typically encounter content that is a static representation of knowledge, not dynamic or changing as knowledge or events change;
- students often do not choose what content to learn, when to try to learn it, how long to spend on it, or how deeply to delve into it;
- since the rate at which learning objectives are undertaken is externally paced much of the time, many students do not solidly master those objectives;
- many students are not enthusiastic the subject matter they are expected to learn--too often they are bored and alienated.

C. Teacher ⇄ Content Relationships. Some typical examples:

- teachers themselves have previously learned most subject matter during their own formal education, including college or university study; afterwards they are mostly on their own for further learning;
- teachers themselves have had past relationships with content similar to those described for students immediately above (*B*);
- teachers have little control over what content is to be covered and when; commercial publishers, state and local textbook adoption agencies, school boards and school administrators make most of the choices;
- teachers often use learning materials produced externally, such as textbooks, workbooks, films, videotapes and computer courseware;

D. Student ⇄ Context Relationships. Typical examples:

- students attend class in rooms, usually in a large school building with literally hundreds of other students;
- students spend much of their time as a member of a group of other students who are in the same grade and are about the same age;
- schedules, bells and the calendar govern teaching-learning activities--students attend class beginning in the morning and ending in mid-afternoon, five days a week, and seldom during the summer or weekends;
- students read considerable amounts of printed material;
- students write/draw with pencils and paper;
- students often sit at desks oriented to the front of the room;
- there is typically little private storage space for student personal effects, textbooks, notebooks, and the like except for a student's desk or hallway locker;
- students are mostly isolated from the rest of the world while in school (i.e., from the community and from telephones, televisions and computer networks).

E. Teacher ⇄ Context Relationships. Some examples:

- teachers work in a classroom, typically one teacher to a room with about 20-30 students at any given time;
- teachers are isolated by and large from the rest of the world while at work;
- teachers are hired, supervised and fired by principals, superintendents and/or school boards;
- teachers have limited opportunities to discuss their work with other teachers;
- teachers often present information using chalkboards and overhead projection;
- teachers grade student work with "red ink" on paper;

- teachers often spend additional time at home--outside of regular school hours-preparing for class and grading student homework and tests;
- teachers seldom work with students outside the school setting--e.g., at home or in the community;
- there is typically little private storage space beyond a desk for keeping a teacher's professional materials in a classroom--yet a teacher's "office" is her classroom.

F. Content ⇄ Context Relationships. Some examples:

- much content is embodied in print format on paper (in texts, workbooks, dictionaries, encyclopedias and periodicals);
- most content is static, not dynamic in form;
- educational content is slow to change, even after knowledge changes;
- much content is in a verbal, abstract form--content is less often embodied in iconic, representational or concrete format;
- much content is visual in nature, less often auditory, and seldom engages touch, smell, taste or kinesthetic senses.

G. Educational System ⇄ Environment Relationships. Typical kinds of current relationships between educational systems and their environments:

- there is little communication with or participation by parents or other community members during formal teaching-learning experiences (in school);
- students and teachers have to physically *go* to school to *be* there;
- students only attend for a limited time period (not in evenings, on weekends, during summers), many are bussed, and all basically come and go at the same times;
- students only attend elementary and secondary schools between 5 and 18 years of age (K-12); most community members are excluded from participation in formal education (not only as students, but also as guests or teacher helpers);
- teachers are certified and licensed by state agencies or governmental ministries of education;
- most formal educational activities occur in schools, not out in the community itself;
- a school board, elected from and by the local community, monitors the administration and operation of the educational system;
- curriculum materials are selected primarily from those made available by commercial publishers or manufacturers (text books, laboratory equipment);
- educational systems have few communication channels with the rest of the world--e.g., few telephones, radios or televisions, little or no computer network access nor TV cable or satellite access;
- educational systems are highly centralized--it is difficult for community members to exert much direct influence over what their educational system becomes; the channel between

parents and teachers is weak, since teachers must march to the tune of their administration's drummer.

Examples of How Educational Systems Could Be Restructured

There are many possible ways that educational systems could be restructured. In order to bring some order and rigor to the issue of restructuring, I have attempted thus far to show the value of using basic concepts from general systems theory (system, components, component relationships, system environment) and from educational theory (teacher, student, content, context). Seven fundamental kinds relationships were identified (see Figure 1). I then listed above a number of typical extant relationships in these seven categories, which exemplify those basic concepts from systems theory and educational theory. Now I will list a few examples of significant changes in those relationships--i.e., educational restructuring. This discussion is meant only to be illustrative, and *not necessarily an argument that we should make such changes*. The manner in which I believe we should go about restructuring is discussed in the final section.

A.Examples of changes in teacher ⇄ student relationships. If technology is used to deliver instruction to students (e.g., computer-based tutorials, simulations, guided-practice exercises, tests, interactive video, hypermedia), then several basic changes could take place. First, a student would have a multitude of teachers, not just one or a few at some point in time. Each of those teachers would be communicating with students via the technology as authors of computer-based learning materials in which information is presented, practice with feedback is provided, and learning achievement is assessed. Thus, this kind of interaction between teachers and students would be indirect, not face-to-face.

On the other hand, a student's "executive" teacher could establish a different kind of relationship with the student, since the teacher would be freed from spending so much time in the role of an information provider to groups of students. The executive teacher would then have more time to establish with each student an individual plan of instruction and learning. Instruction would then be truly individualized, since not all students in a group would be doing basically the same activities at the same time. The executive teacher would be more like a manager or supervisor of a student's learning experiences. The executive teacher would also need to be available to answer student questions and deal with learning difficulties that were not anticipated or handled sufficiently in the technologically-mediated learning experiences. The executive teacher might also have more time to get to know students personally and listen to what is on their minds.

B. Examples of changes in student ⇄ content relationships. Students could become more actively engaged in learning, if they were to interact with the technologically-mediated learning materials. Well-designed materials would provide students with numerous opportunities to respond and provide immediate, corrective and informative feedback. Student learning would be less passive, compared to reading a textbook or writing with pencil and paper. Students could have more control over the pace of their learning experiences, since group pacing would be less frequent. In addition, students could spend as much or little time as needed to master particular learning objectives. The criterion of when to move on to subsequent objectives would not be the average rate at which a group of students can learn, but rather individual student learning achievement. Students who are actively engaged and who experience success more often might also be more enthusiastic towards subject matter. Finally, if the content is technologically mediated, then it becomes possible to present it in aural as well as visual modalities; content could be embodied more often in iconic and representational forms (e.g., by interactive video); and content could be represented dynamically--compared to reading static print or viewing still pictures of some process or procedure in a textbook.

C. Examples of changes in teacher ⇄ content relationships. Teachers themselves would be able to further their own learning (as students) while professionally employed as teachers, if they have the time to learn and the opportunity. There is no reason why teachers could not learn by the same kinds of technologically-mediated materials as would students, as discussed above. Teachers' learning would not essentially end when they graduate from a college or university. Teachers might also design and produce instructional materials themselves. With today's computer-based authoring systems, desk-top publishing, video technology, and so forth, teachers could be developing some of the content for their educational system--rather than relying almost exclusively on external commercial publishers.

D. Examples of changes in student ⇄ context relationships. One major change that could occur, particularly with older students beyond the primary level, might be that students would not have to *go to school* as much in order to get an education. By this, I do not mean they would not be spending as much time learning, but that learning could occur elsewhere. For example, if a student had access to computer technology at home through which relevant learning experiences were provided, then why would he or she need to go to school to do essentially the same thing? Lord Walter Perry, former vice-chancellor and one of the founders of the Open University in Great Britain, predicts that in the twenty-first century we will be forced into this kind of learning pattern at home [5]. The reason is simple according to Perry: it will become too expensive to transport students to school on a regular basis because of oil shortages.

E. Examples of changes in teacher ⇄ context relationships. One significant change that could occur is that teachers could become technologically linked to the rest of the world. They need not be as isolated as they typically are in classrooms. Teachers could access information electronically. They could not only communicate with each other, using electronic mail, but with students and parents as well.

It is currently possible that teachers could teach from their own homes. If teachers and their students have computers and telephones at home, then audio-graphic technology would allow live interaction between teachers and students. The sound would come through the telephone speakers, and students would see text and graphics on their computer screens--the teacher's electronic chalkboard, so to speak, during a conference call.

F. Examples of changes in content ⇄ context relationships. As alluded to earlier, content can be presented in a variety of formats via multi-media. Dynamic processes can be illustrated, since content is not temporally bound as it is in static print, illustrations and pictures in a textbook. Generally speaking, content--whether text, pictures, video, sound, graphics or animations--can be digitally or analogically encoded and stored in electronic, magnetic and optical technologies. This encoded information can be transmitted literally around the world in a matter of seconds. The electronic global village that Marshall McLuhan envisioned is now a reality. A recent example dramatically reminded us of this: *CNN* brought "live" to the rest of the world the bombing of Baghdad, Iraq, when the war in the Persian Gulf began in January, 1991.

G. Examples of changes in educational system ⇄ environment relationships. Finally, telecommunications technologies may significantly change the kinds of relationships between educational systems and their environments. Previously, educational systems have typically isolated themselves from their surrounding communities rather effectively. School districts in the U. S. became rather large and centralized during consolidation efforts in the mid-twentieth century. Consequently, most students have since been bussed to and from school during well-specified periods of time. Telecommunications technologies could change this, making educational systems much more open and flexible. Some aspects of formal education could be carried out in the home setting or possibly other non-school settings in the community, as discussed above. Moreover, even when students and their teachers are in school settings, matters of the community and persons can be "brought in" to the classroom by telecommunications.

There could be a greater variety of teachers and students in a restructured educational system, as it becomes more integrated with its environment. For example, the same educational resources that normal K-12 students use could also be used by other community members

during "off hours"--i.e., they could be students (and teachers) during evenings and on weekends.

I have discussed only a few possible changes in the seven kinds of relationships in an educational system. This discussion was only meant to be illustrative, not a forecast. I next discuss where I believe educational restructuring should begin.

Form Follows Function, Function Follows Aim

It makes little sense to consider changing the structure of educational system components and component relations before clarifying the aims or purposes of such an organization. Structural changes should not dictate the goals of an educational system, rather the goals should drive the kinds of changes made. Moreover, any changes that are made should always be evaluated with respect to whether they lead to the intended goals.

I believe that the primary aim of an educational system should be to help students succeed in their attempts to learn. If this premise is accepted, then the next question is: To learn what? What content do we want students to come to know, to feel, and to value, and how can we tell that they do? Therefore, we should begin by first addressing the content component of an educational system.

In order to help break bounds with traditional subject matter distinctions such as reading, mathematics, physics, social studies, and the like, I propose to address cognitive content from an epistemological perspective--by looking at the kinds of knowledge we hold in consciousness. From an epistemological perspective, there are four kinds of knowing [6, 7]:

- knowing that one (qualitative knowing):
  - recognitive
  - acquaintive
  - appreciative
- knowing that (quantitative knowing):
  - conceptual
  - theoretical
  - criterial
- knowing how to do (praxiological knowing):
  - procedural
  - performative
- knowing what to do (inventive knowing):
  - innovative
  - creative

1. Knowing that one. Qualitative knowing is cognition of uniques, of particulars, of one-of-a-kind. For example, we can *recognize* the Washington Monument, the current mayor of our city, the house or dwelling we live in, the principal of our school, etc. We can *be acquainted* with the layout of the streets and roads where we live, with the Bill of Rights, with particular people we know, with particular problems in our environment such as the huge oil spill in 1991 during the War in the Persian Gulf. We can appreciate particular persons, places or things. We can *appreciate* the Declaration of Independence, the quality of a particular performance of Mozart's Symphony #41, the design of a particular building, and so on.

2. Knowing that. Quantitative knowing is cognition of generalizations, of that which is true of many persons, places, things, events, relations, and the like. We hold *concepts, theories* and *criteria*. Conceptual knowing (Maccia's instantial knowing) involves being able to categorize or classify things. We hold concepts such as eats, dogs, animals, people, oxygen, water, life, death, property, money, food, etc. We hold theories such as Mendelian genetics, democratic governance, Newton's laws of gravitation, natural selection and evolution, and the like. We hold criteria such as truth, beauty, goodness, effectiveness, parsimony, well-being, justice, and benevolence towards humankind.

3. Knowing how. Praxiological knowing is cognition of means to achieve ends. We can know procedures and we can carry them out. We can solve quadratic equations, read a book, decompose water into hydrogen and oxygen, construct a house, build a superhighway, play a clarinet, play tennis, perform open-heart surgery, repair electronic circuit boards, or know how to bring about learning--i.e., how to teach.

4. Knowing what to do. We can innovate and we can create. We can express ourselves in writing, we can paint a picture, we can invent a car that tuns on water and electricity, we can make a movie, and we can create a new kind of educational system.

In summary, instead of thinking of subject matter as reading, writing and arithmetic, I propose that content be structured epistemologically. That is, *students should learn to specify (qualitatively), to generalize, to perform, and to invent--and that there should be balance among these four areas. Furthermore, I believe that the particular emphases in each of these four areas should be decided by those in, around, and who are served by a particular educational system--i.e., by its community.*

As a community specifies the particular content aims in these four areas, then it becomes possible to consider the remaining three components of the educational system. Who are the students, who are the teachers, and what are the contexts needed to bring about those content aims?

Rejuvenation of Communities

One of the things James Coleman has noted is that in modern times we have lost our sense of community [8]. One of the social functions our new educational systems must encourage is to bring people together again on a regular basis--the young, the old, the people who constitute a community--notjust the parents of children in school, their teachers and administrators, but everybody in a community. Communities of people should not be conflated with geographic groupings necessarily. A city or town may have many communities. And so can rural areas.

Since one of the primary aims of education is to prepare students to participate in a community, then it only makes sense that we involve each community in consideration of what its educational system becomes. This is where we should begin.

Notes

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