DOCUMENT RESUME

ED 254 654 CE 040 858

AUTHOR	Daniels, M. Harry; And Others
TITLE	Toward Excellence in Secondary Vocational Education: Developing Pretechnical Curricula. Information Series No. 295.
INSTITUTION	Ohio State Univ., Columbus. National Center for Research in Vocational Education.
SPONS AGENCY	Office of Vocational and Adult Education (ED), Washington, DC.
PUB DATE	85
CONTRACT	300-83-0016
NOTE	57p.; For related documents, see CE 040 854-856 and CE 040 859-860.
AVAILABLE FROM	National Center Publications, Box F, National Center for Research in Vocational Education, 1960 Kenny Road, Columbus, OH 43210-1090 (IN295--$5.50).
PUB TYPE	Information Analyses (070)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	*Career Change; Criteria; *Curriculum Development; *Models; *Prevocational Education; Problem Solving; Secondary Education; *Transfer of Training; Vocational Education
IDENTIFIERS	Excellence in Education; *Generalizable Skills; *Transition Skills

ABSTRACT

This publication provides curriculum developers with a model of a pretechnical curriculum with special emphasis on human factors at the workplace. Section 1 describes this model, the focus of which is self-empowerment, which in turn is related to an individual's mastery of three categories of interrelated skills and knowledge: generalizable, transition, and problem-solving. Section 2 summarizes predictions about the future of work and the needs of employers. The implications of these predictions are identified. Section 3 provides criteria for building a pretechnical curriculum that will be responsive to both the needs of employers and employees. These criteria are utility, personal options, transferability, and psychosocial value. Sections 4 and 5 describe transition skills and problem-solving skills and their applications. Models for handling transitions and for problem solving are provided. Section 6 describes how the pretechnical curriculum may be implemented in the schools. Topics include responsibilities of academic and vocational educators, an implementation structure, responsibility for teaching generalizable skills, an instructional strategy for vocational educators, and resources and guidelines for implementation of the transition model. (YLB)

ED254654

Information Series No. 295

TOWARD EXCELLENCE IN SECONDARY VOCATIONAL EDUCATION: DEVELOPING PRETECHNICAL CURRICULA

M. Harry Daniels
Joseph S. Karmos
Cheryl A. Presley
Southern Illinois University

The National Center for Research in Vocational Education
The Ohio State University
1960 Kenny Road
Columbus, Ohio 43210-1090

1985

CE 040 858

THE NATIONAL CENTER MISSION STATEMENT

The National Center for Research in Vocational Education's mission is to increase the ability of diverse agencies, institutions, and organizations to solve educational problems relating to individual career planning, preparation, and progression. The National Center fulfills its mission by:

- Generating knowledge through research
- Developing educational programs and products
- Evaluating individual program needs and outcomes
- Providing information for national planning and policy
- Installing educational programs and products
- Operating information systems and services
- Conducting leadership development and training programs

For further information contact:

Program Information Office
National Center for Research
in Vocational Education
The Ohio State University
1960 Kenny Road
Columbus, Ohio 43210-1090

Telephone: (614) 486-3655 or (800) 848-4815
Cable: CTVOCEDOSU/Columbus, Ohio
Telex: 8104821894

FUNDING INFORMATION

Project Title:	National Center for Research in Vocational Education, Applied Research and Development
Contract Number:	300830016
Project Number:	051OC40060/051OC40061
Act Under Which Funds Administered:	Education Amendments of 1976, P.L. 94-482
Source of Contract:	Office of Vocational and Adult Education U.S. Department of Education Washington, D.C. 20202
Contractor:	The National Center for Research in Vocational Education The Ohio State University Columbus, Ohio 43210-1090
Executive Director:	Robert E. Taylor
Disclaimer:	This publication was prepared pursuant to a contract with the Office of Vocational and Adult Education, U.S. Department of Education. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their judgment in professional and technical matters. Points of view or opinions do not, therefore, necessarily represent official U.S. Department of Education position or policy.
Discrimination Prohibited:	Title VI of the Civil Rights Act of 1964 states: "No person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance." Title IX of the Education Amendments of 1972 states: "No person in the United States shall, on the basis of sex, be excluded from participation in, or be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance." Therefore, the National Center for Research in Vocational Education Project, like every program or activity receiving financial assistance from the U.S. Department of Education, must be operated in compliance with these laws.

TABLE OF CONTENTS

TABLE OF CONTENTS-Continued

FOREWORD

Toward Excellence in Secondary Vocational Education: Developing Pretechnical Curricula takes a close look at prerequisite knowledge and skills needed for success in technical education programs. This view of pretechnical education emphasizes generalizable, transition, and problem-solving skills and knowledge necessary to prepare youth and adults for job changes they are likely to experience in their working life.

This publication is one of seven produced by the Information Systems Division of the National Center. This series of information analysis papers should be of interest to all vocational and adult educators, including Federal and State agency personnel, teacher educators, researchers, administrators, teachers, and support staff.

The profession is indebted to Dr. M. Harry Daniels, Associate Professor; Dr. Joseph Karmos, visiting Associate Professor; and Ms. Cheryl A. Presley, Researcher, in the Department of Educational Psychology at Southern Illinois University for a comprehensive review of these essential elements of pretechnical education. Currently, the authors are developing a model for introducing change skills instruction into vocational programs.

Dr. Michael J. Dyrenfurth, Professor of Industrial Education, University of Missouri; Dr. David C. Bjorkquist, Professor and Head, Division of Industrial Education, University of Minnesota; and Dr. Frank Pratzner and Dr. Dan Fahrlander, Senior Research Specialists, of the National Center for Research in Vocational Education contributed to the development of the paper through their reviews of the manuscript. Staff on the project included Dr. William Hull, Senior Research Specialist; Dr. Oscar Potter, Graduate Research Associate; James Belcher, Program Associate; and John Tennant, Graduate Research Associate. Janet Ray served as word processor operator for this manuscript. Editorial assistance was provided by Janet Kiplinger and Judy Balogh at the National Center.

Robert E. Taylor
Executive Director
The National Center for Research
in Vocational Education

EXECUTIVE SUMMARY

Today, most people are ill prepared to cope with workplace changes that occur during their lifetimes. Rapid technological advances have transformed not only present work life, but have drastically altered expectations for the future. Occupational education requires pretechnical knowledge and skills. Pretechnical education is defined in this paper as basic generalizable skills, transition skills, and problem-solving skills. The acquisition of these skills allows an individual to enter available occupations and to benefit from training on the job for progression into higher-level occupations. These skills are viewed as the best preparation for work, given the rapid pace of job changes. The essential characteristics of pretechnical curricula described in this paper provide curriculum developers with the basis for designing these curricula. The focus of these curricula is at the secondary level.

Even now, workers are continually confronted with change. Traditional views of labor and management are rapidly changing as the economy moves from an industrial to an informational base. The composition of the work force is changing, too. Technological advances in equipment and techniques are making jobs obsolete. More workers are experiencing the reality of changing jobs or entering retraining programs. The prospect of multiple job changes during the life span is becoming certain. Tomorrow's workers will be confronted with even more changes.

Vocational education always has been influenced by technological innovations that have altered the requirements of occupations and work environments. In fact, a central feature of vocational education programs typically was specialized job skills training. Vocational training programs have been most effective when they emphasize highly specialized skills that are tied to specific needs of employers, particular equipment, or production processes. Programs of this type have enjoyed a long and strong tradition among vocational educators and, in the past, have often been very successful. Specialized skills continue to be important, but workers must prepare for retraining experiences during their work life. The rapid increase in technological change requires an emphasis on human factors in the workplace.

Human resources are increasingly recognized to be the least understood and most underutilized element in the workplace. Some experts have suggested that the future of the marketplace depends on the ability of business and industry to maximize the personal power of work force members. An increase in personal power is dependent on an individual's ability to learn new ways to adapt to impending change.

Vocational educators must accept new responsibilities for preparing students to work and live in a technological world. In addition to job skill training, vocational educators must now consider two important and related tasks. The first task involves the identification and development of skills needed to prepare individuals for career progression, as well as career entry. Most graduates start with available entry-level occupations, but they must undertake more education, training, and retraining. The second task concerns the integration of that knowledge into an implemented curriculum in the schools. The thrust of this paper is directed toward implementation at the secondary school level. However, implementation of a pretechnical curriculum at the postsecondary level should not be ruled out.

This paper presents a model for a pretechnical curriculum, with special emphasis on human factors at the workplace. The model focuses on *self-empowerment*, or the individual's ability to understand and to deal effectively with events that influence career changes. An individual's self-empowerment is related to his or her mastery of three categories of interrelated skills and knowledge. These form the core of the pretechnical curriculum proposed in this paper. They are as follows:

- **Generalizable skills and knowledge**—skills and knowledge actively used in work performance, that are transferable across jobs and occupations, and that are instrumental to job and classroom success
- **Transition skills and knowledge**—skills and knowledge used to manage life transitions, particularly occupationally related ones such as job loss, job change, promotions, demotions, and so on
- **Problem-solving skills and knowledge**—skills and knowledge employed in the resolution of situations involving interpersonal problems, information and task-related problems, or problems related to people's behavior in cooperative group settings

Core knowledge in these areas precedes and supplements more specialized technical knowledge acquired later during the education cycle. This core knowledge is applicable to a wide variety of jobs and occupations. It can be integrated with scientific concepts underlying the cluster of occupations selected by the student as a career education emphasis.

This publication recommends ways to implement the concepts in this curriculum and confronts issues and problems associated with the introduction of this pretechnical curriculum in vocational education.

INTRODUCTION

The Need for a Pretechnical Curriculum

Basic job skills are a reflection of the American worker's activities and values. For a long time, it has been relatively easy to revise our basic skills needs as technology and society changed. Now changes are occurring so rapidly that predicting lifelong basic skills needs has become very difficult. In fact, change itself has become the only predictable certainty of the future. Already, the ability to deal with change is critical for many Americans. They are now confronting changes in their jobs, changes in their schooling, changes in their personal lives, and changes in the world around them. Contemporary education must provide opportunities for students to learn how to adapt to these changes, and the skills that are needed must be considered basic skills. This publication describes a model for preparing students to adapt and cope with change.

Coping with change requires generalizable skills, transition skills, and problem-solving skills. These areas form the heart of pretechnical education. Acquisition of these skills should allow an individual to enter available occupations and to benefit from training on the job for progression into higher-level occupations. Acquiring pretechnical knowledge and skills begins at a very young age. During elementary school, students use this knowledge to form a foundation for later learning. This paper focuses on the secondary grades as the ones where proficiency in these skills should be evident.

Change has always been central to American life. More than a century ago, de Tocqueville remarked that "the American has no time to tie himself to anything, he grows accustomed only to change and he ends by regarding it as a natural state of man" (Pierson 1938). This social commentary about 19th-century America seems remarkably apt as our Nation approaches the 21st century. Contemporary theorists (Bridges 1980; Gould 1978; Levinson et al. 1978; Moos and Tsu 1976; Schlossberg 1981, 1984; Schneider 1984) have noted that American adults are encountering an increasing number of changes during their life spans that call for new patterns of behavior or for revisions in their perceptions of self and environment.

Even though our predecessors always accepted and adapted to change, they usually had relatively stable life-styles. Contemporary Americans, however, are living in the midst of a technological revolution for which the rate of change is accelerating. They will have to be even more flexible, more versatile, and more adaptable in planning and actualizing their respective careers and lives (Naisbitt 1982; Pratzner 1978). They will have to learn how to learn throughout the rest of their lives. Support for this assertion is as follows:

> We don't believe a high school graduate in 1985 will retire 35 years from now from the same job for which he was hired—during that period he will need to be trained and retrained many times. (Education Commission of the States 1983, p. 14)

> In our view, formal schooling in youth is the essential formulation for learning throughout one's life. But without lifelong learning one's skills will become rapidly dated. (National Commission on Excellence in Education 1983, p. 9)

Learning never reaches a terminal point. As long as one remains alive and healthy, learning can go on and should. (Adler 1982, p. 31)

Educational systems will be called upon to play a central role in educating students who can adapt to the changes that the future holds. Parents will expect schools to provide the skills and strategies that their children will need to survive and prosper with ever-increasing social and technological change as they enter the world of work. In the monograph *Adaptation to Work* (Ashley et al. 1980), it was noted that many workers in the American labor force were unable to adapt to the changes, demands, and responsibilities of work. Business and industry will look to the schools to produce workers who possess and use skills that contribute to achievement of employers' goals. The education sector has no alternative but to respond to this emerging imperative because society will surely hold public schools accountable for accomplishing this important task. The frame of reference for this publication is what Lemons (1984) called "technology education," which he defined as "singular and cumulative educational experiences provided to students for developing technological literacy prior to their entry into technological occupational training programs or employment" (p. 2).

These educational experiences are general in nature and normally provided at the elementary and secondary levels. The concept of "pretechnical education" as used in this publication is synonymous with technology education. The student, either youth or adult, acquires the necessary prerequisite knowledge and skills during his or her pretechnical experiences to negotiate a career path successfully. This path may take the student through a number of job changes. Success is defined as optimizing satisfaction from work, while minimizing resource costs of time, money, and expertise. Adequate pretechnical experiences as outlined in this publication would allow an individual to move from job to job in an efficient manner. Such a move may be a promotion within a career cluster or a lateral transfer to another company or another career field. Thus, pretechnical experiences must be general in nature, primarily intended to prepare the individual for career change.

A Model for Self-empowerment

How should the educational community respond to these clear, urgent, and pressing demands? Alternative solutions have been proposed from a variety of sources (Adler 1982; Botkin, Dimancescu, and Stata 1982; Boyer 1983; DeBevoise 1982; Gisi and Forbes 1982; Goodlad 1984; Naisbitt 1982; Pratzner 1978; Ravitch 1983; Selz 1980; Timpane 1982). Based on a review of these and other resources, research, interviews, and workshops, the authors have identified a comprehensive model for pretechnical curricula for preparing students to adapt with change. The model has two basic assumptions:

- The nature of work in the future will be characterized by constant change, which means that most workers will be employed in several different jobs within or across occupational clusters during their lifetimes. Accelerated change represents a significant factor that must be considered by individuals as they prepare for their initial employment.

- Individuals' employability options in the future will be shaped by the acquisition and maintenance of specific classes of skills and knowledge. Three classes of such skills and knowledge have been identified: generalizable skills, problem-solving skills, and transition skills.

Figure 1 displays the three classes of skills and knowledge within which instructional strategies and pretechnical curricula decisions may be developed.

- **Generalizable skills and knowledge** (hereafter referred to as generalizable

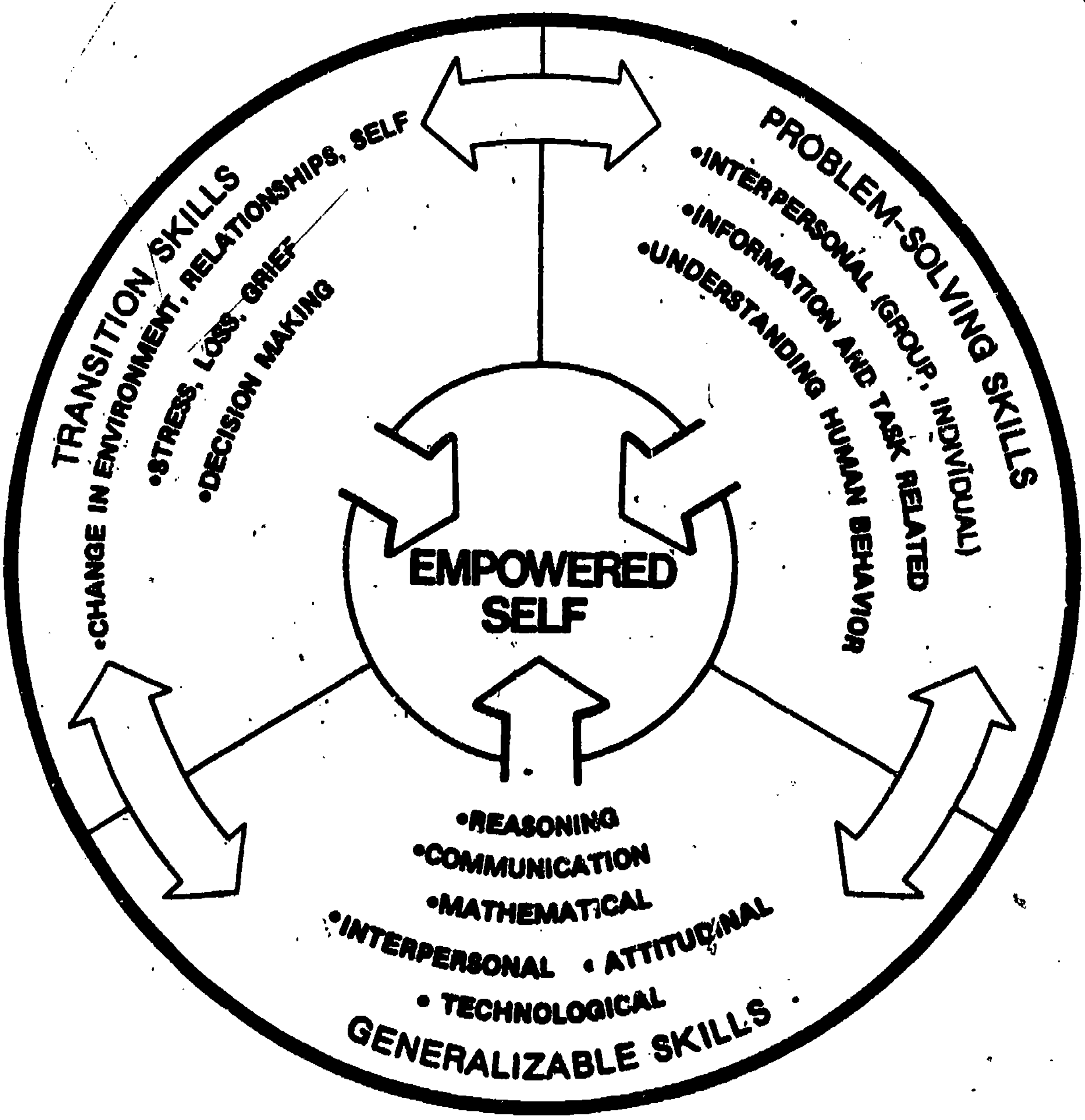

Figure 1. Skills for adapting to change

skills) are actively used in work performance, are transferable across jobs and occupations, and are instrumental to success on the job and in the classroom. Examples include mathematical, reasoning, communication (written and oral), interpersonal, technological, and attitudinal skills.

- **Transition skills and knowledge** (hereafter referred to as transition skills) are used to manage life transitions, especially occupationally related ones. They include managing changes in the environment, in relationships, and in oneself; managing stress, loss, and grief; and making decisions.

- **Problem-solving skills and knowledge** (hereafter referred to as problem-solving skills) are employed in the resolution of problematic situations, including interpersonal problems (group and individual), information and task-related problems, and problems related to people's behavior in cooperative groups.

Two classes of skills from the model are discussed in this report: transition skills and problem-solving skills. Generalizable skills have been described in detail in several current sources, one of which is Greenan's (1983) *Identification of Generalizable Skills in Secondary Vocational Programs*. Generalizable skills, including the three Rs—reading, writing, and arithmetic—are crucial for adapting with change, but they are no longer a sufficient education for the workers of tomorrow. We have extended essential skills to include transition skills and problem-solving skills. These skills will help provide tomorrow's worker the opportunity for lifelong employability and well-being.

The model introduced here represents an extrapolation of available knowledge and opinion concerning the future of work and the skills that individuals will need if they are to find work in the future. The purpose of the remainder of this publication is to explicate the model and to demonstrate its usefulness. This purpose will be achieved by—

- summarizing predictions about the future of work and the requisite needs of employees and identifying the implications of those predictions,

- providing criteria for building a pretechnical curriculum that will be responsive to both the needs of employers and employees,

- describing transition skills and problem-solving skills and their applications, and

- describing how the pretechnical curriculum may be implemented into the schools.

FUTURE OF WORK: EMPLOYER AND EMPLOYEE NEEDS

Employers and employees have always had interrelated concerns about work. For employers, future concerns will revolve around the need to sustain state-of-the-art production and service capabilities in order to remain competitive within the market. For employees, future concerns will center on the need to find meaningful and satisfying employment and to adapt with changes that occur within or are related to the work setting. Based on a review of the literature, however, three major factors are predicted to disrupt the balance that must exist between the concerns of employers and employees: (1) the impact of technological change on the structure of the labor market, (2) the increase in the transitory nature of work, and (3) the emergence of participatory work environments in business and industry. Each of these factors has important implications for the formulation of a pretechnical curriculum.

Structure of the Labor Market

A Two-tiered Work Force

One estimate of the net impact of technological changes has been provided by the AFL-CIO Committee on the Evolution of Work (1983). This committee's report, based on reports from a variety of experts from business, industry, and public and private research institutions, predicted the formation of a two-tiered work force.

> As computers and robots take over more and more functions in the factory and the office, a two-tier work force is developing. In some cases, jobs are being upgraded. In many other cases, jobs are being downgraded. . . . At the top will be a few executives, scientists and engineers, professionals, and managers, performing high-level, creative, high-paid, full-time jobs in a good work environment. . . . At the bottom will be low-paid workers performing relatively simple, low-skill, dull, routine, high-turnover jobs in a poor work environment. These jobs will often be part-time and usually lacking job security and opportunities for career advancement. (p. 8)

The AFL-CIO report gave two additional characteristics of the committee's labor market projection:

> Between these two major tiers will be fewer and fewer permanent well-paid, full-time, skilled, semi-skilled, and craft production and maintenance jobs which in the past have offered hope and opportunity and upward mobility to workers. (p. 4)

> Below the two-tier work force is a labor surplus underclass, the workers who don't have jobs and don't have job prospects. There is some movement in and out of this labor surplus underclass, but upward movement is essentially limited to the bottom level of the two-tier work force. (p. 9)

Craig (1983) of The Ohio State University stated that the work force of the future will require researchers and scientists and "a few highly skilled technical engineers and mechanical machine maintenance people. . . . But the mass of people will not have advanced technical skills" (p. 7).

Types of Occupations

Implicit within these predictions about the structure of the future labor market are assumptions about the types of occupations that will be available to the majority of individuals. The predominant assumption is that an increasing number of workers will be limited to low-skilled, routine, high-turnover jobs. Levin (1984) of Stanford University predicted that in the future, the vast majority of jobs will be "low-level service occupations such as waiters, sales clerks, kitchen helpers, fast-food workers, and cashiers" (p. 4).

Rumberger (1984) contended that technological innovations will have a negative impact on the structure of the future labor market. According to him, these innovations will not only reduce the total number of jobs, but they will also reduce the skill requirements of most jobs. Moreover, others have predicted that the reduction of jobs and skill requirements will be pervasive. Not only will people in such specific occupations as secretarial, bookkeeping, paralegal work, and repair be affected by technical innovations (Levin 1984), but entire industries and occupations will be affected as well (Faddis, Ashley, and Abram 1982).

In most instances, the redirection of job or skill requirements will involve the dislocation of workers and the incorporation of machines or technical equipment. The net result of this trend is that workers will be limited in both the number and variety of available occupations. Some workers will be able to obtain high-tech positions (approximately 3 percent), but the remainder will be limited to occupations that will require only a high school education (Levin 1984). Most of these jobs will lack security or opportunity for career advancement. In either situation, workers nevertheless will be confronted with the prospect of change, change that will affect not only their work, but almost every other aspect of their lives.

Implications

These projections about the structure of the future labor market have important implications for the formulation of a pretechnical curriculum. If the pretechnical curriculum is designed to provide *everyone* with the opportunity to live successfully in a technological society, then it must prepare people to adapt to change. The importance of adaptability for high school graduates was emphasized in a recent report from the National Academy of Sciences (1984) entitled *High Schools and the Changing Workplace: The Employers' View*. As a panel of economists, educators, and employers stated, "Graduates of American high schools need to be adaptable to changes in the workplace more than they need any particular job skill. . . . This adaptability is by far the most important characteristic of the young person entering the workplace" (pp. xi-xii). A growing number of people believe that adaptability is most likely to be achieved when students receive a solid basic education as opposed to one with a narrow vocational focus (Lemons 1984; Levin 1984; Levin and Rumberger 1983; Rumberger 1984). Vocational education can make significant contributions to the goal of adaptability.

Transitory Nature of Work

Work is becoming increasingly transitory in nature. There are two reasons why work can no longer be viewed as a static concept. First, we are entering a period of rapid technological change in which both entry-level and high-skill positions are being transformed, often in unpredictable ways. Second, no one can accurately predict which jobs will be available to people during their lifetimes (Levin 1984).

Dislocation and Retraining

The certainty of technological change and the unpredictability of its outcomes, coupled with the inaccuracy of job forecasting, guarantee that most workers will change jobs several times during their lives. Change may be forced (e.g., jobs may be eliminated), or it may be selected (e.g., a new and different position may be sought or accepted). In either instance, workers will be expected to make the necessary transitions both in their work and in their day-to-day living; these transitions will often involve being retrained to do a different job.

Successful retraining as a necessary component of future workers has been endorsed by industry. As Elliman (1983), vice-president and general manager of Lucas Industries, a multinational conglomerate, put it:

> Today's industrial workers must never cease learning and growing. Regardless of what individuals have accomplished or learned up to a point in time, in five years their skills will be obsolete and they will have to be retrained. . . . Industrialists have to deal with their end products for forty-eight years; every five years we have to teach them a new skill. Furthermore, many of these people never really learned how to study effectively so that we can retrain them easily. (p. 4)

It appears that a worker's best counter to the prospect of "dislocation due to technological innovation" is to exercise a primary human characteristic, the capacity to learn. The ability to apply previous learning to the process of retraining will be the landmark characteristic of future workers. Those who possess the ability to learn new skills and information throughout their lives will be better prepared to meet the retraining demands of their employers. For them, technological innovations will not seem so ominous. Schultz (1980), the Nobel prize-winning economist, put the issue as follows:

> Mankind's future is not preordained by space, energy, and cropland. It will be determined by the intelligent evolution of humanity. . . . Future workers will need to be generalists, flexible enough to change course and train for new careers with a minimum of disruption. (p. 643)

Given the transitory character of work, workers may enhance their employment opportunities if they have learned to learn (Toffler 1970); that is, if they have prepared themselves to be retrainable. Yet, as Ashley, Zahniser, and Connell (1984) have noted, many workers, especially dislocated workers, lack this essential skill:

> The dislocated workers who are currently suffering from the results of rapid industrial declines characteristically are unionized workers with seniority in blue-collar jobs, who earned high wages in manufacturing industries. Among the dislocated, females and minorities often are the more disadvantaged and suffer greater economic hardships following the loss of their jobs. In general, many dislocated workers, particularly the older workers, are lacking in their educational backgrounds and do not have skills that are in demand in other occupations. (p. ix)

Dislocation and Psychological Problems

For workers who have not learned how to learn, who have not prepared themselves to be retrained, job dislocation represents only half of their trauma. The other half is relocation. For many dislocated workers, the process of relocation is neither easy nor successful. In addition to lacking skills that are in demand in other occupations, dislocated workers are often ill-prepared to deal with the social, psychological, and physical problems that accompany the loss of their positions. Their inability to resolve these work-related problems frequently results in increased incidences of depression, grief, alienation, substance abuse, marital difficulties, heart disease, and other stress-related illnesses such as increased rates of suicide (Ashley, Zahniser, and Connell 1984). Their lack of job flexibility is paralleled by a lack of flexibility in other areas of their lives.

Implications

The plight of the dislocated worker has

several important implications for the articulation of a pretechnical curriculum. First, the prospect of becoming a dislocated worker places special emphasis on the skills and knowledge that enable individuals to learn, that is, be retrained. Second, the skills and knowledge that individuals need to adapt to the transitory character of work will include those relating to the social, psychological, and physical problems associated with loss of position.

Finally, as noted by Rumberger (1984), job displacement will occur at all levels of the economy, not just at the bottom. And, as Ashley, Zahniser, and Connell (1984) have noted, "Future economic conditions and technological changes are likely to increase the numbers of adult workers who will face the problem of job dislocation or skill obsolescence throughout their work lives" (p. xi). Thus, all future workers will need to possess the skills and knowledge that will enable them to participate fully and effectively in a transitory work force.

Participatory Work Environments

The emergence of participatory work environments, which are characterized by the collaborative efforts of labor and management, the importance of personal involvement in the production process, and the full expression of one's humanity through one's work, represents one of the important products of revolutionary high-technology innovations. Whereas this particular development may appear to be an anomaly at present, it represents an altogether human reaction to an environment marked by rapid drastic change (Hedist as cited in Wirth 1981). The central theme of this trend, which is the importance of people, has been acknowledged by economic and labor theorists (Gyllenhammer 1977; Schultz 1980; Wirth 1977) and by industrialists (Elliman 1983; Frey 1983). The thrust of the theme, as stated by Gyllenhammer (1977), is as follows:

> People don't want to be subservient to machines and systems. They react to inhuman working conditions in very human ways: by job-hopping, absenteeism, apathetic attitudes, antagonism. The younger the worker is, the stronger his or her reactions are likely to be. People entering the work force today have received more education than ever before in history. We have educated them to regard themselves as mature adults, capable of making their own choices. Then we offer them virtually no choice in our overorganized industrial units. For eight hours a day they are regarded as children, ciphers, or potential problems and managed and controlled accordingly. (p. 4)

People-centered versus System-centered Industries

One alternative to a machine- or system-centered industry is a people-centered structure. A people-centered industry has different economic and industrial assumptions. From an economic perpective, it assumes a new economics which starts from a commitment to make the fullest practicable use of whatever talents are inside people (Wirth 1977). From an industrial perspective, a people-centered industry assumes a commitment to obtaining the key elements that workers and managers need if they are to create "good work" for themselves (Wirth 1981). Examples include the following:

- Adequate elbow room—enough room to feel autonomous, but not so much room as to seem disconnected from the overall task
- Chances of learning on the job on a continuous basis
- An optimal level of variety
- Conditions that promote help and respect among co-workers

- A sense of one's own work meaningfully contributing to the welfare of society
- A desirable future

Quality of Work Life Programs

The collective goals of people-centered industries have been actualized in the American workplace through quality of work life (QWL) programs (Pratzner and Russell 1984). According to Pratzner and Russell, QWL programs embody a philosophy, a set of values and models, and a multitude of practices and techniques for understanding, explaining, and affecting how work is organized and carried out. "QWL programs and participative management are democratizing the workplace and involving employees in more decisions that affect their work, through the use of quality circles, problem-solving task forces, labor management committees, group incentive plans, job redesign, and a variety of other approaches and techniques" (p. 3).

Quality of work life programs create two broad areas of job skills demands for employees: group problem solving and the organization and management of production (Pratzner and Russell 1984). Group problem solving incorporates a number of specific skills, including interpersonal skills, group process skills, decision making, communication, and reasoning. Organization and management of production incorporate skills that include business economics, management, statistical quality control, and introduction to QWL. Considered collectively, these several skills represent the foundation of sociotechnical literacy (Pratzner 1984b). According to Pratzner:

> Socio-technical literacy emphasizes a balanced concern for the social, human aspects of work, as well as the technological aspects, and an appreciation of their interactions. It includes development of (1) group problem-solving skills (e.g., interpersonal and group process skills, problem solving and decision making, planning, and communication), and (2) skills in the organization and management of production (e.g., skills in business economics, business operation, and statistical quality control). It also includes (3) an understanding of the philosophical underpinnings and consequences of the shift from a mechanistic, technological, scientific management perspective of work to a high involvement, participative management perspective. (p. 56)

Quality of work life programs are changing the characteristics of work by influencing the ways in which workers relate to one another, to management, and to the production process itself. Programs of this type require employees who have sufficient sociotechnical literacy to make such efforts effective. Sociotechnical literacy transcends the performance of a single specific job, or the operation of a particular piece of equipment, or responsibility for a certain part of the production process. Its focus is broader and includes the human and business aspects of production, as well as the technological aspects. The essence of sociotechnical literacy is contained in the following description of an ideal worker:

> I am looking for individuals who can read and write. . . . My ideal worker would also have common sense, understand my industry, be willing to accept that he or she will not reach the top in a year, and realize that he or she will have to work hard for the rest of his or her life . . . [workers] who will accept me as an ally and not as an enemy. I want this person to have been taught some of the basic social graces. (Elliman 1983, p. 10)

Implications

The trend toward participatory work environments and the emergence of QWL programs also have important implications for the formulation of a pretechnical curriculum. Assuming that QWL programs will remain an important dimension of high-involvement industries, the demand for socio-technically literate workers will increase. Curricula that focus on the skills needed for socio-technical literacy will have to be designed and implemented. Moreover, because participatory work environments stress collaboration among the various levels of production, *all* students should have the opportunity to acquire the skills and knowledge that prepare them for collaboration and cooperative problem solving.

Summary

Three factors that are predicted to influence the future of work are the impact of technological change on the structure of the labor market, the increase in the transitory nature of work, and the emergence of participatory work environments. Each of these factors has important implications for the development of a pretechnical curriculum. A summary of the specific conclusions of this section and the implications of those conclusions for the formulation of a pretechnical curriculum are listed below.

- **Conclusions**

  —Technological innovations will create new jobs in high-tech occupations; there will also be an increase in the number of low-skilled jobs.

  —Most workers will change jobs or occupations several times during their lifetime, which will require them to be retrained periodically.

  —For most workers, occupational changes will involve differing types of psychological problems that may limit their future employment opportunities.

  —QWL programs are placing new skill demands on workers, including group problem solving and the organization and management of production. They are also helping to change the basic character of the workplace.

  —A pretechnical curriculum must prepare students to participate successfully in the workplace. Thus, it must be responsive to the new skill demands that are experienced by workers.

- **Implications**

  —A pretechnical curriculum must be able to address the needs of both types of workers.

  —A pretechnical curriculum needs to emphasize the skills and knowledge that will allow workers to benefit from retraining programs.

  —A pretechnical curriculum must minimally prepare future workers to understand and cope with the psychological problems associated with occupational changes.

  —A pretechnical curriculum must prepare students to participate successfully in the workplace. Thus, it must be responsive to the new skill demands that are experienced by workers.

Based on these implications, decisions must be made about specific skills to be included in a pretechnical curriculum. Before discussing two categories of skills—transition and problem solving—some criteria for making these curriculum decisions will be presented.

CRITERIA FOR CURRICULAR DECISIONS

High-tech innovations are expected to cause substantial changes in the structure of the labor market as well as in the characteristics of work settings. These changes have led us to challenge traditional approaches to vocational curricula (such as specialized job skills training programs) and to set forth new criteria for judging secondary vocational education curricula. The four criteria are utility, personal options, transferability, and psychosocial value.

Instructional developers must consider the *usefulness* of knowledge incorporated into the curriculum. Preparation for work is the primary criterion for designing vocational education curricula. Students must be able to *use* pretechnical knowledge on the job. The goal of this knowledge is self-fulfillment. Pretechnical knowledge can help individuals increase satisfaction by opening *personal options* for advancement and progression on the job. To do this, knowledge acquired in the classroom must be *transferable* to the workplace. Teachers should incorporate work-based experiences into their pretechnical curricula. Systematic instruction aimed at identifiable cues in the workplace can enhance a student's performance on the job. Finally, pretechnical education possesses a *psychosocial value* for the student and for society. Persons with a pretechnical education who have been displaced by a new technology have a better chance of understanding why they were displaced, and they are better prepared to deal with the crisis. Pretechnical education should minimize the stress experienced by workers due to occupational shifts in the economy.

Utility

It is the authors' position that a pretechnical curriculum will contribute to the adaptability of individuals to the degree that they recognize the curriculum's *utility* for their personal situations. The criterion of utility, then, represents one basis for identifying the core skills and knowledge for a pretechnical curriculum.

Utility, however, will mean different things to different people. For some, utility may represent the assurance of employment in an entry-level position in a particular business or industry. For others, utility may mean receiving skills and knowledge that are prerequisites for postsecondary training in a specific technological field. Still others may view utility as the skills and knowledge that will give the assurance of career flexibility throughout their lifetime. A pretechnical curriculum must be responsive to each of these personal definitions of utility.

Personal Options

A second criterion, personal options, identifies the contents of a pretechnical curriculum. When the job offers a variety of alternatives from which to choose, people's interests, values, and strivings can be expressed in the work they do. Employees and employers benefit in many ways when the work provides the employee with an opportunity for self-expression, while simultaneously fulfilling the needs of the employer.

Taken together, the criteria of utility and personal options represent a practical basis for identifying the content of a pretechnical curriculum.

The essence of this process has been expressed by Levin (1984):

> We cannot predict accurately which jobs will be available to any particular person over a career of four to five decades, nor can we predict which particular job or combination of jobs an individual will actually obtain among those that are available. Given these circumstances, education must be provided that will allow individuals the option of starting at entry level in the available occupations, and of undertaking education and training as needed in order to move into higher level occupations. (p. 21)

Transferability

Transferability of educational outcomes to the workplace has drawn the attention of researchers who have attempted to identify those skills that are transferable from school to work (Greenan 1983) and across work settings (Pratzner 1978). After investigating the relationship between occupational adaptability and transferable skills, Pratzner (1978) concluded the following:

> Schools cannot prepare students for all unknown future contingencies. But it does seem reasonable to expect them to help students develop their individual attributes, potentials, or capacities to levels of proficiency useful in a wide range of situations. By such development they may be adaptable and better able to perform successfully in changing environments.
>
> Having transferable skills will *not* guarantee successful adaptability, but should facilitate it. To the extent that individuals perceive similarities among jobs and are able to transfer their skills and knowledge effectively, the time and costs associated with supplemental training or retraining should be reduced and reflect a savings to employers and individuals alike. (p. 47)

A good deal of research has focused on the identification of the skills and knowledge that are usable across a wide range of situations. One of the more recent and carefully defined investigations was completed by Greenan (1983).

For Greenan, a skill is generalizable if it is basic to a particular occupation or training program, if it is necessary for success in a particular occupation or completion of a particular program, and if it is applicable across occupational settings and clusters. Greenan developed an instrument to measure the generalizability of specific skills in mathematics, communication, interpersonal relations, and reasoning. The instrument was administered to teachers in five vocational training areas: agricultural occupations; business, marketing, and management occupations; health occupations; home economic occupations; and industrial occupations. Based on the result of his study, Greenan (1983) concluded that

> there is a core of mathematics, communication, interpersonal relations and reasoning skills which are basic to, necessary for success in, and transferable across several secondary vocational training program areas and programs; most of these core skills are very important and highly generalizable. (p. 57)

The importance of transferability has also been recognized by industrialists. Elliman (1983) stated:

> I would much prefer that the schools concentrate on teaching students the basic transferable vocational skills that they will need when I teach them the applied technology I utilize. The basics are the skills that business and industry can most capitalize on in years to come. (p. 4)

Transferability and utility must be balanced in a pretechnical curriculum. A curriculum that has utility teaches students to use specific tools, repair highly specialized equipment, or gather specific types of data. However, transferability in a curriculum ensures that students also learn to use tools that are applicable across many jobs or job clusters, repair equipment that is used in many areas, and gather data in many ways, such as using microprocessors, computers, and electronic data processing. Transferability helps students work and learn, be more easily retrained, and gain confidence that change is not an overwhelming threat but merely a part of one's life.

Psychosocial Value

Clearly, job preparation for the future will have to influence knowledge and skills that are related to the psychosocial issues of work and work loss (Baker 1982). Several factors contribute to the emergence of this need: the incidence of worker dislocation and its subsequent psychological stresses (Ashley, Zahniser, and Connell 1984), the prospect of multiple changes in jobs or occupations in a lifetime (Levin 1984), and the need for individuals to participate fully in a rapidly changing society (Rumberger 1984). Future workers will need to be prepared to cope with these and other work-related factors that involve psychosocial issues. According to Silberman (1983), "The acquisition of appropriate personal skills and attitudes is just as important an outcome of vocational education as is the acquisition of technical and basic literacy skills" (p. 39).

Summary

Traditionally, the vocational education curriculum has related to specialized job skills training. Recent technological innovations and their resultant impact on the world of work have created the need to reevaluate traditional curricula using the four criteria of utility, personal options, transferability, and psychosocial value. Such criteria have important implications for the formulation of a pretechnical curriculum.

These criteria, coupled with the authors' experiences with current writings, views of educators, business people, teachers, students, and unemployment victims, lead to three categories of essential skills for helping people cope with their work lives: generalizable skills, transition skills, and problem-solving skills. There is self-empowerment in these skills. Generalizable skills satisfy the criteria of transferability and personal utility. Problem-solving skills satisfy the criteria of transferability, personal options, and psychosocial value. Transition skills satisfy the criteria of transferability, psychosocial value, and utility. It is the interrelatedness of these three categories of skills that provides a comprehensive framework for self-empowerment of the individual and curricular decisions.

Self-empowerment is the key for guiding schools in preparing young people for their futures. People can help *themselves* lead more meaningful, balanced, and productive lives. It is ultimately the individual who must apply the new techniques in the workplace. People must not become the slaves of technology and change. A machine, a process, or a system is no more effective than the people using it. The *human factor* in education and work must stand above all others.

TRANSITIONS

During the last decade, educators have become more aware of the influence of change and transition on the lives of students. A transition results in changes in relationships, routines, assumptions, or roles within the settings of self, work, family, school, health, or finances (Schlossberg 1984). Adolescents face many transitions: becoming educated, choosing a career, finding first jobs, and seeking individual identity. Passage from youth to young adulthood often involves decisions to marry, to drop out of school, to leave parents, and to have children. Throughout their life span, changes in values, purposes, and circumstances will continue. As adults, some will lose or change jobs, experience retraining, become successful, encounter illness, divorce or be divorced, develop and change emotional and spiritual perspectives, and adjust to retirement and the challenges of old age.

The U.S. economy is undergoing a major restructuring, and the implications for the individual worker are serious. As a result of foreign competition, changing global markets, and consumer preferences, America's economic position in the world has eroded. Many workers in such major manufacturing industries as steel, automobiles, rubber, textiles, radio and television receivers, and electrical equipment have lost their jobs and been forced suddenly to change their occupations and life-styles (Pratzner and Ashley 1984, p. 5). Simultaneously, the advent of high technology ensures continued and accelerated change in the nature of available jobs.

> The increased use of industrial robots, office automation, microelectronic devices, and computerized information and telecommunications systems, will not only affect where and how we live, and what we purchase, but also how we work. The impact of changing technology, especially the continued expansion of computer applications in the work place, will affect the skill requirements and work styles of millions of workers over the next ten to twenty years. New technology will in some cases reduce the skill requirements of some occupations, especially those involved with more routine and repetitive functions such as parts assembly, equipment operations, signal monitoring, and information handling functions. Other occupations involving the functions of planning, evaluating, analyzing, interpreting, troubleshooting, and maintaining complex systems will likely experience an increase in skill requirements. (pp. 5-6).

Change is also increasing in our social institutions and will continue to increase. Traditional roles of men and women are being rapidly transformed, more women are entering the work force, family units tend to have less stability, and traditional values and practices are continually challenged and rejected by some segments of the population and renewed by others. Occupationally related transitions will interact with and be intensified by transitions resulting from such changes in societal norms and trends that began in the sixties and are now becoming commonplace in our society. Imagine, for example, the coping skills needed by a person who must relocate in order to maintain present income when at the same time, such a move would be detrimental to the spouse's occupational progress. Never before has the interface between technology, change, and the people who use technology been more important if our society is to prosper. A balance must be struck between the impact of technology and change and the human beings who are affected by it.

Educators cannot be expected to prepare students for *all* possible contingencies. Nevertheless, as noted by the National Academy of Sciences (1984), society, business, and industry will expect educators to help students develop skills that prepare them to cope, adapt, and change with their environment. The challenge for educators seems overwhelming as powerful alternatives to public schooling threaten to change the social context of education. The idea of socio-technical literacy (Pratzner 1984b) no longer rests on the teaching of a fixed body of information in a fixed routine but instead on the incorporation of ways of transforming students' abilities to function in a changing world, to learn how to learn for a lifetime; and to cope, manage, and adapt to the challenge of an uncertain future. It is the responsibility of educators to identify and pass on those skills. It is for this purpose that transition skills have been identified and an educational framework for attaining those skills introduced. The aim of this class of skills is consistent with the image of vocational educators serving the needs of employers, the labor market, and the individual. It maximizes the preparation of the individual for a lifetime of transitions.

Framework for Transitions Curriculum

The term *transition* skills refers to those skills that are used to manage life transitions, especially occupationally related ones. Subsumed within this class of skills are those that include managing changes in environment, relationships, and self; managing stress, loss, and grief; and making decisions. The framework introduced in table 1 is an attempt to introduce a comprehensive approach to handling transitions that may be incorporated into the public school curriculum. It utilizes an understanding of adolescent development, organizes the knowledge and process necessary for maximizing an individual's ability to adapt and manage transitions across settings (personal, interpersonal, workplace, institutional, or community), and focuses on the self-empowerment of the individual to understand and deal with events as they occur.

Managing transitions depends upon people's ability to acquire and mobilize the skills that will enable them to adapt with change successfully. These skills are identified in each step of the framework. Each step focuses on the acquisition of a series of skills that maximize management of transitions and prepare the individual to manage future ones. The four steps identified are as follows:

- Identify the transition.
- Identify the coping resources.
- Identify ways of managing the transition.
- Utilize trial, integration, and self-transformation methods.

Table 1 identifies the components of the framework with requisite skills and outcome variables.

Model for Handling Transitions

The model may be used by educators by implementing the questioning format presented here. Each question is designed to accomplish the outcome variables identified in each component in table 1.

- Identify the transition
  - —What has ended? (something personal, interpersonal, family, school, friends)
  - —How much *stress* are you under? What is causing it?
  - —What *fears* do you have? Be specific.

TABLE 1

FRAMEWORK FOR INCORPORATING TRANSITION SKILLS INTO CURRICULA

Components of Framework	Skills Necessary to Attain Mastery of Individual Components of the Framework	Outcome Variable
	The individual will:	
I. Identify the Transition	Identify type of transition A. Anticipated/Developmental B. Unanticipated C. Chronic hassle (Schlossberg 1984) Identify setting A. Self B. Family C. Work D. Health Identify relationship of person to the transition A. Self B. Other C. Interpersonal D. Community	Assessment of stress Assessment of impact of event on assumption
II. Identify Coping Resources	Identify support systems A. Internal B. External Identify possible and actual coping responses A. Immediate/Short term B. Future/Long term Assess impact of personal variables A. Socioeconomic status B. Psychological resources (development—ego strength) C. Commitments, values	Mobilization of resources necessary to assist in management of transition Identification of needs which must be met to cope and adapt Enhancement of personal awareness necessary to respond to transition Regaining control over stress and meaning of transition

TABLE 1—*continued*

Components of Framework	Skills Necessary to Attain Mastery of Individual Components of the Framework	Outcome Variable
III. Identify and Choose Ways of Managing the Transition	Examine and identify alternatives for coping A. Support groups B. Counseling C. Restructuring support system D. Learn new coping skills (exercise, relaxation, time management) Utilize problem-solving model A. Identify problem B. Brainstorm possible solutions C. Choose tentative solution D. Carry out tentative solution E. Learn Utilize "neutral zone" A. Identify what you really want B. Find time to be alone	Increased ability to make effective decisions regarding the transition Increased awareness of the options for transition management Increased ability to reapproach work, love, play with renewed energy
IV. Trial, Integration, Self-renewal	Act upon identified coping strategy Identify learnings from the transition A. About self B. Others C. Assumptions Evaluate Action Reevaluate plan if necessary	Learn from current transitions ways of transferring skills to future transitions. Discover strengths about the self. Return to equilibrium of pretransition environment.

—Describe the transition as best you can.

—What kinds of things are changing in your life (people, job, school, values)?

—What is the impact on you? How do you *feel* about the transition?

- Identify coping resources

—Who can help you?

—Who could provide a personal support network? (emotional, physical, group, individual)

—How can you help yourself?

—What are some of your *options*? List them.

—Will preplanning help you cope with the hardest part of the transition?

—Remember the five main steps for solving a problem. (This is discussed thoroughly in the next section.)

1) Understand the problem (transition).

2) Brainstorm for solutions.

3) Choose a tentative solution.

4) Implement the solution.

5) Learn from the experience.

—What obstacles do you have to overcome in order to change (financial, psychological, interpersonal)?

—How might you benefit or not benefit from the transition?

- Identify ways of managing the transition

—What are various alternative *actions* for coping?

—Maybe a problem has to be solved. If so, use the five steps for solving a problem.

—Individual or group counseling is always a possibility.

—Do you need to learn new coping skills (relaxation skills, exercise program, time management, health care, and others)?

—Examine the positive and negative consequences of all planned actions.

—Are you taking full advantage of the "neutral zone"?

—Find a regular time to be alone and to *reflect* on the transition.

—Identify what you really *want*.

—Reexamine your values and your goals.

—What do you know about yourself that you can use in managing the transition?

- Utilize trial and error, integration, and self-transformation

—As you try things out, with whom can you discuss your experiences?

—In what ways is this a positive experience? A negative one?

—How are you different?

—What did you learn from this experience? What did you learn about yourself?

—Is your grief or disappointment part of a healing process?

—What are some options open to you if you think you are not managing the transition well?

—Can you *accept* the transition and go on with your life?

PROBLEM SOLVING

Daniels and Karmos (1983) have found that aside from the three Rs, problem solving was listed most frequently in the literature and by employers as an essential skill for dealing with the future. Pratzner (1984b) has stated that "the first priority is for secondary level vocational education to offer good education in reading, writing, computing, listening, and problem solving" (p. 6). Brown (1984), from the University of Illinois, conducted an interview with Alfred Binet, a noted researcher in problem solving, on the teaching of problem-solving skills. Binet said:

> What I object to in traditional classes is that it is the teacher who produces, and the student who passively listens. Such a lesson has two faults: it does not impress the student other than by its verbal function, it gives him words instead of making him deal with actual objects, and it appeals only to his memory, reducing him to a passive state. He doesn't judge, doesn't think, doesn't invent, and doesn't produce. He needs only to retain. His aim is to repeat without mistake, make his memory work, know what is in the lecture, in the textbook and reproduce it. The results of such practices are deplorable (e.g., a lack of curiosity for what is not in the book or lecture; a tendency to look for the truth only in the book, the belief that one is doing some original research by going through a book, too much respect for the writer's opinion, a lack of interest in the world and the lessons it gives, a naive belief in the power of simple formulas, a difficulty to adapt oneself to contemporary life, and, above all, a static regimentation unwelcome at a period when social evolution is so fast). (pp. 14-15).

Something is being done about teaching problem-solving skills by business and industry. In 1983, General Motors trained approximately 50 percent of its employees in problem-solving skills. Kathy Long*, spokesperson for General Motors, says that the training has been successful, that productivity and positive attitudes have both increased, and that General Motors is going to devote more time and money to problem-solving training. The training has improved worker competency, enabled workers to diagnose and solve job-related problems, taught them to examine their own behavior and consequences of it, and helped workers be more cooperative with each other in solving problems (Guest 1979). Henry and Raymond (1982), in *Basic Skills in the U.S. Work Force*, identified other corporations and also schools that are currently involved in problem-solving training.

A Model for Problem Solving

For students to hold jobs, to be retained, and in general to adapt to a constantly accelerating rate of change in their lives, they will need *strategies* for attacking and solving problems. Possession of at least one general model for solving problems is one essential strategy. There are many different models. The one developed here is based on problem-solving models from General Motors' *Employee Participation Groups Member Manual* (Kolb and Baker 1980), from G. Polya's (1957) *How to Solve It*, and from Gordon's (1974) *Teacher Effectiveness Training*. The model described here has five steps.

- Understand the problem.

*Personal interview with Kathy Long, director of research and development, General Motors.

—If people are involved, then there should be explicit *agreement* among them on what the problem is.

—If appropriate, analyze the problem for possible *causes*. (In mathematics, causes are usually not involved.)

- Brainstorm for possible solution strategies.

—No evaluations or judgments should occur here. This should be a free-wheeling act of idea generation.

- Choose a tentative solution strategy.

—For "people" problems, *consequences* of behaviors and solutions must be carefully considered.

—If people are working out an interpersonal problem, then the tentative strategy is likely to be a compromise.

- Carry out the tentative strategy.

—In implementing most strategies involving people, it is important to decide who does what when.

- Learn from the experience.

—Immediately and over time, think about what can be learned from the experience. What are the implications of what has been done?

—If appropriate, evaluate the effectiveness of the solution. (You may have to start over.)

In the beginning, students follow the five-step model step by step. Later on they are encouraged to use their own creativity and intuition freely to solve problems, since no single model is directly applicable to all problems.

The five-step model is currently being used by students for their academic work and for their interpersonal lives. The model is also practical for the workplace. Students use it in their part-time jobs, and General Motors uses it to get employees to work together to solve problems. In a 1983 personal interview, Long of General Motors' Research and Development Division stated that competition among workers often turns out to be a liability. "They work separately against each other. We need our employees to work together to solve problems. That will increase their job competence." The problems on which the groups focus are not generally psychological ones; they are job-related problems. Workers, supervisors, managers, and executives get involved in the groups. Whoever is being affected by the problem or the solution is in the group. They use a model very similar to the five-step model.

The Need for Transfer

Schools teach problem solving, but most students have difficulty transferring their problem-solving capabilities from one setting to another (Johnson 1984; Snowman 1984). We believe there are two major reasons for lack of transferability:

1. Not enough diverse kinds of problems are given to students to encourage transfer over a wide range of settings. Only math problems are given, or science problems, or social studies problems, and so on. These problems are context bound. They are too similar to each other. There are many commercial programs for teaching problem solving, and they provide a wide variety of problems.

2. Most students are not explicitly taught strategies for solving problems. Some strategies are: using a

model, reading information carefully, breaking the problem into manageable parts, and making a sketch. The authors have taught strategies to students, they have learned them, and they have improved their problem solving.

For additional sources on problem-solving strategies, see the Appendix.

Strategies for Solving Problems

DeBono (1982) has formulated guidelines for good thinking and problem solving. His system has been adopted by corporate executives, taught in schools, and studied by government officials from more than a score of countries. Here are some basic tools taken mostly from deBono's (ibid.) *The Learning-to-Think Coursebook*.

First, consider all factors and don't limit perceptions. A conscious effort should be made to think of everything that might be relevant for solving the problem. Suppose you're thinking about buying a new house. Consider all factors to be sure you ask all the right questions. Although obvious issues such as size, cost, and layout are bound to come to mind, without a deliberate effort to list every relevant factor, you might overlook others. How good is TV reception? Is there a local leash law? Can the pipes be drained quickly in case of a power failure in freezing weather?

Even after using various tools of thought, you may not have found a satisfactory solution to your problem. The key to finding alternatives is to look for possibilities outside your usual thinking patterns. Edison, in searching for a light bulb filament, tried thousands of unlikely materials including cork, fishing line, and tar, before succeeding with a strip of carbonized cardboard.

Second, imagine consequences and sequels. One of the traits that makes us different from animals is our ability to imagine the outcomes of our actions. But we can greatly improve this ability by learning to use it in a systematic way. The deBono technique is to imagine the probable outcome of a decision at four distances in the future: immediate, short term (1 to 5 years), medium term (5 to 25 years), and long term (over 25 years). By weighing the consequences of thoughts and actions, people can be less impulsive and make better decisions for themselves, based upon careful thought and not on sudden emotion.

Third, list aims, goals, and objectives. An often unused tool of better thinking is the practice of making a list of reasons for doing a particular thing. Defining goals can also lead to creative solutions to problems. DeBono (1982) tells of a grandmother trying to knit while her yarn was being tangled by the family toddler. Exasperated, she put him in his playpen, but he howled so loudly that she had to take him out. Then she realized that her goal wasn't to pen the child but to separate him from her yarn. So she solved the problem by leaving him out—and climbing into the playpen herself.

Fourth, consider other points of view. Often problems involve a conflict with someone such as a friend, parent, boyfriend, or girlfriend. It is the mark of a good problem solver to be able to find a solution that will agree with the other person's viewpoint. This is particularly difficult to do when one is upset or angry. But, if you can take another person's point of view at such times, then you have one of the major skills of a good problem solver.

An additional set of guidelines for problem solvers is given by Whimbey and Lochhead (1979) in *Problem Solving and Comprehension*. They describe the beliefs, practices, and tendencies of good problem solvers and also the characteristics of poor problem solvers.

First, have a positive attitude. Good problem solvers have a strong belief that academic reasoning problems can be solved through careful, persistent analysis. Poor problem solvers, by contrast, frequently express the opinion that "either you know the answer to a problem or you don't know it, and if you don't know it you might as well give up or guess."

Second, understand the data and the problem thoroughly. Good problem solvers take great care to understand the facts and the relationships in a problem fully and accurately. They are almost compulsive in checking whether their understanding of a problem is correct and complete. By contrast, poor problem solvers generally lack such an intense concern about understanding the problem.

Third, break the problem down into parts. Good problem solvers have learned that analyzing complex problems and ideas often consists of breaking the ideas into smaller steps. They have learned to attack a problem by starting at a point where they can make some sense of it, and then proceeding from there. In contrast, poor problem solvers have not learned the approach of breaking a complex problem into subproblems—dealing first with one step and then another.

Fourth, avoid guessing. Poor problem solvers tend to jump to conclusions and guess without going through all the steps needed to make sure that the answers are accurate. Sometimes they make intuitive judgments in the middle of a problem without checking to see whether the judgments are correct. At other times, they work a problem through part of the way but then give up and guess on an answer. Good problem solvers tend to work problems from beginning to end in small, careful steps.

The tendency for poor problem solvers to make more errors—to work too hastily and sometimes skip steps—can be traced to the three characteristics already discussed. First, poor problem solvers do not believe that persistent analysis is an effective way (in fact the only way) to deal with problems. Thus, their motivation to persist in working an entire problem precisely and thoroughly until it is completely solved is weak. Second, poor problem solvers tend to be careless in their reasoning. They have not developed the habit of continuously focusing and checking on the accuracy of their conclusions. Third, they have not learned to break a problem into parts and work it out step by step. As a result of these three characteristics, poor problem solvers have a strong tendency to make hasty responses as they work academic reasoning problems, causing errors in both simple computations and in logic.

Fifth, include activity in problem solving. Another characteristic of good problem solvers is the tendency to be more active than poor problem solvers when dealing with problem solving. Put simply, good problem solvers do more as they deal with a problem. For example, if a written description is hard to follow, good problem solvers may try to create a mental picture of the ideas in order to "see" the situation better. If a presentation is lengthy, confusing, or vague, they try to pin it down in terms of familiar experiences and concrete examples. Furthermore, they will ask themselves questions about the problem, answer the questions, and "talk to themselves" as they try to clarify their thoughts. They may try a flowchart, brainstorm for possibilities, write on the problem, make diagrams, or use other physical aids to thinking. All in all, good problem solvers are active in many ways, which helps them get a clearer understanding of problems and how to progress through them.

The Problem Solver's Knowledge Base

Robert Glaser (1984) stated that the knowledge of novice problem solvers is organized around the literal objects explicitly given in a problem statement. Experts' knowledge, on the other hand, is organized around principles and abstractions that subsume these objects. The principles are not apparent in the problem statement but derive from knowledge about the things making up the problem or the subject matter associated with the problem. Knowledge of dietetics is needed to solve problems concerning nutrition, knowledge of auto mechanics is needed to fix a car, and so on. The problem-solving difficulty of novices can be attributed largely to the inadequacies of their knowledge bases and not to limitations in their processing capabilities, such as the inability to use problem-solving strategies. "Current studies of high levels of competence support the recommendation that a significant focus for understanding expert thinking and problem solving and its development is investigation of the characteristics and influence of organized knowledge structures that are required over long periods of time" (Glasser 1984, p. 99). Feuerstein (1980) sums it up very well: "It is when cognitive processes become detached from specific tasks that cognitive structures are established. These structures are of a more general nature than the learning of specific tasks and, hence, result in more adaptive behavior by the individual" (p. 22).

Students with a wider knowledge base are better at brainstorming for solutions across a wide range of problems. They are more able to understand and construct analogies, they make more discoveries, they see patterns, and they establish new relationships.

Some Specific Problem-solving Strategies

There are other strategies that can help people become better problem solvers. The ones to be discussed here are thinking aloud, using the trial and error method, working backwards, finding all the possibilities, managing time, reasoning logically and critically, and gathering, recording, and analyzing data. These strategies have helped students become confident and skillful problem solvers.

Thinking Aloud

When using this strategy, people say aloud their thoughts while attempting to solve a problem. All mental processing, however, need not be vocalized. For example, it is not reasonable to explain the meaning of every word read for a problem. When a student is unsure of what to do, confused by an idea, or stops for some time to think about it, then some thinking aloud may be appropriate. When the strategy is used, students should try to think aloud as much as possible. Expressing thoughts, especially at sections of a problem where difficulties or hesitancy arise, is a good way to avoid skipping steps in reasoning, jumping over important information, or being unaware of the point at which being bogged down occurred.

Thinking aloud while solving problems requires practice. At first, many students find it difficult to vocalize their thoughts as they work problems. However, students do get used to expressing in words the steps they take, and then gain confidence in "talking out" the problem in front of the teacher and other students. This technique is used in full class settings, in small groups, and in one-to-one discussions between student and teacher. The choice of setting depends on the nature of the problem, the students, and the teacher.

From thinking aloud, students have learned to listen to each other, to locate breakdowns in reasoning, to learn where the stumbling point is, to realize how different people approach the same problem, and to see more than one solution to the same problem at the same time. Students and teachers are often amazed at how much they can learn from each other by thinking aloud.

Using Trial and Error

Trial and error is often underestimated as a problem-solving strategy, but it can be a key strategy in the solution of some problems. Trial and error can be applied systematically by simply trying different solutions to see if they work. More often than not, however, the search can be narrowed by taking into account relevant knowledge and, by inference, reducing the number of solutions to be tried.

Trial and error can also be advantageous in getting a feel for a problem. Trying out a reasonable guess even if it does not work, can give valuable information. For example, if trying to find a decimal approximation for the square root of 2, one might try 1.5 (1 is too small because $1 \times 1 = 1$, and 2 is too big because $2 \times 2 = 4$). Since $1.5 \times 1.5 = 2.25$, 1.5 is too big, but that is valuable information because it directs the next attempt to a number between 1 and 1.5. Teachers should encourage students to make reasonable guesses at times and should specify for them the value of what was learned from trial and error and how an error can narrow the search for a solution.

This same way of thinking about the information gained from an imperfect attempt can be applied to solutions of interpersonal problems. Suppose a father and his daughter are applying the problem-solving process to the condition of her room, particularly in regards to the dirty clothes on the floor and on the furniture. An idea to try might be to put a clothes hamper in her room. Both would agree that this is a trial solution to be evaluated, say, in 3 weeks. If the solution is not the right one, the attempt still will help to clarify the problem and will lead to a better solution.

One roadblock to becoming a good problem solver is reluctance to take a risk. Many adults have been conditioned over the years to believe that there is some strategy or way to proceed in solving a problem that they "should" have learned, and if they can't "remember how to do this kind of problem," they simply give up. Teachers are confronted with this attitude frequently when their students complain that "we haven't had this yet." Indeed, there are many approaches to problems that can be learned. Good problem solvers are not hampered by the conviction that there is only one way to solve a problem. They do not rely on some outside authority but have confidence in their own ability to generate ideas. Teachers can encourage students to become self-reliant by freeing them to make reasonable guesses and to use trial and error to gain insight into a problem.

Working Backwards

Sometimes it is easier to solve a problem by working backwards rather than attacking the problem head on. Working backwards has many useful applications. Suppose you are writing a position paper to your boss to convince her to accept a particularly crucial idea. In thinking about how to draft the paper, you might begin by working backwards and ask yourself, "What kinds of questions would she ask me? What would be her major objections? How do I keep from offending her?" By working backwards, by starting with the goal, a more convincing paper can be written.

Finding All the Possibilities

Another important strategy for problem solving is to have a systematic way of listing all possible outcomes of some occurrence. The system must ensure that all possibilities are listed and also that only those possibilities which "make sense" from the structure of the problem are listed.

Time Management

Time management can influence problem solving. Poor scheduling can result in insufficient time for thinking through a problem, or perhaps never even getting to the problem. An appropriate amount of time must be allocated for reflecting on the problem, for considering different ways to approach a solution, and for reviewing and critiquing the steps used. The pressure that can result from poor scheduling can cause subpar problem solving by limiting the amount of planning time and the time needed for patient deliberation. A student's patience and perseverance are often keys to good problem solving. Good time management skills are a necessary condition for this.

One might recommend to students that they keep a chart of their activities to use as a basis for managing their time better. Time priorities often have to be set each day and a chart or list can help. Some students do not manage their time well enough to acquire an essential piece of knowledge, get to the library, or talk to someone who can help them. Allocating specific blocks of time to specific tasks according to their importance and the time they require is a useful skill. Systematic reflection on one's use of time and on how much is lost if time is used inefficiently can lead students to modify their own behavior.

Reasoning Critically and Logically

By observing students talk aloud about their problem solving, checking their papers, and observing their activities, the extent of their deficiencies in logical and critical reasoning can be discerned.

One of the major problems students have is dealing with ambiguities in the English language. For example, consider the real-life story of a famous mathematician who had to take a driving examination. He had memorized many statements from a booklet, including "It is illegal to park within 15 feet of a fire hydrant." As part of the test, he was given some true-false questions, one of which was "It is illegal to park within 9 feet of a fire hydrant." The mathematician checked "true" on the grounds that if the statement he had memorized was true, then the question in the test was true. The examiner, however, claimed that the correct response was "false," since the statement in the booklet explicitly mentioned "15 feet" and not "9 feet."

Students need to be given more practice and guidance in dealing with the logic of problem solving. A particular emphasis should be placed on teachers' giving them many sound and appropriate problems to work and listening to them reason aloud. In this regard, the authors strongly recommend *Introductory Logic*, by Exner and Kaufman (1973).

Critical reasoning is another area of student deficiency. Students often lack skills to assess expressed ideas, beliefs, and statements that one encounters daily through the media and through remarks made by people in the form of opinions, reports, rumors, and so on.

The process of critical inquiry must be an impartial one. Judgments and evaluations are delayed until the data have been collected. Observations, people's opinion, and collected information should all be assessed before decisions are made. The process is to be objective, avoiding preconceived versions of the results. It should be open enough to invite further inquiry if people are not satisfied and problems are not solved. Also, in critical inquiry, people's feelings are often involved. Respect for people's personal dignity must be remembered when people are the objects of the inquiry.

Another important part of critical inquiry is evaluating the assumptions being made during the inquiry. If assumptions are not clearly in mind, then invalid conclusions can be drawn, inappropriate decisions made, or people's feelings hurt. An example from Hearn's (1982) *More Life Skills* is as follows:

> Willie Jones is a 15-year-old, grade 10 student who spent Saturday night breaking windows at his high school.
>
> **His mother's assumption** is that he is a crazy, mixed-up kid.
>
> **His father's assumption** is that boys will be boys.
>
> **His principal's assumption** is that there are too many boys like Willie and that the school is better off without them.

The police's assumption is that public property must be protected and wrongdoers must be discouraged.

It is clear that if Willie's mother were to discuss Willie's activities with his high school principal, neither of them would get anywhere because they would be arguing from different assumptions.

People can improve their critical reasoning skills. It is evident from the authors' experiences that there is no substitute for practice. Students must be given good situations, problems, and simulations from which to develop and sharpen their skills.

Gathering, Recording, and Analyzing Data

The first step in the problem-solving model is to understand the problem. When full information is presented to a student, understanding the problem involves reading carefully, eliminating extraneous information, and for some problems, drawing a sketch or a diagram or organizing given data in a table. These are the usual kinds of problems students are given in school. Unfortunately, most problems encountered in one's life (at work, at home, or socially) are not so "neat."

Crucial or helpful information is often missing and the problem solver must have skills not only for obtaining necessary information, but also for recognizing what information is needed. Some examples of such problems follow.

- What steps can I take to effect a behavior change in person Y?
- To cut costs and maintain sales volume, where can money best be saved in the production of product X, packaging or advertising?
- What is the best solution for a problem involving a disagreement between labor and management?

Data gathering can occur on many levels. In some cases, *unstructured observation* is useful. For example, simply watching a production line for an hour could help a person generate ideas for a more structured efficiency study. Or, a task-oriented group could be observed for clues about group discord. More analytical data gathering involves the use of *checklists* or *coding* of events or behaviors. Once data are collected, a second skill is to *summarize* the information in a meaningful form. If the information is quantitative, data from a checklist can be recorded in a variety of graphs, tables, or figures. Nonquantitative observations can be categorized or written up as a case study. The skill of selecting a way to represent data interacts with a third skill, *analyzing observational results*.

Social and interpersonal problem solving can also require data gathering. Much of this must be done via observation of people and their interactions. For problem-solving conflicts between two people, the needs of both persons must be known, and good listening skills can provide much of the necessary data. For example, if an employee gradually becomes less productive and less cooperative, a supervisor's listening skills might reveal problems ranging from poor health to financial problems to unsatisfactory working conditions. Such information gathering is critical for interpersonal problem solving.

Many interpersonal problems involve needs, preferences, or values of groups of people. Useful information can be collected via interest surveys, evaluation forms, or other questionnaires. One of the most effective ways to improve the quality of training programs is to conduct frequent anonymous evaluations by participants. Responses to objective items, when tallied, often reveal patterns of possible causes of problems. For example, ratings for the instructor's rapport with the class might be low, whereas ratings for instructional materials are high. Asking open-ended questions to uncover such causes can be extremely useful as well as give additional relevant information.

Objective observation of group dynamics is often the key to solving problems involving group cohesiveness and group productivity. In most groups, people assume roles (leader, follower, antagonist, peacemaker, clown). Observation of interactions among members of a group is useful information for a group facilitator.

If instruction in problem solving is to be transferable to real-life problems, students must learn to gather relevant information, and they must be armed with tools for recording and analyzing their observations.

Higher Order Problem-solving Skills

Since its inception in 1969, the National Assessment of Educational Progress (NAEP) has surveyed the knowledge, skills, and attitudes of over 1 million students. The Education Commission of the States (1983), which collects these data, reported that "today's minimum skills are demonstrated successfully by a majority of students. Higher order skills, however, are achieved only by a minority of 17-year-olds, and this proportion declined over the last decade. If this trend continues, as many as two million students may graduate in 1990 without the skills necessary for employment in tomorrow's marketplace" (p. 2). The Commission further noted that the "basics" of tomorrow are the higher level skills of today. These skills include the following:

- Evaluation and analysis
- Critical thinking
- Problem-solving strategies (including mathematical problem solving)
- Organization and reference
- Synthesis
- Application
- Creativity
- Decision making given complete information
- Communications skills through a variety of modes (ibid., p. 6)

A survey of 123 school systems showed these systems as evaluating students' preparation in the basic skill of reason as the weakest of all the skills (Henry and Raymond 1982). Sixteen percent of the schools acknowledged that "the majority of work force-bound students were inadequately prepared to reason through complex problems and decisions" (p. 21).

Lapointe (1984), executive director of the National Assessment of Educational Progress (NAEP), drew the following conclusion from NAEP findings.

> Closer examination of the data reveals that poorly developed problem solving skills hinder students' performance in mathematics. Indeed, weaknesses exist in the so-called higher-order skills in general. Most students do well with literal comprehension but lack the skill of inference, analysis, and interpretation. Today's definition of functional literacy calls for these higher-order skills more than ever before, even as students' mastery of them is seemingly on the decline. Clearly, a renewed focus on these skills is needed. (p. 606)

As students are faced with solving more and more complex problems, the need for them to acquire higher order problem-solving skills increases. For General Motors employees, some of these needed skills are problem analysis, decision making, and planning. Some higher order skills listed by Piaget (1952) are thinking hypotheticallly, observing and discovering patterns, establishing relationships, making generalizations, and showing sophistication with combinatorial and probabilistic thinking. Bloom et al.'s (1956) hierarchy of cognitive skills, described next, begins with knowledge of facts and extends to higher order skills.

- **Level 1: Knowledge**. The ability to recall specific facts, methods, procedures, terminology, rules, trends, classification schemes, criteria, methodology, principles, generalizations, theories, and structures. This level involves little more than retrieving stored information.

- **Level 2: Comprehension**. The ability to make use of what is being communicated; to translate or put information in another form (restate an idea, interpret a diagram, summarize, draw a picture); to interpret or reorder ideas and comprehend interrelationships. This level involves understanding ideas.

- **Level 3: Application**. The ability to apply knowledge and principles to actual situations; to generalize to another situation. This level involves putting into action knowledge that has been understood from level 2.

- **Level 4: Analysis**. The ability to classify or break material down into its components, to understand the relationships between the components, and to recognize the principle that organizes the structure or the system; to compare and contrast, to distinguish between fact and opinion, to recognize extraneous information, to recognize unstated assumptions, to compare theories. This level involves a kind of logical thinking similar to Piaget's formal operations.

- **Level 5: Synthesis**. The ability to bring together ideas and knowledge from many sources to form new ideas, methods, or procedures; unique communication, a plan, a set of operations, a strategy. This level involves creative or original thinking.

- **Level 6: Evaluation**. The ability to make quantitative and qualitative judgments, meaning to weigh, to examine, to analyze, to use criteria, to recognize the best of several reasonably good answers or solutions. This level requires the abilities of the first five levels and is crucial for substantive problem solving.

Although Bloom and his associates prepared their widely accepted taxonomy in 1956 as a guide for developing and evaluating educational objectives, actual classroom instruction has generally focused on level 1 and level 2 objectives. Bloom (1984) observed:

> Teachers in the United States typically make use of textbooks that rarely pose real problems. These textbooks emphasize specific content to be remembered and give students little opportunity to discover underlying concepts and principles and even less opportunity to attack real problems in the environments in which they live. The teacher-made tests (and standardized tests) are largely tests of remembered information. After the sale of over one million copies of *The Taxonomy of Educational Objectives—Cognitive Domain* (1956) and over a quarter of a century of the use of this domain in preservice and in-service teacher training, it is estimated that over 90% of test questions that U.S. public school students are now expected to answer deal with little more than information. Our instructional material, our classroom teaching methods, and our testing methods rarely rise above the lowest category of the Taxonomy—knowledge. (p. 13)

There is no better context within which to develop higher order skills than in the context of problem solving. A bonus in doing so is that the cognitive levels of knowledge and understanding can also be developed via problem solving. The National Council of Teachers of Mathematics (1980), in its *Agenda for Action—Recommendations for*

School Mathematics of the 1980s, had as its number one recommendation that mathematical content for K-12 be taught primarily in a problem-solving context.

Problem Solving in Groups

Problem solving in groups is now emerging as an important part of the work world for all levels of employees, not just managers (Pratzner and Russell 1984). Many companies are involving workers in diagnosing problems and implementing effective solutions. These organizations have implemented "quality circles programs," of which one important element is the quality control circle. Very briefly, quality control circles have these things in common:

- **Size**—Preferably 5-10 members
- **Volunteerism**—Freedom of choice to join
- **Meetings**—1 hour weekly, with exceptions
- **Skills**—Brainstorming, cause and effect analysis, data collection, effective-planning

Japanese industrialists have been using quality control circles since 1960. As many as 11 million workers are involved in the quality circle movement throughout Japan, and industries in all of the world's industrialized countries have shown interest in implementing the process. The Lockheed Company's Missile and Space Division in 1974 was the first organization in the United States to put the concept into action, and their $500,000 investment in the program resulted in an estimated savings of $3 million (Lloyd and Rehg 1983).

Lloyd and Rehg (1983) have listed organizations in the public sector that have implemented employee participation groups. Among these are the U.S. Air Force, the U.S. Army, the U.S. Navy, and the Federal Aviation Administration. Also listed were 162 organizations in the private sector that operate employee participation groups. Among these are such major companies as Bendix Corporation, Firestone, G. E. Major Appliances, General Foods, General Motors, Hewlett Packard, Hughes Aircraft, J. C. Penney, McGraw-Edison, Polaroid, 3M, Union Carbide, Uniroyal, and Westinghouse.

Not only are quality control circles advantageous for productivity in business and industry, they are very effective for problem solving in any organization. Lloyd and Rehg (1983) gave an example of effective use of quality control circles by school districts.

> A midwestern school district has used the QC process to solve problems that result from declining enrollments and escalating costs (Rehg 1982). Ten quality circles made up of administrators, faculty, staff, and citizens met to develop solutions which were then compiled and distributed to the ten groups. Consensus was reached, and the proposed solution was then presented to the public for review. The school board adopted the solution essentially as proposed by the quality circles. No complaints were received nor were any grievances filed despite the facts that some teachers were reassigned and some terminated, and that some schools were closed. In contrast, the school board, in an adjoining district facing a similar problem, made a unilateral decision to close certain schools. In response, a citizen's group filed a lawsuit in an attempt to block the closing. (p. 3)

Pratzner and Russell (1984) have delineated the skills, knowledge, and abilities needed for the high-involvement participative work setting. They list eight subcategories of skills under group problem solving: interpersonal, group process, problem solving, decision making, planning, communication, thinking, and reasoning. The specific skills for two of these categories are as follows:

- **Interpersonal Skills**

  —Self-directed
  —Flexible
  —Assertive
  —Open
  —Curious to learn
  —Able to share/teach
  —Responsive
  —Understanding of behavior

- **Communication Skills**

  —With individuals
  —With groups
  —Presentation skills
  —Verbal skills
  —Writing skills
  —Listening skills

The *Employee Participation Groups Member Manual* (Kolb and Baker 1980) is used to train General Motors employees to be effective group members. Many of the skills the employees learn are interpersonal skills. Here are some examples:

> **Involving others**—You may notice some people are quiet during a meeting. They may have information or ideas but may be reluctant to break into the discussion. You can "invite" them in. An example is: "John, we haven't heard from you yet. What do you think?"
>
> **Give credit—avoid "put downs"**—If you borrow another's idea or add to it, give them credit for the basic idea. If you don't like another's idea, avoid criticizing the person. An example is: "Mary's idea of using the scrap is a possibility. I like it better than not using the scrap." (Not using the scrap was Paul's idea.)

It is not sufficient for a person to be adept at problem-solving strategies without also having the good interpersonal skills that make group problem solving possible. Unlike individual problem solving, group solution strategies are usually arrived at through processes that require listening, empathy, cooperation, and concern for everyone's needs.

The five-step model, introduced earlier, is highly adaptable to group problem solving, whether mutual problems exist for only two individuals or a group. Some problems center around conflict of needs. That is, the needs of one or more persons are not being met, and a change in the behavior of the other person or persons is necessary to solve the problem. In such situations, the specific interpersonal skills listed earlier are necessary, particularly in understanding and defining the problem.

The Need for Interpersonal Skills in Negotiation

Whether used by individuals or in groups, interpersonal skills are central to successful negotiation, as described by Fisher and Ury in their 1983 best-seller, *Getting to Yes: Negotiating Agreement without Giving In*. Negotiations occur in everyday life, as when a person returns a defective product and needs a settlement or when price differences must be resolved. In more formal negotiating processes, individuals represent constituencies and negotiating sessions are sometimes hard-hitting encounters, even to the point of using "dirty tricks." Fisher and Ury, however, advocate an approach that consists of skillful interpersonal interactions combined with assertive skills. Some of the skills they mention are awareness of one's feelings, active listening, and "I-messages." "Human beings . . . are creatures of strong emotions who often have radically different perceptions and have difficulty communicating clearly. Emotions typically become entangled with the objective merits of the problem. . . : Figuratively if not literally, the participants should come to see themselves as working side by side, attacking the problem, not each other" (p. 11).

Conclusion

It is clear that the American workplace is placing increasing importance on employee problem solving and that interpersonal skills are needed to be effective in problem-solving groups. In addition, most citizens are involved in several groups in their daily lives—in classes they take, in PTAs, in social groups, in church groups—and the quality of their participation would be enhanced by being more skilled interpersonally. This fact is sufficient evidence for considering interpersonal skills "basic" and for seriously considering where and how they should be taught in the pretechnical curriculum.

There is a need for a formal curriculum for teaching problem-solving skills. Skills must be studied, analyzed, and practiced. At the same time, teachers should acquire these skills themselves so that they will be effective models for students. Teachers must be prepared to facilitate problem solving whenever the need arises. These learning experiences students will remember above all others. Active involvement in actual problem solving is invaluable and should occur at *all* grade levels.

IMPLEMENTATION

A word needs to be said about the interface of pretechnical education experiences, as proposed in this publication, with academic and technical education. The genesis of pretechnical skills occurs at a very young age. The ability to communicate, to solve problems, to cope with unexpected career changes develops over the years. These skills are taught not as an all-or-none strategy with a single episode of instruction. Rather, they are acquired slowly over time with costs borne of trial and error. A sound pretechnical curriculum would minimize the error and, thus, upgrade the process of acquiring pretechnical skills. Fully implemented, the concepts inherent in a pretechnical curriculum have implications for instruction at all levels of schooling. This publication focuses on the secondary school level because it precedes immediate preparation for work. Pretechnical concepts will be introduced in the primary grades, but the secondary grades are the ones where proficiency in these skills should be evident.

Much can be said about the integration of pretechnical skills with academic and technical skills. Some programs, such as those in New York, provide an introduction to careers and instruction in math and science (115 minutes a day each) at the seventh- and eighth-grade levels (Daggett 1984). Others, such as the experimental program at Great Oaks Joint Vocational School in Ohio, offer math and science instruction needed for an occupational area in sequence with the vocational curriculum (Migal 1984). Math and science materials are taught by subject-matter specialists and related to the student's occupational area. This integrated academic and vocational instruction is offered at the 11th and 12th grades.

In addition to the academic skills needed for an occupation, understanding of generalizable scientific principles is essential. For example, a knowledge of chemical action in electrolysis is necessary to understand types of electricity. A person glazing glass and plastics is helped by a knowledge of thermal expansion and contraction. Acids and bases play a role in the oxidation of plumbing devices. Students planning to enter a career area need to acquire requisite knowledge of that area. Hull and Pedrotti (1983) have outlined a structure for a high-technology curriculum that contains a core of technical knowledge in the areas of electricity, mechanics, fluids, graphics, and controls, among others. This technical knowledge is dependent upon an understanding of scientific laws that can be taught as technical information that is highly generalizable.

The design for implementation of a pretechical curriculum presented in this section synthesizes ideas of Dyrenfurth (1984) on technological literacy, of Levin and Rumberger (1983) on recurrent education, of Silberman (1983) on the goals of vocational education, and of Pratzner (1984b) on socio-technical literacy. It delineates skills to be addressed at various grade levels and responsibilities for teaching those skills.

Overall Responsibilities of Academic and Vocational Educators

The responsibility for providing pretechnical as well as technical education for youth and adults should be shared among all teachers. Leadership roles for implementing curricula belong to administrators at the local and State levels and to teachers serving on school committees and through professional organizations. The guidelines for implementation in this publication assume strong administrative endorsement of any proposed curricula. Vocational educators would be primarily responsible for appropriate application of pretechnical concepts within their areas of expertise, for example, agriculture, nursing, and business education. Vocational teachers need to cooperate and perhaps coordinate pretechnical units with academic teachers in the middle schools. Vocational teachers would be primarily responsible for teaching entry-level job skills and for preparing students to deal with their work lives (how to get and hold a job, how to make occupational decisions, and so forth). Individuals enter the labor force at different times in their lives, so vocational teachers must relate to a wide range of educational needs. For instance, they must provide for out-of-school youth who have not achieved a minimal level of technological literacy as well as for enrolled students who are seeking first jobs with minimal entry-level job skills.

Implementation Structure for the Proposed Curriculum

Pretechnical skills to be implemented in the proposed curriculum are depicted in figure 2. This structure assumes pretechnical skills are needed by youth and adults throughout their life stages. One person may have mastered job search behavior at the secondary level, but another may be a 35-year-old displaced worker who is learning for the first time to look for employment. Structures proposed for vocational education must allow all individuals, regardless of age, access to vocational education.

The generalizable skills, transition skills, and problem-solving skills depicted in figure 2 show up in grades 7-10 and again in grades 11-12. They occur in the curriculum during the later grade levels at increasingly more detailed skills levels. A 12th-grade student, for example, should be more competent to search for occupational information to identify prospective employers than a high school freshman. The determination of which teacher presents a particular instructional unit to selected students should be left to curriculum developers in local school systems. However, every student needs to become proficient in these skills to attain his or her career goals.

The skills taught in grades 11 and 12 are likely to be taught in specific career cluster classes. The New York program (Daggett 1984, p. 13), for example, reserves grades 11 and 12 for specialized occupational programs. These programs allow broad-based, pretechnical skills to be fine tuned. For example, a typist may be taught in the 10th grade how to set up a letter and produce it according to a commonly accepted format. But, the demands of the marketplace may require that a typist vary the margins or typeface in a letter to facilitate the function of a specific job. The generalizable, transition, and problem-solving skills taught at earlier grade levels are applied within areas of specialization.

Pretechnical skills development may extend into postsecondary levels for adults and out-of-school youth. They may be integrated into very general courses with a view toward helping students select technical courses, or they may be taught to develop specific prerequisite skills for a particular technology. Courses in computer science, for example, often require high levels of computational skills. These courses are similar to ones taught within comprehensive high schools or at joint vocational schools. At the Great Oaks Joint Vocational School District in Ohio, for example, a course taught in technical communications leads into careers such as sales, clerical specialty, and broadcasting.

Generalizable Skills
- Reasoning
- Communication
- Mathematical
- Interpersonal
- Attitudinal
- Technological

Transition Skills
- Change in Environment
- Change in Relationships
- Change in Self
- Stress, Loss, Grief
- Decision Making

Problem-solving Skills
- Cooperative Group Skills
- Interpersonal Skills
- Information-related Skills
- Task-related Skills
- Understanding Human Behavior

PRETECHNICAL EDUCATION (7 - 12)		TECHNICAL EDUCATION
EDUCATIONAL LEVEL: 7-10	EDUCATIONAL LEVEL: 11-12	EDUCATIONAL LEVEL: 13 and beyond
CONTENT: Generalizable Skills Transition Skills Problem-solving Skills	CONTENT: Generalizable Skills Transition Skills Problem-solving Skills Entry-level Job Skills High Tech Skills (The emphasis will be on simulations)	CONTENT: Job skills related to specific occupations
INSTRUCTIONAL RESPONSIBILITY: Cooperative teams of vocational teachers and academic teachers	INSTRUCTIONAL RESPONSIBILITY: Vocational educators	INSTRUCTIONAL RESPONSIBILITY: Vocational educators Industrial trainers Apprenticeship programs

↓

ENTRY-LEVEL JOBS, TRAINING PROGRAMS, AND RETRAINING PROGRAMS

Figure 2. Implementation structure

Responsibility for Teaching Generalizable Skills

Generalizable skills are those that are actively used in work performance, which are transferable across jobs, and that are instrumental to success on the job and in the classroom. Typically, generalizable skills are associated with the traditional subject-matter classes such as mathematics, reading, English, social studies, and science and include reasoning, communication (written and oral), interpersonal, and attitudinal skills attainment. These well-formed bodies of knowledge are the "basics" of grades 7 through 12. It is appropriate and necessary that subject matter specialists continue to teach these generalizable skills.

However, researchers have suggested that there exist other generalizable skills that intersect with every subject-matter field and vocational education class (Adler 1982; Brammer and Abrego 1981; Daniels and Karmos 1983; DeBevoise 1982; Gibbons 1984; Gisi and Forbes 1982; Goodlad 1983; Pratzner and Ashley 1984; Timpane 1982). These skills have been classified as transition skills and problem-solving skills. Transition skills have seldom been taught directly, and problem-solving skills that have been taught within specific content areas (math, science, and so forth) have been highly context bound and taught in such a way that transferability is not likely. Subject-matter teachers should be trained to integrate general models for transition skills and problem-solving skills into their curricula and to apply the models in their areas of expertise.

General models for transition skills and problem-solving skills have been presented in this publication. As figure 2 shows, it is proposed that *all* 7th- through 12th-grade teachers be trained to implement these models. For problem solving, two purposes would be served. Problem solving would be taught in all subject-matter areas, and a unified approach to problem solving across context and situation would result, thus increasing the likelihood of transferability. Application of the general transitions model would result in direct training for adapting to the educational and developmental changes that affect many areas of 7th- through 12th-grade students' lives and that continue across their life spans. Their awareness of the applications of transition management skills in all subject-matter-related areas would also be enhanced.

The responsibility of vocational educators in grades 7 through 12 is central to the implementation of problem-solving and transition skills in that they act as liaisons between the work world and academic teachers to strengthen and increase the applicability of problem solving and the reality of transitions that will be confronted during work life. From grade 11 on, vocational educators have the additional responsibility of passing on the skills for *getting* and *holding* a job and for assisting students in choosing high-tech or other specific skills training. Each of these situations would involve use of the problem-solving and transition skills and emphasize hands-on applications and simulations.

Problem solving is a difficult subject to teach. But there are some essential guidelines:

- Students must be given substantive problems to solve and must pursue their solutions actively. People learn by doing and their "doing" must have substance. There is no merit in teachers' being superb at teaching trivia.

- Students are to be armed with models and strategies for solving problems. Breaking problems into simple parts, making sketches, reading carefully, and so on, are all necessary strategies for good problem solving.

- Knowledge in specific content areas is necessary for solving problems in that area. One can't solve many problems in mathematics if one doesn't know much math. The best problem solvers have a very broad base of specific and general knowledge.

- Some problems are more appropriately solved in a group setting and others in an individual setting. The group setting needs to be used more so students can better learn the give and take of *cooperation* that is now so vital to business and industry.

- Students need to reflect more about themselves as problem solvers (e.g., "What kinds of problems do I have difficulty with?" "What are my strengths, weaknesses?" "Where do I need to improve?" "What can I learn from that mistake?" "How do I learn best—hearing, seeing, touching, imagining?" "Where do I go for help?") Students can become better problem solvers, and educators can improve materials and instruction to aid in learning (for helping it happen).

An Instructional Strategy for Vocational Educators

An effective strategy for teaching problem-solving and transition skills within vocational education is through simulation. Good *simulations* require real-life representations of essential skill needs. The successful resolution of problems presented by the simulation provides an opportunity for students to gain experience and confidence in their use of pretechnical skills.

Vocational educators should develop simulations that reflect actual work-related problems and transitions such as problems with quality of work; worker-supervisor conflicts; and transitions caused by losing jobs, being unemployed, being transferred or retrained, losing friends, being divorced, or being promoted. Simulations can be developed for situations specifically related to problems encountered in automotive work, air-conditioning, metal work, agriculture, and so forth. These simulations should involve many subject-matter areas (reading comprehension, understanding graphs, utilizing technical information) and could substantively involve generalizable skills. For example, a nonfarm agricultural business—such as a lawn and garden store—often has to respond to customers' needs for insecticides and herbicides. An employee must be able to locate the proper treatment and communicate technical reasons for its application in a clear and concise manner. Simulations provide a rich domain for students as they continue to develop and apply skills for analyzing and synthesizing information, and from which they may generalize in conclusions and evaluations. Vocational educators can make school "come alive" for students by simulating problems and transitions that are occurring in their lives, and students could use problem-solving and transition skills to manage the simulation. This would enable students to gain confidence in their abilities to manage critical problems and transitions in their personal and work lives.

Resources and Guidelines for Implementation of the Transition Model

The transition model is applicable to almost any kind of transition. The model may be used by students contemplating career or college choices, experiencing the loss of a friendship, or dealing with the loss of a parent through death or divorce. A variety of existing programs may be integrated into a curriculum.

- Danish and D'Augelli (1980) have developed a comprehensive approach to teaching coping skills for preventing crisis and stress. The program teaches life development skills necessary for dealing with anticipated transitions. It also deals with ways of managing crises or unplanned events and stresses communication and helping skills.

- Brammer and Abrego (1981) use problem-solving strategies as skills for coping with and responding to transitions.

- Meichenbaum (1977) presents guidelines for training people to cope with stress. The training model emphasizes cognitive skills and recognizes individual and cultural differences.

- Fuchs and Rehm's (1977) program trains people to manage feelings and emotions when dealing with transitions.

Two references—Abrego and Brammer (1979) and Schlossberg (1984)—are useful for high school teachers. Both give excellent suggestions for helping students handle transitions. Some additional guidelines for implementation in the 7th-through 12th-grade curriculum are as follows:

- Students should become aware that life transitions are natural and inevitable and that they already have personal resources for dealing with them.

- Students should first examine and analyze transitions they are *already experiencing*. They should become aware of their values, interpersonal skills, competencies, and other personal resources that strengthen their ability to cope with change.

- Students should perceive instruction as relevant to their present lives so that a meaningful extension can be made to typical anticipated and unanticipated transitions later in life.

- Students should become aware of future *anticipated* transitions such as graduating, leaving home, and so on, and future *unanticipated* transitions such as not being accepted for college, losing a job, losing a spouse, and so forth.

- Throughout the study of transitions, the model for handling transitions should be consulted as a problem-solving strategy.

A Problem-solving Model for Teacher Training and Classroom Use

In addition to a model for teaching about transitions, all teachers should have a general problem-solving model. Students could use the model to solve problems from any part of the curriculum, especially those presented in simulated situations. For students to hold jobs, be retrained, and in general to adapt to a constantly accelerating rate of change in their lives, they will need strategies for attacking and solving problems. Knowing how to use at least one general model is an essential strategy. There are many different models, including the one presented by the authors earlier in this publication.

Conclusion

This publication has presented conclusions from a broad investigation of the work world of the future and the skills needed to survive and succeed in that world. Based on these conclusions, the authors have developed several products: a model for pretechnical curricula, criteria for evaluating existing curricula, an implementation design, and models and resources for teaching two nontraditional categories of highly transferable skills—managing transitions and problem solving. Much work remains to be done. This publication is only a beginning.

APPENDIX

Additional Sources

For other excellent sources for information on transfer of problem-solving skills, see the following:

The Edward deBono School of Thinking, P.O. Box 711, Larchmont, NY 10538.

Institute of Advancement of Philosophy for Children, Montclair State College, Upper Montclair, NJ 07043.

The Productive Thinking Program from the Charles E. Merrill Publishing Company in Columbus, OH.

Problem Solving and Comprehension by Arthur Whimbey and Jack Lochhead, The Franklin Institute Press, Philadelphia, PA, 1979.

More Life Skills by Joan Hearn, Advanced Development Division, Employment and Immigration, Ottawa, Canada, K1A OJ9, 1982.

Problem Solving in School Mathematics, 1980 Yearbook, National Council of Teachers of Mathematics, Reston, VA.

Instrumental Enrichment by Reuven Feuerstein, University Park Press, Baltimore, MD, 1980.

The New MCAT Student Manual (Quantitative Skills) from the Association of American Medical Colleges, Washington, DC, 1984.

Medical College Admission Test (Quantitative Skills) by Morris Bramson and Lawrence Solomon, Arco Publishing, Inc., NY, 1982.

A Complete Preparation for the New MCAT, Vol. II (Quantitative Skills) by Beryl Brain, Drew Love, and Philip Kelleher, Health Professional Education Service, Inc., Bethesda, MD, 1981.

The World Future Society published a directory of information resources that includes descriptions and references for 45 simulation games (Cornish 1979, pp. 627-638). Some other resources are the following:

Simulation Games for the Social Studies Classroom by William A. Nesbitt, Foreign Policy Association, Glenview, IL, 1971.

Simulation Games in Learning by Sarane Boocock and E. O. Schild, Sage Publications, Beverly Hills, CA, 1968.

There are many commercial programs for teaching problem solving. The June 1983 issue of the *Phi Delta Kappan* listed more than 30 programs, videotaped presentations, computer-assisted instruction, instructional programs for teachers, and materials for student use.

REFERENCES

Abrego, P., and Brammer, L. *Developing Coping Skills for Career-related Changes. Module 42.* Palo Alto, CA: American Institutes for Research, 1979. (ERIC Document Reproduction Service No. ED 182 676).

Adler, M. J. *The Paideia Proposal.* New York: Macmillan, 1982.

AFL-CIO Committee on the Evolution of Work. *The Future of Work.* Washington, DC: AFL-CIO Executive Council, 1983. (ERIC Document Reproduction Service No. ED 233 137).

Ashley, W. L.; Cellini, J.; Faddis, C.; Pearsol, J.; Wiant, A.; and Wright, B. *Adaptation to Work: An Exploration of Processes and Outcomes.* Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1980. (ERIC Document Reproduction Service No. ED 199 428).

Ashley, W. L.; Zahniser, G. C.; and Connell, J. B. *Assisting Dislocated Workers: A Collection of Practices and Resources.* Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1984.

Baker, D. E. "Illinois' Economic Future and New Technology: The Special Role of Vocational Education." Testimony before the House Education and Labor Subcommittee on Elementary, Secondary and Vocational Education, 1982.

Bloom, B. S. "The 2-Sigma Problem: The Search for Methods of Group Instruction as Effective as One-to-One Tutoring." *Educational Researcher* 13, no. 6 (June-July 1984): 4-16. (ERIC No. EJ 303 699).

Bloom, B. S.; Engelhart, M. D.; Furst, E. J.; Hill, W. H.; and Krathwohl, D. R. *Taxonomy of Educational Objectives, Handbook I, Cognitive Domain.* New York: Longmans, Green, 1956.

Botkin, J.; Dimancescu, D.; and Stata, R. *Global Stakes: The Future of High Technology in America.* Cambridge, MA: Ballinger, 1982.

Boyer, E. L. *High School: A Report on Secondary Education in America.* New York: Harper and Row, 1983.

Brammer, L. M., and Abrego, P. S. "Intervention Strategies for Coping with Transitions." *Counseling Psychologist* 9, no. 2 (1981): 19-36.

Bridges, W. *Transitions: Making Sense of Life's Changes.* Reading, MA: Addison-Wesley, 1980.

Brown, A. L. *Mental Orthopedics, the Training of Cognitive Skills: An Interview with Alfred Binet.* Urbana: University of Illinois, Center for the Study of Reading, 1984.

Cornish, E. S. *The Future—A Guide to Information Sources*. Washington, DC: World Future Society, 1979.

Craig, P. G. *Structural Changes in the Economy and Future Job Prospects*. Occasional Paper no. 92. Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1983. (ERIC Document Reproduction Service No. ED 239 107).

Daggett, W. R. *Strategic Vision and Planning: Keys to Educational Improvement*. Occasional Paper no. 100. Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1984.

Daniels, H., and Karmos, J. *Skills for Adapting to Change*. Carbondale: Southern Illinois University, 1983. (ERIC Document Reproduction Service No. ED 237 687).

Danish, S. J., and D'Augelli, A. R. "Promoting Competence and Enhancing Development through Life Development Intervention." In *Competence and Coping during Adulthood*, edited by L. A. Bond and J. C. Rosen. Hanover, NH: University Press of New England, 1980.

DeBevoise, W. "Education and Technology: Predicting the Needs of the Future." In *R & D Perspectives*. Eugene: Center for Educational Policy and Management, University of Oregon, 1982.

deBono, E. *The Learning-to-Think Coursebook*. New York: Edward deBono School of Thinking, 1982.

Dyrenfurth, M. J. *Literacy for a Technological World*. Information Series no. 266. Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1984. (ERIC Document Reproduction Service No. ED 241 715).

Education Commission of the States. *Action for Excellence*. Denver: Education Commission of the States, 1983. (ERIC Document Reproduction Service No. ED 235 588).

Elliman, P. J. *Critical Issues in Vocational Education: An Industrialist's View*. Occasional Paper no. 95. Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1983.

Exner, R., and Kaufman, B. *Introductory Logic*. St. Louis, MO: CEMREL, 1973.

Faddis, C.; Ashley, W. L.; and Abram, R. E. *Preparing for High Technology—Book 2: Strategies for Change*. Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1982. (ERIC Document Reproduction Service No. ED 216 168).

Feuerstein, R. *Instrumental Enrichment*. Baltimore: University Park Press, 1980.

Fisher, R., and Ury, W. *Getting to Yes: Negotiating Agreement without Giving In*. New York: Penguin Books, 1983.

Frey, D. N. *The Economy, Productivity, and Training—A CEO's View*. Occasional Paper no. 88. Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1983. (ERIC Document Reproduction Service No. ED 225 001).

Fuchs, C., and Rehm, L. "A Self-Control Behavior Therapy Program for Depression." *Journal of Consulting and Clinical Psychology* 45 (April 1977): 206-215. (ERIC No. EJ 156 801).

Gibbons, M. "Walkabout Ten Years Later: Searching for a Renewed Vision of Education." *Phi Delta Kappan* 65, no. 2 (May 1984): 591-600. (ERIC No. EJ 298 048).

Gisi, G. C., and Forbes, R. *The Information Society: Are High School Graduates Ready?* Denver: Education Commission of the States, 1982. (ERIC Document Reproduction Service No. ED 223 812).

Glaser, R. "Education and Thinking." *American Psychologist* 39, no. 2 (February 1984): 93-104.

Goodlad, J. I. *A Place Called School: Prospects for the Future*. New York: McGraw-Hill. 1984.

———. "A Study of Schooling: Some Implications for School Improvement." *Phi Delta Kappan* 13, no. 6 (April 1983): 552-558. (ERIC No. EJ 279 532).

Gordon, T. *Teacher Effectiveness Training*. New York: David McKay Company, 1974.

Gould, R. *Transformations: Growth and Change in Adult Life*. New York: Simon and Schuster, 1978.

Greenan, J. P. *Identification of Generalizable Skills in Secondary Vocational Programs*. Urbana: University of Illinois, 1983. (ERIC Document Reproduction Service No. ED 233 223).

Guest, R. "Quality of Work Life." *Harvard Business Review* 57, no. 4 (1979): 76-88.

Gyllenhammer, P. G. *People at Work*. Reading, MA: Addison-Wesley, 1977.

Hearn, J. *More Life Skills*. Ottawa: Canada Employment and Immigration Commission, 1982. (ERIC Document Reproduction Service No. ED 218 437).

Henry, J. F., and Raymond, S. U. *Basic Skills in the U.S. Work Force*. New York: Center for Public Resources, 1982.

Herbst, P. G. *Socio-technical Design*. London: Tavistock Publishers, 1974.

Hull, D. M., and Pedrotti, L. S. "Meeting the High-Tech Challenge." *VocEd* 58, no. 4 (May 1983): 28-31. (ERIC No. EJ 279 084).

Johnson, T. W. *Philosophy for Children: An Approach to Critical Thinking*. Bloomington, IN: Phi Delta Kappa Educational Foundation, 1984. (ERIC Document Reproduction Service No. ED 242 629).

Kolb, D. A., and Baker, R. J. *Employee Participation Groups Member Manual*. Detroit: General Motors, 1980.

Lapointe, A. E. "The Good News about American Education." *The Phi Delta Kappan* 65, no. 10 (June 1984): 663-667. (ERIC No. EJ 299 507).

Lemons, C. D. *Education and Training for a Technological World*. Information Series no. 267. Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1984. (ERIC Document Reproduction Service No. ED 240 384).

Levin, H. M. *Education and Jobs in a Technological World*. Information Series no. 265. Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1984. (ERIC Document Reproduction Service No. ED 240 383).

Levin, H. M., and Rumberger, R. W. *The Implications of High Technology*. Project Report no. 8344. Washington, DC: National Institute of Education, 1983.

Levinson, D. J.; Darrow, C.; Klein, E.; Levinson, M.; and Mckee, B. *Season's of a Man's Life*. New York: Alfred A. Knopf, 1978.

Lloyd, R. F., and Rehg, V. R. *Quality Circles: Applications in Vocational Education*. Information Series no. 249. Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1983. (ERIC Document Reproduction Service No. ED 229 607).

Meichenbaum, D. *Cognitive Behavior Modification*. New York: Plenum Press, 1977.

Migal, C. A. "Teachers Are Part of the Team." *VocEd* 59, no 5 (August 1984): 42-44.

Moos, R. H., and Tsu, V. "Human Competence and Coping: An Overview." In *Human Adaptation: Coping with Life Crises*, edited by R. H. Moos. Lexington, MA: Heath, 1976.

Naisbitt, J. *Megatrends: Ten New Directions Transforming Our Lives*. New York: Warner Books, 1982.

National Academy of Sciences. *High Schools and the Changing Workplace: The Employers' View*. Washington, DC: The National Academy of Sciences, 1984. (ERIC Document Reproduction Service No. ED 244 081).

National Commission on Excellence in Education. *A Nation at Risk: The Imperative for Educational Reform*. Washington, DC: National Commission on Excellence in Education, 1983. (ERIC Document Reproduction Service No. ED 226 006).

National Council of Teachers of Mathematics. *Agenda for Action—Recommendations for School Mathematics of the 1980s*. Reston, VA: National Council of Teachers of Mathematics, 1980.

Piaget, J. *The Origin of Intelligence in Children*. New York: International University Press, 1952.

Pierson, G. W. *de Tocqueville and Beaumont in America*. New York: Oxford University Press, 1938.

Polya, G. *How to Solve It*. 2nd Ed. Garden City, NY: Doubleday Anchor Books, 1957.

————. "The Redirection of Vocational Education in Comprehensive High Schools." *Journal of Industrial Teacher Education* 21, no. 3 (Spring 1984c): 3-12.

Pratzner, F. C. *Occupational Adaptability and Transferable Skills*. Information Series no. 129. Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1978. (ERIC Document Reproduction Service No. ED 186 717).

———. "Quality of School Life: Foundations for Improvement." *Educational Researcher* 13 (March 1984a): 20-25. (ERIC No. EJ 296 329).

———. "Socio-Technical Literacy: An Alternative View of Vocational Education." Paper presented at "Jobs and Skills for Alabama's Future," First Annual Invitational Conference of the Center for Vocational and Adult Education, Auburn University, 1984b.

Pratzner, F. C., and Ashley, W. L. *Occupational Employability and Transferable Skills: Preparing Today's Adults for Tomorrow's Careers.* Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1984.

Pratzner, F. C., and Russell, J. F. *The Changing Workplace: Implications of Quality of Work Life Developments for Vocational Education.* Research and Development Series no. 249. Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1984. (ERIC Document Reproduction Service No. ED 240 283).

Ravitch, D. "On Thinking about the Future." *Phi Delta Kappan* 65, no. 5 (January 1983): 317-320. (ERIC No. EJ 276 269).

Rumberger, R. *Demystifying High Technology.* Occasional Paper no. 97. Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1984. (ERIC Document Reproduction Service No. ED 240 305).

Schlossberg, N. K. "A Model for Analyzing Human Adaptation to Transition." *Counseling Psychologist* 9 (1981): 2-19.

———. *Counseling Adults in Transition: Linking Practice and Theory.* New York: Springer, 1984.

Schneider, J. *Stress, Loss and Grief.* Baltimore. University Park Press, 1984.

Schultz, T. W. "Nobel Lecture: The Economics of Being Poor." *Journal of Political Economy* 88 (1980): 639-651.

Selz, N. *The Teaching of Employability Skills: Who's Responsible?* Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1980. (ERIC Document Reproduction Service No. ED 199 429).

Silberman, H. F. *Determining Goals for Vocational Education.* Occasional Paper no. 96. Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1983. (ERIC Document Reproduction Service No. ED 239 109).

Snowman, J. "Learning Tactics and Strategies." In *Cognitive Instructional Psychology: Components of Classroom Learning*, edited by G. D. Phye and T. Andre. San Diego, CA: Academic Press, 1984.

Timpane, M. *Corporations and Public Education in the Cities.* New York: Carnegie Corporation of New York, 1982. (ERIC Document Reproduction Service No. ED 230 648).

Toffler, A. *Future Shock.* New York: Random House, 1970.

U.S. House of Representatives. *The Human Factor in Innovation and Productivity*. Washington. DC: Subcommittee on Science, Research, and Technology, U.S. House of Representatives, 97th Congress, 1982. (ERIC Document Reproduction Service No. ED 225 814).

Whimbey, A., and Lochhead, J. *Problem Solving and Comprehension*. Philadelphia: The Franklin Institute Press, 1979.

Whimbey. A., and Lochhead, J. *Beyond Problem Solving and Comprehension*. Philadelphia: The Franklin Institute Press, 1984.

Wirth, A. G. *Alternative Philosophies of Work: Implications for Vocational Educational Research and Development*. Occasional Paper no. 78. Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1981. (ERIC Document Reproduction Service No. ED 212 828).

Wirth. A. G. "Issues Affecting Education and Work in the Eighties: Efficiency versus Industrial Democracy, A Historical Perspective." *Teachers College Record* 79, no. 1 (September 1977): 55-67. (ERIC No. EJ 170 714).

TO ORDER ADDITIONAL COPIES OF THIS PUBLICATION, USE—	ORDER NUMBER	PRICE
• *Toward Excellence in Secondary Vocational Education: Developing Pretechnical Curricula*	IN 295	$5.50

TO ORDER RELATED PUBLICATIONS, REFER TO—		
• *Toward Excellence in Secondary Vocational Education: Elements of Program Quality*	IN 291	$4.75
• *Toward Excellence in Secondary Vocational Education: Implementing Standards*	IN 292	$4.25
• *Toward Excellence in Secondary Vocational Education: Improving Teaching*	IN 293	$4.75
• *Toward Excellence in Secondary Vocational Education: Using Evaluation Results*	IN 294	$4.75
• *Toward Excellence in Secondary Vocational Education: Providing Job Training*	IN 296	$4.75
• *Toward Excellence in Secondary Vocational Education: Using Cognitive Psychology in Curriculum Planning*	IN 297	$7.25
• *The Unfinished Agenda: The Role of Vocational Education in the High School*	IN 289	$4.75

ORDERING INSTRUCTIONS

To order additional copies, please use order number and title. Orders of $10.00 or less should be prepaid. Make remittance payable to the National Center for Research in Vocational Education. Mail order to:

The National Center for Research
in Vocational Education
National Center Publications, Box F
1960 Kenny Road
Columbus, Ohio 43210–1090

Prices listed are in effect at the time of publication of this book. All prices include postage and handling. Prices are subject to change without notice.

Quantity Discounts

Orders of five (5) or more items, as listed by publication number and title, with a total dollar value for the order of:

$ 50 to $100, the discount is 5%
$101 to $200, the discount is 10%
$201 to $300, the discount is 15%
$301 to $400, the discount is 20%
$401 and above, the discount is 25%

International Orders

All orders, in any amount, from outside the United States and its possessions are to be paid in U.S. currency. Additional postage and handling charges may be added for foreign shipments if necessary.