An Educational Technology Curriculum Emphasizing Systematic, Scientific Problem Solving

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It should not be surprising that the educational technology curriculum developed for a university in the Netherlands differs markedly from its counterparts in North America. After all, the structure of university degrees and programs differ as do the historical backgrounds of the fields of education and educational technology in the two regions. Perhaps most importantly, the program described here was built systematically from the ground up using a unique conceptual scheme, a scheme that truly places systematic, scientific problem solving at the core of the educational technology process.

SETTING

Technische Hogeschool Twente, known in English as Twente University of Technology (TUT), was founded in 1962 primarily as an engineering school. A new master plan drafted in 1969 called for expansion of the University into applied social sciences areas. Later, departments of business administration and public administration were added. In 1976 a planning committee was appointed to study the feasibility of starting a program that would combine the traditional social science approach of education, exemplified in departments of pedagogy and psychology, with the technological or engineering approach to solving problems.

By the end of 1978 the planning committee had completed its proposal for the establishment of a new program: Toegepaste Onderwijskunde (literally, Applied Educational Science), known in English as Department of Educational Sciences and Technology (DEST). It was approved in 1979. Curriculum development began then and continued intensively until September 1981 when the first wave of 50 freshmen was admitted.

STRUCTURE OF DUTCH UNIVERSITY PROGRAMS

The DEST program is a 4-year post-secondary program, but it is not directly equivalent to an American undergraduate bachelor's degree program. First, entrants into a Dutch university are graduates of a highly selective pre-university high school. They are academically further advanced than American college freshmen and more homogeneous as a group. Second, the Dutch university curriculum moves students rapidly into specialized studies in the "major" area, enabling them to attain academic depth equivalent to a U.S. master's degree within their 4-year program.

Reforms instituted in 1982 restructured all university programs in the Netherlands into a uniform pattern. The first year, known as "propedeutics" or preliminary year, lays a foundation for later specialized studies, gives an overview of the "major,"

and gives a basis for the students and his or her major department to decide whether he should continue.

The next 3 years—the "main phase"—consist of in-depth studies in the major area. At the end of the "main phase," the student receives the degree of "doctorandus" (drs.), roughly comparable to a master's degree in the U.S. This 4-year program is known as the first phase of the university curriculum. Some students—typically up to 25%—are allowed to continue for an additional 1 or 2 years (the second phase) to achieve depth specialization in an aspect of the major field, e.g. as a researcher. This phase yields a certificate, not a formal degree. A small number continue on to pursue the Ph.D. degree ("doctor"), which requires only dissertation work.

EDUCATIONAL TECHNOLOGY IN THE NETHERLANDS

The term "educational technology" does not have the same connotation in the Netherlands as it does in the United States or other places that subscribe to the AECT definitions. In North America, educational technology has grown from the employment of audiovisual media and mass communications technology in education on the one hand and the development of systematic methods to plan and carry out instruction, such as programmed instruction, on the other. One might say that the roots of educational technology in North America are in the physical sciences. Gradually, different fields became interconnected and developed into the more general field of educational technology. According to the AECT definition, many aspects of education are more or less involved in the field of educational technology, with the systematic approach as an organizing principle to solve educational and instructional problems. Nevertheless, there is a lasting effect from the roots of the field, which may be characterized by saying that in many ways North American educational technology is still relatively product oriented.

In the Netherlands, and in Europe generally, the starting point was different. In the Netherlands, until recently, there existed no separate curriculum to prepare academics to be practitioners in the field of education. One could enter the field via pedagogical studies, with an emphasis on ethics and philosophy, or via sociology or psychology, with an emphasis on empirical research, for example, for psychological testing of students. Educational technology has lately become a third perspective on education and instruction. Media and other technical means were never of main interest for people educated in a social science approach to educational problems; they were treated as stepchildren by traditional educators apart from the few people directly concerned with media. As yet, in the Netherlands there exists no large professional association devoted exclusively to educational technology.

The new Department of Educational Sciences and Technology (DEST) at TUT is the first department in a Dutch university where educational technology is explicitly a main interest in the curriculum. Other programs for preparing educators are still oriented predominantly toward social sciences.

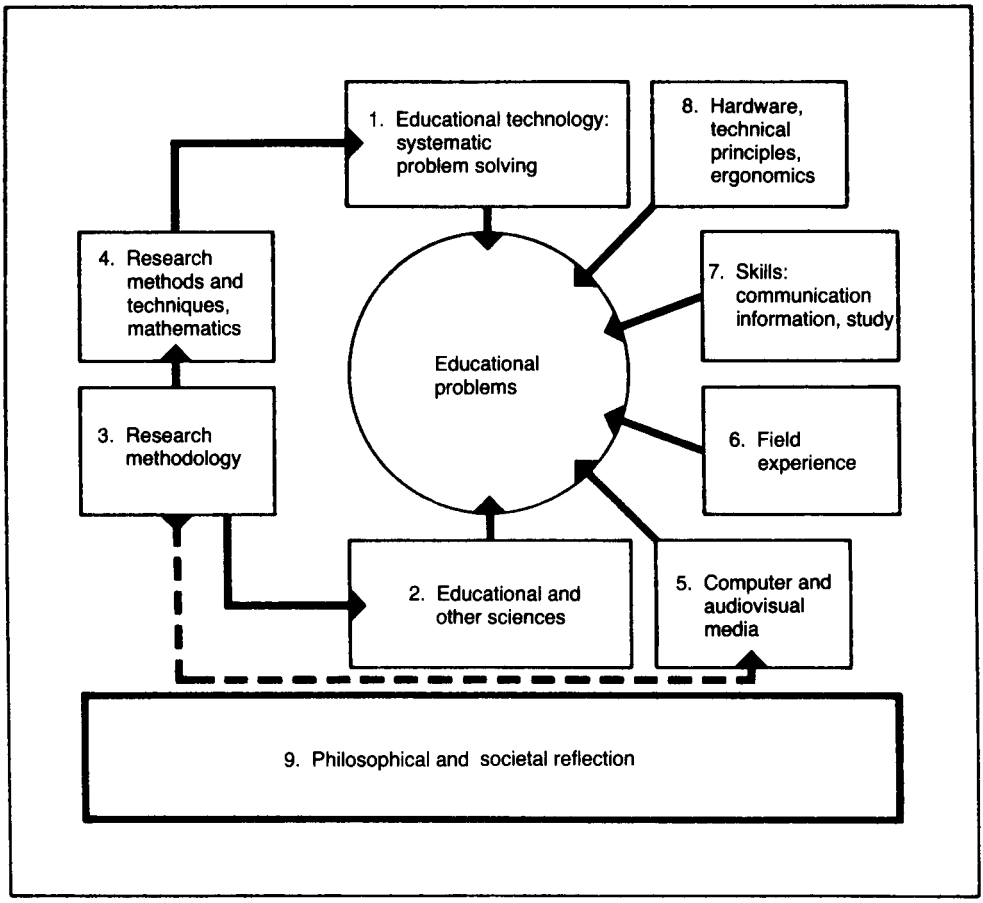
From the above descriptions, it may now be clear how and why the program that emerged at TUT differs in several ways from North American ones. This background will give perspective to the conceptual scheme around which the DEST curriculum was shaped.

AIM OF THE DEPARTMENT

The aim of DEST is to educate students to be able to solve problems arising from educational practice. The emphasis is on employing relevant scientific knowledge and applying systematic strategies for problem solving and appropriate methods and techniques. From this aim it can be concluded that DEST does not provide a traditional teacher-training program nor does it train for fundamental research as such.

DEST students are educated for careers in which the solving of complex problems within educational practice is central. It follows that a DEST graduate must (a) possess applicable knowledge from several disciplines fundamental to education; (b) be able to apply appropriate technological principles, methods, and techniques; and (c) be

FIGURE 1
Structure of the DEST Curriculum



aware of his/her societal responsibilities—that is, foreseeing the side effects of one's solutions.

OUTLINE OF THE CURRICULUM

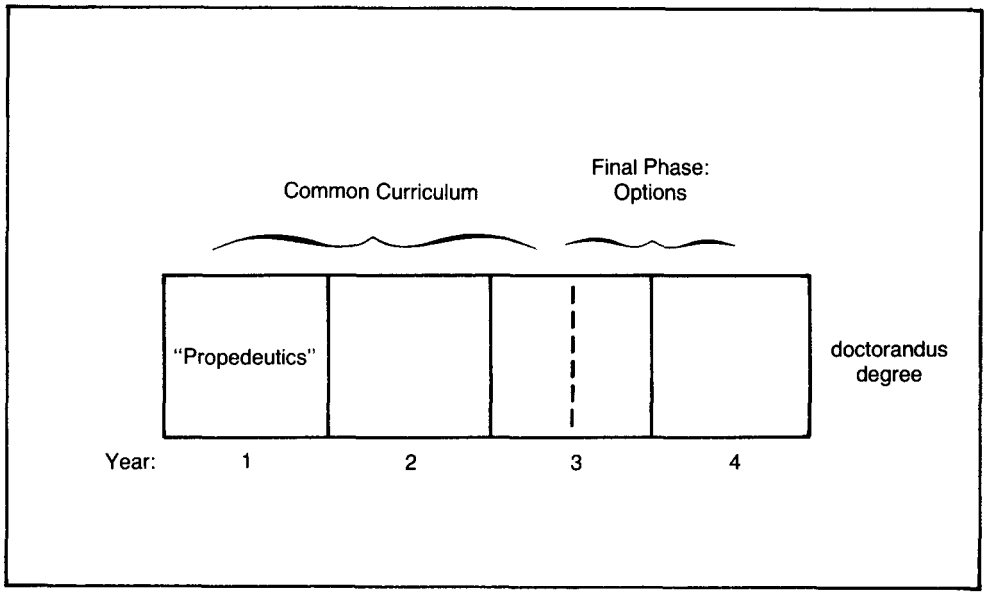
Early in the curriculum development process, the planning group enumerated a set of elements representing the knowledge and skills that were the presumed goals of the DEST program. These elements were arranged into a conceptual scheme, shown in Figure 1. At the core of this conceptual scheme is the idea of applying a systematic problem-solving approach to educational problems. The surrounding elements describe the supporting knowledge, skills, and techniques needed to carry out that basic mission. They will be spelled out in greater detail below as each part of the curriculum is described.

The conceptual scheme shown in Figure 1 has implicit a number of broad program goals. During the curriculum development process, coherent goals were clustered together, and relevant subject matter content was fleshed out to form courses. Actually, this description applies only to those courses that are compulsory for all DEST students—the common curriculum. As shown in Figure 2, students spend the first 2½ years in a common curriculum comprising the core courses required for all; for the Final Phase—the last 1½ years—there are broad options available from which students may draw up their own curriculum.

THE COMMON CURRICULUM

As noted earlier, the DEST curriculum is shaped around preparing practitioners who

FIGURE 2
Chronology of the DEST Curriculum in the First Phase



are able to develop solutions for *educational problems* (the central circle in Figure 1). The solutions will take the form of products, means, procedures, processes, techniques, or systems.

The way of developing solutions is systematic; it can be described as a cycle with phases such as needs assessment, design of a prototype, evaluation, and implementation. This is a general *educational technology* model for structured problem solving (block 1 in Figure 1). Each phase has its own specific methods and techniques. Each class of problems has its own elaboration of the general model and, consequently, its specific choice of methods and techniques. One of the aims of DEST is to improve and to extend educational technology. Courses in educational technology will be a substantial part of the common curriculum—17% of the credit hours. These courses are especially characteristic of DEST, and in these courses DEST will distinguish itself from other programs in the Netherlands in which educators are prepared (e.g., within departments of pedagogy or psychology).

The first educational technology course is in the very beginning of the first year. It introduces students to the general model for educational problem solving. The second educational technology course, taken at the end of the initial year, broadens the understanding of the general model by demonstrating and providing experiences with real-world problems. In the third course of this sequence, taken during the second year, specific methods and techniques of needs assessment, design, development, evaluation, and implementation are discussed and practiced in depth. The fourth course, taken during the third year as closure of the common curriculum, emphasizes practice in applying problem-solving skills.

During the educational technology courses, project work provides ample opportunity for practice. The fourth course consists almost entirely of project work. As an extra feature, this course will give students a chance to orient themselves to the subdomains of DEST, within one of which they will spend the Final Phase of their study.

Educational problems tend often to be people problems, so in addition to technological skills the EST practitioner must understand the dynamics of human interactions; therefore, *educational, social, and other relevant sciences* will be an essential part of the common curriculum (block 2 in Figure 1). Courses in the educational and social sciences occupy 25% of the common

curriculum, and half of that portion is devoted to social sciences, particularly psychology. Depending on the candidate's topic for project work at the conclusion of studies, he or she may take extra courses in this area.

Fairly often it will happen that a practitioner will conclude that knowledge gained or the available handbooks are not adequate sources in a given problem situation. In such cases, the practitioner must be able to generate this scientific knowledge either by doing research or by judging whether the results of research by others published in journals and reports is reliable and useful. Therefore, the DEST graduate has to have some knowledge of and experience in *research methodology* and the *methods and techniques* used therein (blocks 3 and 4 in Figure 1).

Because educational research methods and techniques are largely rooted in statistics and probability theory, which in their turn are founded in mathematics, it was decided to add some *mathematics* to the DEST curriculum to bridge the gap with mathematics at the level of pre-university school. In Figure 1, an arrow is drawn from block 4 to block 1 because research methods and techniques are also important tools in solving problems, especially in conducting evaluation. Altogether, blocks 3 and 4 constitute 19% of the common curriculum.

The character of the program dictates that substantial attention be paid to *media*—the computer as well as audiovisual media (block 5 in Figure 1). With many curricular and instructional problems, one can anticipate that media will play an important role because of their varied potentials for delivering instruction. The common curriculum calls for practice in audiovisual media use during the first and second years. Courses and practica running throughout the first 3 years are devoted to study of the computer, not only as a teaching/learning tool but also as a data processing aid. This cluster accounts for 12% of the common curriculum.

Graduates of DEST will cooperate as professionals with other educators, such as teachers and administrators. A condition for a useful and successful functioning is not only an understanding of the national educational system, which is covered in the "educational sciences" courses described earlier, but also an intensive *experience within educational practice* (block 6 in Figure 1). A DEST graduate must know about opinions, problems, and traditions within the wider field of education. Some field experience will be acquired by means of field trips and projects in schools or other field sites. In the common curriculum phase, there is only restricted field experiences, but much more is provided in the Final Phase, especially in the final project.

Certain personal skills are useful both in being a successful student and in being a successful practitioner; these are clustered under the heading of *communication skills, study skills,* and *information seeking skills* (block 7 in Figure 1). Included are library search skills, use of documentation systems such as ERIC, and the like. In the common curriculum, some time is specified for all these skills. Study skills are developed in a short course at the very beginning of the program so that students may profit from those skills throughout their studies. The use of complex information systems is taught in a short course at the beginning of the third year, when students have proceeded far enough in their studies to appreciate the relevance of such skills. To develop the skill of communicating with colleagues and lay people, a practicum on communication skills runs all through the 4 years. It emphasizes oral and written communication and effective functioning within groups.

In courses on media, DEST students will learn about ways of applying media to instruction. The department considers it important that they also know something of the *technical principles of the equipment* they will use (block 8 in Figure 1) so that they are at least capable of communicating adequately with technicians. In the common curriculum, two short courses are included to attain these goals. One of them focuses on ergonomics, dealing with problems concerning people and their work environment; in the realm of instruction, this means adjusting the physical teaching/learning environment to human requirements.

The technological mind set entails a potential danger in that people become so

fixed on searching for means to attain the stated ends that the ends themselves are not critically examined or, in other cases, that undesirable side effects of solutions often occur. DEST considers it very important that students learn to reflect on their professional work. For this reason, a substantial place is reserved in the program for courses on *philosophical and societal reflection on educational research and development activities* (block 9 in Figure 1). In the common curriculum, there are two courses in this domain, covering philosophical perspectives on education, educational research and development, and educational utopias. There is an additional course in the Final Phase, while in the report of the final project, the social impact of the work done has to be discussed.

CURRICULUM OPTIONS

It is not desirable that an initial preparation program should educate specialists for only a small range of jobs or for only one sector of the total domain of education. So the program must contain elements that are fundamental to a wide variety of applications. Yet the planning committee felt that it was important for each student to attain depth competencies in at least one subdomain of the field and should be involved in complex problem-solving activities in that subdomain. The Final Phase—the last 1½ years—are spent on such relative specialization.

This decision leads to a division of the DEST staff into four groups, each group concentrating in their research and teaching on a rather specific subdomain of the field. The criterion for these divisions was not derived from the professional roles of educationists (e.g., developer, researcher, evaluator), nor from the basic disciplines (e.g., psychology, sociology, economics), but from the type of problems educators are confronted with, analogous to engineering departments. The following groups were determined: (a) *instruction*—dealing with problems in the design and implementation of teaching/learning situations and with instructional methods; (b) *curriculum*—dealing with problems in curriculum design, evaluation, and implementation; (c) *instrumentation*—dealing with the use of media, including computers, in education, and also with the physical teaching/learning environment; (d) *administration*—dealing with policy, planning, and management problems in education.

In addition, a group for research methodology and techniques was created. The creation of these groups does not imply that the field should be divided into discrete parts. The initiators explicitly stated that these groups were created to give students identification points for the Final Phase, recognizing that most educational problems demand an approach from several points of view (e.g., from instruction, curriculum, and instrumentation).

THE FINAL PHASE

The Final Phase of the 4-year DEST program will take about 1½ years. The curriculum for this phase is no longer common; there is great latitude for individual choice.

Because of the program's overall commitment to development of applied problem-solving skills, it is appropriate that a major part of the program be devoted to field-based project work. As mentioned above, student effort during the project work is focused in one of the four subdomains of DEST. To encourage thoughtful application of theory and research, a literature review must be part of every project. Since projects should arise from problems in a particular sector of education, a short internship is also part of the project. Altogether, the project work occupies about 50% of the Final Phase.

The other half of Final Phase credit derives from course work, which will be largely chosen in connection with the project work. To attain that purpose, the total package of available courses is broad but with certain constraints. For example, every student has to choose one course within the domain of philosophy and reflection on education and educational research and development. One course must be on educational research methods and techniques, and at least one more must be on educational technology. Besides these, the student may choose at least five courses according to personal interest or preference.

ORGANIZATION OF COURSES AND INSTRUCTIONAL METHODS

It was felt that the organization of the program and the instructional methods employed in it should be consistent with the educational technology perspective. Consequently, the following guidelines were adopted:

- Variety in teaching/learning strategies;
- Alternation of studies between theory and practice;
- Emphasis on project work as a culminating activity;
- Even distribution of student effort over the whole academic year;
- Monitoring of student progress to prevent falling behind;
- Modular course structure for courses in the common curriculum.

As a general pattern, the courses in the first 2 years are built of modules, each requiring about 40 hours of student work. Each module concludes with a test or practical task for assessment. The mastery learning concept is applied as much as possible. This means that tests are followed by rapid feedback leading to remedial work if required; retests are taken after a short time, generally within 2 weeks.

A major rationale for this modular approach is to assist students in making the transition from secondary school to the university. The modules typically represent an independent study mode, but the work pace is guided at the beginning to help students understand the pace required for academic success in the DEST program. As they advance, students assume more and more responsibility for managing their own studies independently.