DOCUMENT RESUME

ED 146 420 95 CE 013 528

AUTHOR Sjogren, Douglas
TITLE Occupationally-Transferable Skills and Characteristics: Review of Literature and Research. Information Series No. 105.
INSTITUTION Ohio State Univ., Columbus. Center for Vocational Education.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
PUB DATE Mar 77
CONTRACT NE-C-00-3-0078
NOTE 38p.
AVAILABLE FROM Center for Vocational Education Publications, Ohio State University, 1960 Kenny Road, Columbus, Ohio 43210, ($2.80)

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS Basic Skills; *Job Skills; Literature Reviews; *Occupations; Research Reviews (Publications); *Transfer of Training; *Vocational Education

ABSTRACT

In this synthesis of research and literature on the nature of occupationally-transferable skills, the author identifies skills that seem to be highly transferable in the sense of being general to a number of occupations. He then speculates about characteristics of skills that are generalizable or transferable and discusses some implications for educational programs, hiring, and employment search practices, and for research. Specific transfer questions also addressed are these: Are there optimal sequences for developing the component skills of complex behaviors? At what level of abstraction should a skill be taught? and Are some behaviors more amenable to training than others? Close attention is given to three studies: (1) the "Dictionary of Occupational Titles" classification of occupations according to common elements, (2) the generic skills project of W.J. Kawula and A. Smith, and (3) research on egometrics (application of psychometric principles and procedures to the study of human work) directed by J. William Cunningham. The author concludes that there is no nontransferable skill and that a good education through high school will provide an individual with a good repertoire of skills for the world of work. A further conclusion is that training programs should be designed to teach specific skills very well and to allow for skill practice in a variety of situations after ensuring utility for one situation. (JT)

Information Series No. 105

OCCUPATIONALLY-TRANSFERABLE SKILLS AND CHARACTERISTICS:

Review of Literature and Research

Douglas Sjogren
Colorado State University
Fort Collins, Colorado

The Center for Vocational Education
The Ohio State University
1960 Kenny Road
Columbus, Ohio 43210

March 1977

An Interim Report
On a Project Conducted Under
Contract No. NE-C-00-3-0078

The material in this publication was prepared pursuant to a contract with the National Institute of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under government sponsorship are encouraged to freely express their judgement in professional and technical matters. Points of view or opinions do not, therefore, necessarily represent official National Institute of Education position or policy.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

National Institute of Education

THE CENTER MISSION STATEMENT

The Center for 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 Center fulfills its mission by:

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

FOREWORD

Because many people change jobs, and some do so frequently, future education and work programs have to be concerned with and improve the ability of individuals to make career changes. Under sponsorship by the National Institute of Education, The Center is conducting research and development on questions of what schools should be teaching to all students to improve their chances of adapting to new jobs when a job change is desirable or necessary.

One interim product of the effort is this review of literature and research on occupationally-transferable skills. This summary and discussion serves as one component of a multifaceted R&D effort aimed at identifying the types of personal and job characteristics that previous research has identified as common and potentially transferable from one work situation to another. The review is intended to form the basis for a synthesis of what is presently known about the skills and personal characteristics useful in a wide range of job settings and their implications for education and occupational adaptability. While the focus of the review is the identification of transferable skills and characteristics, the author discusses briefly three related critical questions where the literature and research are less clear and compelling, and offers some thoughts and conclusions on each.

Published separately but augmenting this review of occupationally-transferable skills are two other review papers. Though prepared independently, all three papers relate to the common concern for identifying factors that can facilitate occupational adaptability. One paper (*Transferability of vocational skills: Review of literature and research,* Info. Series No. 103) is a review of what is known about the transferability of occupational skills, focusing on the process or the facilitators of skill transfer. The other (*Characteristics of jobs that are considered common: Review of literature and research,* Info. Series No. 102) is a review of what is known about the characteristics of jobs that are considered common. It focuses on various approaches to job classification, exploring how they may contribute to a better understanding of occupational adaptability and skill transfer. These and other planned project reports are listed inside the back cover of this report.

We wish to express our deep appreciation to Dr. Sjogren for his scholarship in the preparation of the report. We also want to thank Mr. Arthur DeWitt Smith, Department of Manpower and Immigration, Ottawa, and extend appreciation to the project's Panel of Consultants: Dr. Marcia Freedman, Conservation of Human Resources; Dr. Jerome Moss, University of Minnesota; Dr. Calvin Taylor, University of Utah, for their helpful reviews and discussions of the paper. Special appreciation is extended to Mr. Robert Stump, National Institute of Education, for his help and contributions throughout the project and to the development of this report.

The report was prepared under the general oversight of Dr. Frank C. Pratzner, program director of The Center's study of occupationally-transferable skills.

Robert E. Taylor
Executive Director
The Center for Vocational Education

TABLE OF CONTENTS

FOREWORD iii

INTRODUCTION 1

TRANSFER ISSUES 1

DEFINITIONS 2

Transfer 2
Skill 2

QUESTION ONE—WHICH SKILLS ARE HIGHLY TRANSFERABLE? 5

Dictionary of Occupational Titles 8
Generic Skills Project 14
Ergometrics 18
Discussion 22

QUESTION TWO—ARE THERE OPTIMAL SEQUENCES FOR DEVELOPING THE COMPONENT SKILLS OF COMPLEX BEHAVIORS? 23

QUESTION THREE—AT WHAT LEVEL OF ABSTRACTION SHOULD A SKILL BE TAUGHT? 23

QUESTION FOUR—ARE SOME BEHAVIORS MORE AMENABLE TO TRAINING THAN OTHERS? 25

CONCLUSION 25

BIBLIOGRAPHY 27

LIST OF TABLES

1 Composite List of Transferable Skills Identified by Conference Participants 7

2 Percent of DOT Worker Trait Groups at Each Level on Data, People, Things Dimensions 9

3 Percent of Times a GED Category Is Listed in Qualification Profiles of DOT Worker Trait Groups 10

4 Percent of Times Each Level of an Aptitude Is Listed in Qualification Profiles of DOT Worker Trait Groups 11

5 Percent of Times a Temperament Is Listed in Qualification Profiles of DOT Worker Trait Groups 13

6 Percent of Times a Physical Demand Category Is Listed in Qualification Profiles of DOT Worker Trait Groups 13

7 Content of Core Skill Clusters of Nonsupervisory Occupations in Generic Skills Project 15

8 Content of Core Skill Clusters of Supervisory Occupations in Generic Skills Project 16

9 Content of Separate Skill Clusters in Generic Skills Project 17

10 Percent of 622 Work Elements for Which an Attribute Is Judged Relevant in Ergometrics Project 20

INTRODUCTION

The purpose of writing this paper was to attempt to synthesize research and literature on the nature of occupationally-transferable skills. More specifically we have attempted to identify skills that seemed to be highly transferable in the sense of being general to a number of occupations. We have then speculated about characteristics of skills that are generalizable or transferable. Finally, we have discussed some implications for educational programs, hiring and employment search practices, and for research.

A primary concern of education has been and continues to be whether the knowledge and skills learned in school transfer to other situations. Curricula are developed to a great extent on the basis or expectation that the sequence optimizes transfer from one level to the next and that the end product transfers to out-of-school situations.

Transfer of knowledge and skills is of special concern in occupationally oriented programs such as vocational, technical, and professional preparation programs and training programs in business and industry. Clearly such programs are based on the assumption that there is a direct transfer of knowledge and skill from the educational program to the job situation. Yet, there is very little empirical support for this assumption. One might conclude that the expectation of transfer is mostly an act of faith. On the other hand, it may be that the informal empirical support is so pervasive and obvious that it is unnecessary to attempt to study the problem formally, if indeed there is even a problem. It seems quite rational to expect that a person who has learned how to tune an automobile or write a computer program in an educational setting is going to be able to perform the task in other settings.

TRANSFER ISSUES

The preceding paragraph suggests that transfer is really *not* an issue or problem. If there is a strong possibility that knowledge and skills transfer across situations, why worry about it? The question or problems as we perceive then, are listed below:

1. There are many different occupations and many different occupational skills. The problem is to decide which occupational skills to teach to provide an optimal preparation for employability both in a specific job and in a variety of jobs.

2. Job behaviors vary in terms of complexity. The question is whether there are optimal sequences for developing the skills that are components of complex behaviors.

3. Job behaviors vary in terms of situational specificity. The associated problem, then, is determining the level of abstraction that is required to permit reasonably efficient transfer to any given situation.

4. With our present level of knowledge, some job behaviors are more amenable to training than others. The problem is to determine those that can be dealt with effectively and efficiently in an educational/training setting.

We have attempted to address each of these matters in this paper, although the primary emphasis is on the first. Before the discussion of each, however, it is important that some key terms used in this paper be defined.

DEFINITIONS

Transfer

Ellis (1965) provides a nice phrasing of the classical definition of transfer.

> Transfer of learning means that experience or performance on one task influences performance on some subsequent task. Transfer of learning may take three different forms: (1) performance on one task may *aid* or facilitate performance on a second task, which represents *positive transfer;* (2) performance on one task may *inhibit* or disrupt performance on a second task, which represents *negative transfer;* and (3) finally there may be *no effect* of one task on another, in which case we have an instance of *zero transfer.* Zero transfer can occur either as a result of no effect of one task on another, or as a result of equal effects of positive and negative transfer that cancel (p. 3).

We have attended primarily to positive transfer in this paper because the intent of the paper was to deal with transferable skills. Altman's (1976) paper in this series provides a useful discussion of the problem of negative transfer of occupational skills.

Skill

Skill is a term that is used in different ways and with different meanings. Some restrict its use to motor behaviors. Others include cognitive behaviors such as reading and mathematics skills. Social behaviors will also be included by some. Use of the term is further confounded by the fact that some will restrict its meaning to discrete acts and others will include relatively complex behaviors in the definition.

Many variations in meaning are reflected by the following definitions of skill:

1. Great ability or proficiency (*Webster's new world dictionary,* 1964).
2. An organized sequence of actions, proficiently executed and usually displaying a flexible but systematic temporal patterning (Krech & Crutchfield, 1958).
3. An individual's level of proficiency on a specific set of tasks (Cunningham, 1971).
4. Those behaviors which are fundamental to the performance of many tasks (Smith, 1975).

Each of these definitions reflects a common theme of proficiency. The claim that a person has a skill is taken to mean that the person is proficient in some behavior. The problem we have with these definitions and others is that the definitions do *not* provide a clear basis for distinguishing between a skill and a nonskill.

Our review of the usages and definitions of the term *skill* in psychological literature suggests a resolution of the dilemma. Usage of the term has declined noticeably in this literature over the past two decades as a definer of behavior, except for literature on basic skills. This decline was exemplified by the fact that Krech and Crutchfield defined the term and used it widely in their 1958 text but indexed only one reference in their 1974 text (Krech, Crutchfield, & Linson, 1974). Most recent psychology textbooks did *not* index the term. The tendency seemed to be to deal with the behaviors themselves rather than to use the more general designation of *skills*.

The conclusion we have made is that *skill* is *not* a definer of behavior in the sense that one behavior is a skill and another behavior is *not* a skill. It is difficult to think of any learned behavior with intellectual and/or psychomotor elements to which the term *skill* would *not* apply. Thus, a *skill* can refer to any learned behavior. Throughout this paper, we have used the term to refer to a learned behavior.

In our review we found the term *skill* used frequently to imply a measure or level of proficiency in the performance of a behavior. In this sense, to say that a person has acquired a skill is to say that the person has attained an acceptable level of proficiency in some behavior or action. This paper does not use *skill* in this sense of the word.

The word *skill* is considered also to be evaluative and the value connotation to be positive. To say that a person has acquired a skill is to say that the person has acquired something of value. The value of a skill is determined by its utility and its utility is determined by the extent to which the skill is used. In this sense, every skill is transferable in that utility determines transferability. Essentially this argument represents a basic assumption of this paper. The assumption is that all skills are transferable in a positive sense. Again the question is *not* whether skills are transferable, nor which skills are transferable. All skills can be transferable by our definition. The important questions were identified earlier and will be addressed in the remainder of the paper.

QUESTION ONE — WHICH SKILLS ARE HIGHLY TRANSFERABLE?

We have argued that all skills are transferable in the sense that when a skill is learned it is available for use in a variety of situations. There is another approach to the question of the *high transferability of skills,* however. This approach is to determine which skills are highly transferable in the sense of being used in many occupations and/or being skills that differentiate people from one another. When examined in this framework, there is considerable evidence on skills that are general and discriminating.

There is a long history of research on the problem of identifying abilities that discriminate among persons. Most of the work in this area has been with intellectual abilities. While intellectual abilities are usually *not* thought of as skills, they can be regarded as such under the definition of skill used in this paper and under the assumption that the abilities are developed under a learning paradigm.

Since the work of Spearman (1927), many investigators have worked on the problem of identifying and defining the intellectual ability domain. Guilford (1959) defined an interesting model of intelligence and one that is quite useful in that the 120 cells in the model represent relatively discrete abilities (i.e., skills). The 120 cells are formed by the combination of 5 kinds of operations (cognition, memory, divergent thinking, convergent thinking, evaluation), 6 kinds of products (units, classes, relations, systems, transformations, implications), and 4 kinds of content (figural, symbolic, semantic, behavioral). The model essentially defines the intellectual domain in terms of discrete behaviors that can be used to differentiate among people. Empirical confirmation has been obtained for 98 of the cells.

The potential utility of the Guilford model, in our opinion, stems from the relatively discrete nature of each ability. Most other conceptions of the intellect include factors or dimensions that are much more general than those of Guilford. It is likely that any intellectual skill can be classified into a factor in whatever conceptual scheme is used. The advantage of the Guilford scheme, however, is that the discrete nature of the factor along the three dimensions permits the skill to be classified in terms of the operations performed on the kind of content to obtain some product. This approach should be very useful for determining the kinds of educational activities that would optimize the teaching of a skill. The scheme would be especially useful if there were a model similar to Guilford's for defining the intellectual skill structure of occupations.

Individual variation in psychomotor skills has been studied most intensively by Fleishman (1975). He has named 11 perceptual/motor factors and 9 physical proficiency factors. They are listed below.

Perceptual/motor	*Physical proficiency*
Control precision	Extent flexibility
Multilimb coordination	Dynamic flexibility
Response orientation	Static strength
Reaction time	Dynamic strength
Speed of arm movement	Explosive strength
Rate control (timing)	Trunk strength

Perceptual/motor	*Physical proficiency*
Manual dexterity	Gross body coordination
Finger dexterity	Equilibrium
Arm-hand steadiness	Stamina
Wrist-finger speed	
Aiming	

These are useful for thinking about psychomotor dimensions that might be involved in job behavior and also represent some basic psychomotor behavior on which levels of proficiency will vary among people. They would be more useful if they were contained in a single framework such as Guilford's so that one could specify the psychomotor operation used with some content to obtain a product.

Kibler, Barker, and Miles (1970) developed a taxonomy of psychomotor behaviors that names the behavioral classification and defines it further by presenting an example of the behavior. The examples suggest possible ways that the content and product aspects of the skill operation might be included. The Kibler, Barker, and Miles taxonomy is primarily oriented toward motor behaviors and does *not* include some of the behaviors that are perceptual in nature. Many of the perceptual behaviors or skills do shade over into being more intellectual than psychomotor, however.

There is ample evidence that people vary in the degree to which they are able to perform intellectual and psychomotor abilities or skills. There also is evidence that this variation is attributable in part to learning. Thus, the skills are amenable to training and education. The models or taxonomies of intellectual and psychomotor abilities and skills would be useful if occupational behaviors could be similarly defined. This would permit determination of the domain of occuaptions to which certain skills or combinations of skills can be transfered or generalized.

The generality of behaviors or skills across occupations has been studied quite intensively over the past 20 years. Much of the work in this area was stimulated by a concern for increasing the efficiency of vocational education by making the programs appropriate to a number of occupations rather than to just one or a few. The methodology of these studies has varied in analytic sophistication from asking people to identify common behaviors or transferable skills across jobs to rather involved job analysis, scaling, and factor analytic procedures. A review of all the literature is beyond the scope of this paper.[1] We have concentrated our description and analysis on three major efforts.

A straight-forward procedure for identifying transferable skills is to ask the question directly of people who are in a position to have some basis for answering. Managers, supervisors, and personnel directors are kinds of people who should be able to respond well to the question of what skills are transferable. Such an approach has probably been used often in many situations and the results have probably been very similar to those shown in Table 1. The transferable skills listed in Table 1 were developed in conferences of personnel officers and career education experts conducted by the project for which this paper was written, and the source for the table was a project interim report (Wiant, 1977).

---

[1] For example, the various studies of the uses of the cluster concepts that had such a high profile in the 60's and the German study reported by Hofbauer and König (1972)—see Bibliography—are not analyzed. Although the latter does not identify skills that are transferable, it does a good job of identifying occupations that have high worker substitutability and is relevant to an examination of transferable skills.

Table 1

Composite List of Transferable Skills Identified by Conference Participants[a]

Intellectual/Aptitudinal	Interpersonal	Attitudinal
Communicating (44)	Working with, getting along with, or relating to others (28)	Diligence, or a positive attitude toward the value of work (11)
Problem solving (17)	Managing, directing, or supervising (13)	Receptivity/flexibility/adaptability
Analyzing/assessing (15)	Empathizing, or being sensitive to others	Determination/perseverance
Planning/layout (14)	Teaching, training, or instructing	Acceptance/appreciation/concern for others
Decision making (13)	Counseling	Responsibility
Creativity/imagination/innovation	Motivating	Willingness to learn
Problem identification/definition	Gaining acceptance, or building rapport	Ambition/motivation
Managing ones own time	Helping, or cooperating	Self-confidence
Basic computation	Cultivating cooperation	Self-discipline
Logical thinking	Selling	Pride
Evaluating	Accepting supervision	Enthusiasm
Ability to relate common knowledge or transfer experiences	Delegating	Patience
Coping with the labor market and job movement	Instilling confidence	Self-actualization
Understanding others	Team building	Assertiveness
Synthesizing		Honesty
Marshalling available resources		Loyalty
Accommodating multiple demands		Reliability
Judgment		Risk taking
Foresight		Compromising
Trouble shooting		Kindness
Job awareness		
Mechanical aptitude		
Typing		
Accounting		
Implementing		
Self-understanding, awareness, actualization		
Situational analysis		
Assessing environments/situations		
Understanding human system interactions		
Organizational savvy		
Conceptualization		
Generalization		
Goal setting		
Controlling		
Quantitative thinking		
Dealing with work situations		
Finance		
Tool usage		
Bookkeeping		
Artistic ability		
Business sense		
Tolerance of ambiguity		

[a]Items are listed in approximate order of frequency within each category. Most frequently mentioned items are followed by a figure in parenthesis to indicate relative frequency, thus, "Communicating" was mentioned about 44 times as often as "Tolerance of ambiguity."

Perhaps a listing such as in Table 1 is useful and adequate, but there are problems in the list. The items are very general. For example, are terms like *Reading* or *Computing* sufficiently specific to be of use? Furthermore, many of the items, especially under the attitudinal area, seem to be traits as much as they are skills and there is the concern about their being susceptible to training.

There is another nagging question for us whenever we read a list like this. The question goes something like this. Do the items reflect transferable skills in that people who possess them can use them in a variety of situations, or do they represent skills that are not very transferable in that people do *not* seem to be able to transfer them from one situation to another? It is common with lists obtained in this manner that technical skills are mentioned less often than problem-solving or decision-making skills. The immediate interpretation is that workers have the technical skills and can transfer them but that they do *not* have problem-solving skills or they cannot transfer them. Is it true, though, that there is a lack of problem solving skills? Almost any functioning member of society is a problem solver and a decision maker, and in some contexts at least is skilled enough to function. Why then is there less transfer? We raise the question here as a critique of the kind of list illustrated by Table 1. Some thoughts on possible answers will be offered in the later section of the paper on skill complexity.

Dictionary of Occupational Titles (DOT)

The third edition of the *Dictionary of occupational titles* (U.S. Department of Labor, 1965) was the result of probably the most comprehensive attempt to classify occupations according to common elements. The DOT has been criticized for providing information that is too general and thus *not* informative about specific occupations. The criticism is *not* fair, in our opinion. First, the scope of the Dictionary was so tremendous that specific details could and should not be expected. Second, a more careful reading and analysis of the DOT does yield a wealth of information at several levels of specificity.

Following the argument that commonality of a skill across a number of occupations is evidence of transferability of the skill, we did some tabulations of the information on the 114 Worker Trait Groups in the DOT.

The Worker Trait Groups were developed by grouping the jobs into 22 general areas according to commonalities on educational requirements, vocational preparation, aptitudes, interests, temperaments, and physical demands. The 22 general areas were further broken down into the 114 Worker Trait Groups that are included in Volume II. For each group there is specification of the DOT codes represented by the jobs in the group and of the educational requirements, vocational preparation, aptitudes, interests, temperaments, and physical demands.

Two cautions should be kept in mind while reading the discussion of this analysis. First, the Worker Trait Groups were the unit of analysis and the number of occupations within each group was *not* equal. The reported distributions are across the Worker Trait Groups, not occupations. Second, the descriptions in the DOT are general and often represent categories of skill rather than specific skills. Our analysis suggests several features of skill transferability, however.

Each occupational title is assigned a 6-digit code number. The last three digits represent the ways in which the job requires a worker to deal with Data, People, and Things. Each digit describes the skills or categories of skills that are the central elements of the job. These do not encompass all the ways workers may deal with Data, People, and Things, only those required for successful performance. Nor do they reflect other job characteristics such as the relative amount of time spent dealing with Data, People, or Things. We have tabulated the frequency with which each skill or category of skill is used to characterize a Worker Trait Group (See Table 2).

Table 2

Percent of DOT Worker Trait Groups at
Each Level on Data, People, Things Dimensions[a]

Level	Data		People		Things	
	Description	%	Description	%	Description	%
0	Synthesizing	11	Mentoring	3	Setting-up	2
1	Coordinating	23	Negotiating	2	Precision working	15
2	Analyzing	22	Instructing	9	Operating-controlling	6
3	Compiling	16	Supervising	6	Driving-operating	6
4	Computing	7	Diverting	5	Manipulating	7
5	Copying	3	Persuading	4	Tending	3
6	Comparing	3	Speaking-signaling	24	Feeding-offbearing	1
7	[(No Relationship)	15	Serving	7	Handling	7
8	(No Relationship)]		(No Relationship)	40	(No Relationship)	53

[a]Each Worker Trait Group is characterized by at least one 3 digit number reflecting the Data People Things levels for that group. Some groups are characterized by more than one 3-digit number, however, so that there are a total of 197 codes across the 114 groups.

The data in Table 2 support a conclusion that the most transferable skills, in the sense of their more frequently characterizing the Worker Trait Groups, are Data handling skills, at the Compiling and higher levels, Speaking-signaling skills, and Precision working skills. The results of the tabulation were surprising because of the size of the *No Relationship* category in the People and Things dimen sions. It was *not* surprising that the Data dimension categories were well-filled. There is a data or symbol-system kind of content to most jobs, thus, the worker needs some data-handling skills to function effectively.

Each Worker Trait Group description also includes a qualifications profile. Among others, the listed qualification dimensions are *G*eneral *E*ducational *D*evelopment (GED), Aptitudes, Temperament, and Physical Demands. The qualifications profile lists the category or categories within each of these dimensions that describe the situations most common to the Worker Trait Groups. The frequency of occurrence for each category was tabulated for each of the dimensions (Tables 3, 4, 5, and 6). The results are presented in terms of percent of the total number of categories listed for that di mension across the Worker Trait Groups. Each group was characterized by at least one value for each dimension, but some groups had more than one value listed. The analysis was based on the total num ber of values listed for a dimension across the 114 groups.

The results for the General Educational Development dimension are presented in Table 3. The GED results in Table 3 are consistent with those in Table 2 with respect to Data. The data handling or symbolic skills in occupations are reasonably involved and most occupations require some sophis tication with such skills. This conclusion is supported further by the results in Table 4.

Based upon the methodology used in this analysis, a high level of General Intelligence and Ver bal skill is demanded by more Worker Trait Groups than the other abilities or skills. The last column

Table 3

Percent of Times a GED Category Is Listed in Qualification Profiles of DOT Worker Trait Groups

GED Level	Category Description (Condensed)	%
6	Apply logical and scientific thinking to wide range of problems.	9
5	Apply advanced mathematical techniques and theoretical techniques. Report, write, edit technical articles. Prepare lectures. Counsel. Evaluate data.	29
4	Use rational systems to solve problems. Perform standard algebraic and geometric calculations. Transcribe dictation, write routine correspondence, interview.	31
3	Understand and carry out instruction. Apply set procedures.	22
2	File and copy data. Give understandable directions.	7
1	Carry out simple instructions. Perform simple arithmetic. Communicate with others.	2

Table 4

Percent of Times Each Level of an Aptitude Is Listed in Qualification Profiles of DOT Worker Trait Groups[a]

Aptitude Category	n	Proportion of General Working Population Possessing Aptitude Level Required					% of Times Listed as Critical Aptitude
		0%-10% Level 1	10%-33% Level 2	33%-66% Level 3	66%-90% Level 4	90%-100% Level 5	
G. General Intelligence	172	19	37	34	10	0	92
V. Verbal	172	18	34	36	12	0	67
N. Numerical	187	7	20	41	27	5	39
S. Spatial	173	5	19	29	42	5	32
P. Form Perception	182	2	20	39	37	2	41
Q. Clerical Perception	181	2	17	38	37	6	39
K. Motor Coordination	172	1	13	39	45	2	35
F. Finger Dexterity	173	1	15	39	43	2	41
M. Manual Dexterity	166	1	13	43	41	2	34
E. Eye-Hand-Foot Coordination	167	1	4	14	26	55	13
C. Color Discrimination	191	1	4	15	35	45	5

[a]Level 1 implies that the highest degree of the aptitude is required (i.e., that which is possessed by only 10% of the population). Level 5 implies that the lowest degree of the aptitude is required (i.e., that which virtually everyone in the population possesses).

in Table 4 presents the percent of times the skill was cited as critical by the DOT. General Intelligence and Verbal skills again are most often judged to be critical. Except for the last two skills in the table (Eye-Hand-Foot Coordination and Color Discrimination), the rest appear to be quite similar both in terms of level and criticality.

Miller (1971) analyzed data obtained from the sample household enumeration conducted in October 1966 by the Bureau of the Census. One aspect of the analysis was to code the occupations held by the respondents on the Data-People-Things and GED dimensions. The following quotes summarize some of the findings of the Miller analyses.

> About a fifth of all workers are in occupations that require them to be able to synthesize or coordinate data and another third are in those that require compilation or analysis of data. Most of the remainder are in occupations that call for no significant handling of data (p. 3).

> Over half of all workers are in occupations that do not require them to deal with people at any significant level. Another quarter operate at a relatively simple level, by serving or conveying information. Less than 10 percent are engaged in occupations requiring complex relationships, such as counseling, negotiating, or instructing (p. 3).

> About one-fifth of workers are in occupations that . . . require them to be able to set up or work precisely with materials and/or equipment in such a way that the ultimate responsibility for standards is theirs. Somewhat less than a third must use equipment, etc., at less complex levels, and close to a half are in occupations that are not considered to require any significant handling of equipment or materials (p. 4).

The proportions obtained in the Miller study are somewhat different from those we obtained, but the pattern is quite similar. The fact that the Miller results are based on coding of individual jobs rather than of groups of job types suggests that the proportions in the Miller study are more accurate descriptions of the way jobs are distributed than are our results.

The Temperaments section of the qualifications profile describes the Worker Trait Group in terms of the work situations to which a worker must adjust. If adjustment to a work situation involves some intellectual affective, or psychomotor behavior, then the Temperament profiles provide information about the kinds of skills involved and most commonly required across occupations. A tabulation was made of the frequency of occurrence of a particular adjustment situation in the qualifications profiles. The results are presented in Table 5.

The first five or so situations in Table 5 probably represent the most common work situations to which American workers must adjust. Thus, workers will often have to deal with people, evaluate information, achieve set standards, and direct the work of others. Skills appropriate for these situations could then be argued to be most useful or transferable.

The final part of the qualifications profile discussed here is called Physical Demands. Table 6 contains the results of the tabulations of the percent of times each of the Physical Demand categories was listed for the occupations in the Worker Trait Group.

According to Table 6, the physical skills of most occupations do *not* demand great strength. The most general skills in the physical area involve arm/hand movements, speaking, listening, and seeing.

Table 5

Percent of Times a Temperament Is Listed in Qualification Profiles of DOT Worker Trait Groups

Code	Description of Situation (abstracted)	Percent[a]
5	Dealing with people.	54
9	Evaluate information against sensory or judgemental criteria.	51
0	Evaluate information against measurable or verifiable criteria.	42
Y	Precision under set limits, tolerances, standards.	33
4	Direct, control, and plan activity or activities of others.	32
1	Variety of duties and frequent change.	26
2	Repetitive operations under set procedures.	18
3	Doing things under specific instruction, little independent action.	14
7	Influencing people.	13
X	Interpret feelings, ideas, opinions.	11
8	Perform under stress, take risks.	6
6	Working alone in physical isolation.	0

[a]The figures total to more than 100% because more than one temperament could be listed for a Worker Trait Group.

Table 6

Percent of Times a Physical Demand Category Is Listed in Qualification Profiles of DOT Worker Trait Groups

Category	Description	Percent
1	Lifting, carrying, pushing, pulling (strength)	
	S – Sedentary (lift 10 lb. max.)	52
	L – Light (lift 20 lb. max.)	82
	M – Medium (lift 50 lb. max.)	37
	H – Heavy (lift 100 lb. max.)	16
	V – Very Heavy (lift over 100 lb.)	2
2	Climbing, balancing	15
3	Stooping, kneeling, crouching, crawling	20
4	Reaching, handling, fingering, feeling	73
5	Talking, hearing	61
6	Seeing	67

Generic Skills Project

Smith (1975) described a project to identify the skills that are generic to a large number of occupations. The results of the project of most relevance to this paper are presented in Kawula and Smith (1975), in which generic skills were defined as:

> those behaviors which are fundamental to the performance of many tasks carried out in a wide range of occupations.
>
> Generic Skills include many of the concepts and skills generally referred to as *mathematics skills, communication skills, reasoning skills, interpersonal skills,* and *manipulative skills* (p. 1).

The Generic Skills Project was sponsored by the Training Research and Development Station of the Canadian Department of Manpower and Immigration. The three objectives of the project were:

1. To develop a simple and coherent system for the identification of skills used by workers in any occupation.
2. To collect and analyze skill data from a variety of occupations as a basis for developing occupational training specifications.
3. To develop training packages for the identified Generic Skills (Smith, 1975, p. 2-4).

The Generic Skills Project devoted much time and effort to development of a conceptual framework and to instrumentation. Data were collected from about 10 incumbents in each of 77 nonprofessional occupations. Thirty-one of the occupations included supervisory tasks and were classified as supervisory occupations. The remaining 46 were classified as nonsupervisory occupations. The occupational surveys included items on the first four skill areas only (i.e., mathematics, communications, reasoning, and interpersonal). Manipulative skills were *not* studied.

The skills identified in the survey were clustered on a rational basis according to content. The 192 separate skill items were reduced to 2 core clusters and 27 unique clusters. One core cluster was for the nonsupervisory occupations and the other for the supervisory occupations. The criterion for inclusion of a skill item in a core cluster was that the skill was used by at least 75% of the occupations. Table 7 contains the content of the core skill clusters for the nonsupervisory occupations, and Table 8 is for the supervisory occupations.

The remaining skills were clustered into "separate clusters," 26 for the nonsupervisory occupations and 3 for the supervisory occupations. They are listed in Table 9. The "separate clusters" were formed by collapsing and grouping skills that did not meet the criterion for being included in the core clusters. The "separate clusters" were formed independently for supervisory and nonsupervisory occupations.

The project attempted to arrange the skill clusters in terms of a hierarchy based on the number of occupations that were represented in each skill. Results of this attempt are quite complex and difficult to summarize. They do suggest some vertical transfer possibilities, however, at least within the three general skill areas.

Another important aspect of the project was to attend to the educational and training requirements for the skill areas. Behavioral objectives for each skill area have been written and are included

Table 7

Content of Core Skill Clusters of Nonsupervisory Occupations in Generic Skills Project

Skill Areas			
Mathematics	**Communications**	**Interpersonal**	**Reasoning**
1. Read, write, and count whole numbers.	1. Know plurals.	1. Attend physically.	1. Obtain information about tasks, materials, and equipment.
2. Add and subtract whole numbers.	2. Know prefixes and suffixes.	2. Attend cognitively.	2 Obtain information about methods and procedures.
3. Multiply and divide whole numbers.	3. Contractions and abbreviations.	3. React to others.	3. Obtain information about sequence.
4. Solve word problems with whole numbers.	4. Use dictionary.	4. Elementary one-to-one conversation.	4. Obtain other job related information.
5. Round off whole numbers.	5. Synonyms, antonyms, and homonyms.	5. Task-focused conversation.	5. Recall theories or principles.
6. Read and write fractions.	6. Meaning from context.	6. Express point of view.	6. Sort objects.
7. Add and subtract fractions.	7. Use books.	7. Personable conversation.	7. Estimate time.
8. Multiply and divide fractions.	8. Comprehend oral communication literally.	8. Participate in group discussion.	8. Estimate weight.
9. Solve word problems with fractions.	9. Interpret oral communication.	9. Respond to information or directions.	9. Estimate distance.
10. Compute dollars and cents.	10. Pronounce words correctly.	10. Give instructions.	10. Sequence tasks.
11. Read, write, and round off decimals.	11. Use good diction and word choice.	11. Demonstrate.	11. Establish task priorities.
12. Multiply and divide decimals.	12. Speak fluently.	12. Monitor.	12. Set goals.
13. Add and subtract decimals.	13. Organize ideas while speaking.	13. Give directions.	13. Determine activities to reach goals.
14. Solve word problems with decimals.	14. Ask the six W questions.		14. Decide about alternatives.
15. Read and write percents.	15. Give directions or information.		15. Set criteria.
16. Compute percentage.	16. Use the telephone.		16. Set priorities.
17. Determine equivalents.	17. Literal comprehension of reading.		17. Analyze situation.
18. Know order of operations.	18. Interpretive comprehension of reading.		18. Make deductions.
19. Solve word problems (mixed operations).	19. Read forms.		19. See cause and effect relationships.
20. Do quick calculations.	20. Read notes, letters, memos.		20: Identify possible problems.
21. Compute averages.	21. Read charts and tables.		21. Set priorities in terms of diagnosis.
22. Read graduated scales.	22. Read manuals.		22. Explore possible methods.
23. Perform operations with time.	23. Write phrases on forms.		23. Ask probing questions.
24. Operate calculator.	24. Write sentences on forms.		24. Use sen es.
	25. Write sentences.		25. Determine relevant information for problem solving.
	26. Write short notes.		26. Arrive at alternative statements
	27. Take notes.		27. Select statement.
			28. Determine alternative solutions
			29. Select alternative.
			30. Update plans.

Table 8

Content of Core Skill Clusters of Supervisory Occupations in Generic Skills Project

Skills Areas			
Mathematics	**Communications**	**Interpersonal**	**Reasoning**
1-24. Same as nonsupervisory occupations.	1-27. Same as nonsupervisory occupations.	1-13. Same as nonsupervisory occupations.	1-30. Same as nonsupervisory occupations.
25. Compute ratios.	28. Evaluative comprehension in listening.	14. Attend covertly or unobtrusively.	31. Sort data.
26. Compute proportions.	29. Evaluative comprehension in reading.	15. Persuasive conversation.	32. Rate objects.
27. Compute rate.	30. Write paragraphs on forms.	16. Prepare group discussion.	33. Rank objects.
28. Compute principal.	31. Write paragraphs.	17. Present information or directions to group.	34. Develop classifications.
29. Measure weight.	32. Write form letters.	18. Lead group discussion.	35. Estimate area.
30. Measure distance.	33. Write single paragraph letters.	19. Maintain groups.	36. Estimate capacity.
31. Measure capacity.	34. Write internal memos.	20. Prepare oral presentation.	37. Estimate cubic measures.
32. Know geometric forms and figures.	35. Write business letters.	21. Give factual information in oral presentation.	38. Estimate costs.
33. Computation on angles.	36. Write information report.	22. Get attention and response to oral presentation.	39. Plan and coordinate activities and sequences.
34. Draw/sketch geometric forms and figures.	37. Write recommendation reports.	23. Give a conceptual oral presentation.	40. Outline plans.
35. Compute perimeters.	38. Write technical reports.	24. Give a persuasive oral presentation.	41. Identify resources.
36. Compute areas.		25. Get reaction to oral presentation.	42. Estimate resources.
37. Compute volumes.		26. Establish training program.	43. Determine critical activities.
38. Read graphs.		27. Evaluate instructional communication.	44. Make a detailed plan.
39. Read scale drawings.		28. Demonstrate to others.	45. Make resource requisitions.
40. Read assembly drawings.		29. Give praise.	46. Monitor results.
41. Read schematic drawings		30. Give discipline.	47. Determine standards of quality.
42. Draw graphs.		31. Prepare evaluation reports.	48. Determine standards of quantity.
43. Measure from scale drawings.		32. Prepare for interview.	49. Determine standards of completion time.
44. Draw to scale.		33. Ask closed questions in interview.	50. Establish priorities of standards
45. Solve algebraic formulas.		34. Ask open questions in interview.	51. Exercise authority and responsibility.
		35. Deal with confrontation situation.	
		36. Interview customers/clients.	
		37. Interview job applicants.	
		38. Negotiate.	

Table 9

Content of Separate Skill Clusters in Generic Skills Project

Skill Area	Nonsupervisory Occupations	Supervisory Occupations
Mathematics	1. Ratios and proportion.	1. Metric measurement.
	2. Rate and principal.	2. Algebra.
	3. Measurement.	3. Logarithms and trigonometry.
	4. Metric measurement.	
	5. Geometric figures.	
	6. Areas, perimeters, volumes.	
	7. Graphs.	
	8. Drawings.	
	9. Formula solution.	
	10. 1-variable algebra.	
	11. 2-variable algebra.	
	12. Logarithms and trigonometry.	
Communications	1. Writing business letters.	
	2. Writing technical reports.	
	3. Evaluative comprehension.	
Interpersonal	1. Covert attending.	
	2. Persuasive communication.	
	3. Control group discussion.	
	4. Oral presentations.	
	5. Supervisory communications.	
	6. Interview/counsel.	
Reasoning	1. Sort and classify.	
	2. Estimate.	
	3. Plan, coordinate.	
	4. Quality control.	
	5. Delegate authority.	

in the report. The project has also developed educational or training packages for many of the skills in the core clusters. Work is continuing on the project. A recent publication contains a report of a study done to identify science skills that are general to a range of occupations. One conclusion was that "over 70% of the science behaviors now taught in the community colleges are not used at all by any of the occupations surveyed or by so few that general instruction may not be an efficient procedure" (Department of Manpower and Immigration, 1977).

The Generic Skills Project has been a useful effort to meet the criticism of the generality or level of abstraction of the DOT. It should be mentioned that the project started from the conceptual base of the DOT and much of the work took off from the Data, People, Things notions of the DOT. The project has identified a large number of very specific skills that are general across a sizable number of occupations at the clerical, service, skilled, technical, and supervisory levels. It might be argued that the sampling base was small, only 46 nonsupervisory and 31 supervisory occupations. The occupations were selected, however, to represent a number of industries and also are the occupations that include a sizable proportion of the work force.

In examining the content of the skill clusters, we were impressed that the Generic Skills Project had identified a goodly proportion of specific skills that are highly transferable in the sense of being used in many occupations. Having the skills in the core clusters certainly will *not* ensure job success in any or all of the jobs. Clearly there are specific skills and contextual factors that will operate to determine successful performance. The results do suggest however, that lack of competence in the core cluster skills will be a serious inhibiting factor to successful job performance in most jobs.

Ergometrics

A research program on *Ergometrics* has been underway for several years at the Center for Occupational Education, North Carolina State University, under the direction of J. William Cunningham. The basic approach to the program is described in Cunningham (1971). The conceptual base for the program uses notions developed by Altman (1966); Guilford (1966), McCormick, Cunningham, and Thornton (1967); and Fine and Heinz (1958).

Ergometrics is a term defined as the application of psychometric principles and procedures to the study of human work. Two other terms, *work element* and *attribute,* are essential to the research program and their definitions are as follows:

Work element — a statement describing a work variable (activity or condition) on which jobs can be rated (Cunningham, Tuttle, Floyd, & Bates, 1971, p. 8).

Attribute — a relatively stable behavioral predisposition, represented by a dimension on which individuals can be measured. Attributes might be classified into two broad categories: (a) abilities, and (b) personality traits (Cunningham, 1971, p. 18).

This definition of attribute is somewhat different from the definition of skill used in this study. Yet it is rather clear that the attribute requirements of jobs provide an indication of the skill requirements of the jobs.

The research program has devoted much effort to developing instruments and procedures for assessing jobs in terms of their work elements and their attribute requirements. An obvious important goal is to match the two dimensions so that occupations can be described in terms of the work elements of the occupation and the requisite attributes.

An instrument called the *Occupational Analysis Inventory* (OAI) has been developed for assessing occupations in terms of their work elements. Some 622 work elements are included in the instrument. Studies have indicated that the instrument provides reliable information about the work elements. Factor and cluster analyses have been done from data on 1,414 occupations. These analyses have yielded clusters or factors of the elements that are interpretable. First order and second order factors provide clustering of the elements at different levels of generality (Boese & Cunningham, 1975).

The second instrument developed by the study is the *Attribute Requirement Inventory* (ARI) (Neeb, Cunningham, & Pass, 1971). The instrument contains 103 human attributes. Several reliability studies have yielded favorable results. While the project has obtained the attribute requirement estimates for a great many jobs, the study has *not* yet been published. Such information would have been useful for this writer because it would have indicated the degree of generality of attributes across a large number of occupations.

A recent publication of the project does contain the judged attribute requirements for each of the 622 work elements (Pass & Cunningham, 1975). The judges were instructed to rate the degree of relevance of an attribute to a work element on a 6-point scale. A rating of *0* indicated that the attribute did not apply to the element and a rating of *5* indicated very high relevance.

We tabulated the data in the attribute-element matrix. The results of the tabulation are presented in Table 10. The rationale for the tabulation was that it would indicate relative generality or transferability of the attributes across work elements.

The attributes are ordered in the table according to the number of work elements to which they are relevant. The first one listed is relevant to the most elements and the last one is relevant to the least number of elements. The ordering is based only on the percent of times *0* was used. The percentages in the table are computed by dividing the number of times the attribute was judged to be in the relevance category across the 622 work elements. The attribute names are those used by the project. Attributes have been grouped by the project into six general areas. The table indicates the general area for an attribute using the following key:

G – General Vocational Capabilities

C – Cognitive Abilities

P – Psychomotor Abilities

S – Sensory Capacities

I Interests

N – Needs

The results provide only an indirect and rough indication of transferability across occupations, however. Such an indication only results if it is assumed that the more work elements involved, the greater likelihood that more occupations are involved. It must be recognized, however, that several work elements may pertain to only a few jobs or one work element may be a characteristic of a large number of jobs.

The tabulations in Table 10 nevertheless suggest a number of conclusions:

Table 10

Percent of 622 Work Elements for Which an Attribute Is Judged Relevant in Ergometrics Project

General Area	Rank Order	Attribute	Rating of Attribute Relevance to Work Elements					
			0 Does Not Apply	1 Very Limited Relevance	2 Limited Relevance	3 Moderate Relevance	4 Substantial Relevance	5 Very Relevant
N	1.	Activity	26.2	30.7	37.1	5 9	.0	.0
N	2.	Ability utilization	29 4	46.3	16.9	7.1	3	0
S	3.	Near visual acuity	30.4	26 0	20.1	20 1	3.2	.1
I	4.	Crafts and precise operations	43.1	23.8	14.0	18.0	1 0	.1
N	5.	Achievement	44.1	33.4	13.5	8.5	.5	0
I	6.	Manual work	48.2	21.4	16.4	10 1	3.4	.5
I	7.	Machine work	50.2	23.8	9.3	7 2	8.2	1.3
S	8.	Depth perception	50.5	31.4	13 2	2 6	2 1	3
I	9.	Appraisal	54.3	30.1	13.0	2.1	.5	.0
P	10.	Eye-hand coordination	60.3	20.4	6.4	10.5	2.2	.1
P	11.	Manual dexterity	61.7	16.6	7.2	9.3	4.8	.3
I	12.	Applied technology	61.9	22.0	9.8	4.3	1.9	.0
N	13.	Responsibility	61.9	31.8	5.1	.8	.3	.0
I	14.	Inspecting and testing	62.2	23.2	8.0	3.2	3 1	3
G	15.	Mechanical systems	62.4	28.3	3.5	3.5	1.8	5
C	16.	Sensitivity to problems	62.4	26.5	7.4	3.4	.3	.0
S	17.	Far visual acuity	62.5	24.8	8.0	2.7	1.6	.3
I	18.	Sales representative	63.0	26.0	7.9	1.9	1.0	.1
N	19.	Advancement	63.0	32.0	3.9	1 0	.1	0
G	20.	Tools	65.6	15.8	9.6	3.2	2.2	3.5
S	21.	Factual discrimination	65.8	28.8	4.0	8	.5	.1
N	22.	Working conditions	66.2	33.6	.1	.0	.0	.0
C	23.	Memory	67.7	25 9	4 3	1.8	.5	.0
I	24.	Medical	68.0	16.4	8.2	2.6	3.1	1.8
P	25.	Arm-hand steadiness	70.1	19 5	8.7	1.0	.5	.3
C	26.	Verbal comprehension	70 6	12.5	4.8	5 3	6.3	.5
C	27.	Deductive reasoning	71.7	17.7	5.1	4 2	1 0	.3
N	28.	Variety	71.9	21 9	5.8	.1	.1	.1
G	29.	Arithmetic computation	72.5	16.7	6.6	1 8	2 3	.1
I	30.	Management and supervision	73.5	14.6	8.4	1.6	1.6	.3
I	31.	Teaching, counseling, social work	73.6	15.8	6.1	3.2	.6	.6
N	32.	Recognition	74.0	20.7	5.1	.1	0	.0
P	33.	Finger dexterity	74.3	20.6	3.5	1 0	.5	.1
I	34.	Promotion and communication	74.6	12.5	7.9	3.7	1.3	.0
I	35.	Personal service	75.2	14.5	6.1	2.3	1.8	.1
G	36.	Materials	75.6	9 6	9.0	3 1	1 4	1.4
G	37.	Verbal communication	75.9	8 4	5 9	4.5	3.5	1.8
I	38.	Numerical	76.7	11.7	7 4	1 6	1 9	.6
I	39.	Artistic	76.7	15.0	5.0	1.3	1.1	1 0
P	40.	Multilimb coordination	77.0	16.6	4.5	1.0	8	.1
I	41.	Nursing and related services	77.5	13.0	3.7	1 8	2.7	1 3
S	42.	Auditory acuity	77.7	14.5	5.9	1 4	.1	.3
N	43.	Social status	77.7	18.5	3.2	.1	.1	.1
I	44.	Skilled personal services	77.8	17.4	3.2	6	.6	3
N	45.	Independence	78.1	14.5	6.4	8	.0	.0
G	46.	Stationary machine and equipment operation	78 6	14.4	2.7	1 1	1.1	1.9
G	47.	Service	78.6	18.3	1.4	1 1	.3	.1
I	48.	Training	79.1	13 3	4.7	1.1	1 0	8
I	49.	Customer services	79 1	14 1	4.0	1.4	.8	.5
I	50.	Literary	79.6	10.6	4.3	2.3	3.1	1

Table 10 — Continued

General Area	Rank Order	Attribute	Rating of Attribute Relevance to Work Elements					
			0 Does Not Apply	1 Very Limited Relevance	2 Limited Relevance	3 Moderate Relevance	4 Substantial Relevance	5 Very Relevant
I	51.	Agriculture	80.1	13.0	4.2	1.3	.1	1.3
I	52.	Clerical work	80.4	8.5	6.3	2.1	2.1	6
C	53.	Number facility	80.7	10.0	2.6	2.6	3.7	.5
C	54.	Expressional fluency	80.7	10.5	2.6	3.7	2.3	.3
I	55.	Care of people, animals	80.9	9.8	4.2	2.3	2.3	.6
P	56.	Stamina	81.0	16.4	1.8	.6	.0	.1
C	57.	Form perception	81.2	12.4	3.1	2.6	.3	.1
N	58.	Creativity	81.2	13.2	2.6	2.4	.6	.0
I	59.	Performing arts	81.4	11.1	4.5	2.3	.6	.1
C	60.	Spatial scanning	81.5	14.3	3.5	.6	.0	.0
S	61.	Color discrimination	81.8	14.3	2.3	.8	.5	.3
P	62.	Control precision	82.8	10.0	4.2	1 6	1.0	.5
P	63.	Dynamic strength	82.8	14.0	2.7	.3	.0	.1
N	64.	Security	83.0	16.6	.3	.0	.1	.0
N	65.	Social service	83.3	7.4	5.0	3.5	.8	.0
C	66.	Grammar	83.4	6.1	4.7	3.5	1.8	.5
G	67.	Measuring instruments	83.6	10.4	2.9	1.0	.5	1.6
N	68.	Authority	84.2	10.0	4.0	.8	1.0	.0
G	69.	Connections and fittings	84.4	9.8	1.6	2.1	1.9	.1
P	70.	Static strength	84.4	12.5	2.7	.1	.1	.0
G	71.	Structures	84.9	9.8	2.1	1.9	1.3	.0
C	72.	Social intelligence	85.0	5.6	4 0	3.5	1.8	0
G	73.	Biological systems	85.0	9.6	1.4	1.0	2.6	.3
C	74.	Ideational fluency	85.2	7.9	4.8	1.6	.5	.0
C	75.	Inductive reasoning	85.4	11.1	2.3	1.3	.0	.0
G	76.	Arithmetic convention	85.7	7.6	2.7	1.8	1.8	.5
G	77.	Clerical	86.2	7.7	2.3	1.0	2.4	.5
G	78.	Medical and first aid	86.3	7.9	1.4	1.1	1.4	1.8
C	79.	Visualization	86.5	7.9	2.6	2.7	1	.1
G	80.	Deal with social situation	86.7	6.8	2.7	2.1	1.8	.0
I	81.	Music	86.8	8.8	2.9	.5	.5	.5
C	82.	Closure	86.8	9.0	3.4	6	.0	.1
P	83.	Reaction time	86.8	10.3	1.4	1.3	.0	.1
C	84.	Originality	87.0	7.7	1 8	1.4	2.1	.0
C	85.	Perceptual speed	87.1	8 0	3.1	.8	.8	1
G	86.	Vehicular operations	87.6	7.4	1.3	1.6	1 1	1.0
G	87.	Electricity	87.9	6.8	.3	.5	1.8	2.3
G	88.	Chemicals	88.1	9.0	1.8	.6	.1	.3
N	89.	Co-workers	88.1	10.6	.6	.1	.3	.1
N	90.	Compensation	88.1	11.1	.6	.1	0	.0
C	91.	Spatial orientation	88.3	9.2	2.2	.3	.0	.0
C	92.	Spelling	88.4	5.1	2.3	3.1	.8	.3
G	93.	Sales	88.4	7.6	2.1	1 0	1.0	.0
P	94.	Explosive strength	89.1	8.5	1.9	.3	0	.1
G	95.	Layout and visualization	89.7	5.6	.8	1.9	1.9	.0
G	96.	Social grace	89.9	5.8	3.4	.6	.3	.0
G	97.	Foods and cooking	91.3	6 3	1.8	.1	3	.1
G	98.	Style and grooming	92.1	6.8	.8	.0	.1	.1
G	99.	Fluid systems	92.4	5 1	1.3	.6	.0	.5
C	100.	Aesthetic judgment	93 9	3.2	.8	.3	1.0	.8
P	101.	Body equilibrium	94.7	4.0	.3	6	.0	.3
C	102.	Musical aptitude	98.2	1.0	.1	.3	.1	.1
N	103.	Moral values	98.7	.8	.3	.0	.0	.0

1. All of the attributes have some degree of generalizability across work elements.

2. On the other hand, most attributes do *not* have high relevance to more than a few work elements.

3. The attributes of the personality trait type (in the Needs and Interests categories) are relevant to more work elements than those of the ability type.

4. Ability (skill) in the psychomotor and sensory areas seems to be somewhat more general across work elements than those in the general and cognitive areas.

5 Generally those cognitive and general abilities that are more often relevant to work elements are similar to the core skill clusters in the Generic Skills Project.

Discussion

What does our review of the DOT, Generic Skills, and Ergometircs systems say to us about transferability of occupational skills? Earlier in the paper, it was argued that skills are transferable by definition and that the lack of specific empirical evidence was perhaps a function of the evidence being so obvious that systematic empirical study was *not* needed. Our present educational and training activities are perhaps *not* completely irrational. Knowledge of mathematics, science, and language is taught in the public schools. One justification for imparting this knowledge is that skills are thereby learned and the skills in these areas are useful. The assumption is that the knowledge being taught in elementary and secondary school produce skills that are most general or transferable. The review seems to substantiate this point.

The Generic Skills Project used a 5-category classification scheme that is useful for discussion of skill transferability. We have attempted to summarize the review on Question One using this scheme.

1 *Mathematics skills.* In the area of mathematics, the evidence seems to be that skills through what is usually regarded as first year algebra are transferable across many occupational situations. Skills at a higher order are certainly transferable but to a much more restricted range of occupations.

2. *Communication skills.* To have some reasonable range of occupational options, a person should have skills in verbal and nonverbal forms of communications, written expression and comprehension, and speaking and listening. The level of development of these skills seems to be about what might be expected of a student in the secondary schools.

3. *Interpersonal skills.* There seems to be considerable overlap between this area and the communication skills area. Generally it would appear that a person should be able to carry on a conversation, give intelligible instructions to others, and generally be able to attend to others in a positive manner. The importance of interpersonal skills to worker success has been recognized increasingly in recent years, to the extent that many organizations provide extensive educational programs in this area. This is an area, however, that has received little emphasis in the regular educational programs. Thus, it is difficult to say at what level of proficiency high school graduates could be expected to have developed interpersonal skills.

4. *Reasoning skills.* Estimation and information-seeking skills are important in this area and are given some emphasis in the schools. Other skills like setting priorities, determining

alternatives, and planning are probably *not* emphasized as much. These skills do seem important, however, for a large number of occupations. Perhaps the current educational/training system does less in this area than in others.

5. *Manipulative skills.* In the psychomotor/sensory area the skills apparently transferable to a large number of occupations seem to be those of sensory acuity, manual dexterity, and coordination. Some of these skills may be more genetically determined than those in the other areas. Skills in this area are amenable to training, however, and this is another area in which our current educational and training programs may be somewhat deficient.

QUESTION TWO – ARE THERE OPTIMAL SEQUENCES FOR DEVELOPING THE COMPONENT SKILLS OF COMPLEX BEHAVIORS?

The common sense answer to this question is *yes*. Much of our current educational practice reflects a belief that component skills are learned first and then integrated into more complex skills. The sequence notion is seemingly self-evident, but the optimal notion is *not* so clear. Gagné (1965) has argued strongly for determining hierarchical sequences that would optimize learning. He has found some empirical support for this in teaching mathematics skills.

On the other hand, there is evidence that in many instances there are several routes to the same end and that none is generally optimal (Posner & Strike, 1976). For example, deductive and inductive approaches involve different processes, but there is much evidence that both approaches result in learning. Ausubel (1961) has provided a strong defense of the deductive approach while Bruner (1961) has done the same for inductive or discovery methods.

Our opinion on this issue is that the search for *the* optimal sequence is doomed to failure. It seems important to note that the teaching of complex behaviors often requires some sequencing. Our current state of knowledge is such, however, to only support a statement that the sequence should be coherent and logical. Optimal sequences may be found on an individual basis as we learn more about aptitude-treatment interactions, but this line of research is only getting started (Berliner & Cahen, 1973).

QUESTION THREE – AT WHAT LEVEL OF ABSTRACTION SHOULD A SKILL BE TAUGHT?

In order for a skill to transfer, some level of abstraction is involved. Unless two situations are identical in every respect, there is stimulus or response generalization involved and that involves abstraction of some property or properties of the situation.

This issue has been an important one in the transfer literature since the work of Thorndike and Woodworth (1901) and of Judd (1908). It is still *not* resolved. The transfer surface of Osgood (1948) suggests that transfer is enhanced when abstraction is minimal. On the other hand, the Judd research and the author's own general experience would indicate that good knowledge of relevant abstract principles facilitates adjustment to a new situation. We do *not* believe there is evidence to support an answer to the *should* question. The evidence does suggest that transfer is increased if the skill has been learned well and practiced in a variety of situations.

One critical factor in transfer that has *not* been well-studied is the role played by processes within the person. The empirical study of transfer has generally been done using the stimulus-response paradigm. Study of the internal processes that mediate between stimulus and response has been neglected. Research on mediation and concept development processes does indicate that a concept needs to be learned to a reasonable degree before it can be used in a mediation sense (Kendler, Glucksberg, & Keston, 1961; Cofer, 1957). Ortony (1975) used the notion of metaphors to argue that the use of concepts in a variety of circumstances will enhance generalizability and transfer.

Another aspect of the abstraction issue is the complexity of the skill. Generally it would seem that the degree of abstraction is positively related to the degree of complexity. The reasoning skills discussed earlier are more complex than the mathematics skills. The list of transferable skills in Table 1 includes many that are quite complex and abstract, for example, Abstract thinking, Creativity, Organizing.

Taylor (1972) has found that skills involved in planning, forecasting, decision-making, and creativity are generalizable even among elementary school children. He seems to argue that skills such as these can be taught and that the person doing these kinds of thinking will be able to transfer these skills across situations.

A related issue concerns the level of specificity for the identification or description of skills. For example, the level of specificity in the DOT factors of Data, People, and Things, and General Educational Development is very broad, while the level of specificity in the Ergometrics and the Generic Skills Projects is much finer. Are these levels of specificity too fine or not fine enough? What is the most broadly useful level of specificity for the identification and description of skills?

Earlier in this paper we commented on the common finding that skills like problem solving, decision making, and creativity are often mentioned as the desired skills for employees to have. The fact that these are mentioned in different contexts suggests that they are transferable. The various problem solving and life skills programs that have been developed and used extensively in business, industry, and government agencies over the past decade may also suggest that these skills are not well developed by many workers. Thus, while these skills may be highly transferable, many workers lack them possibly because they are rarely included in formal educational and training programs. Moreover, skills like decision making, problem solving, and creativity seem to involve two things: (a) skills in the process, and (b) knowledge about the content and context for application. Perhaps these relatively complex and abstract skills are as transferable as any other skills, but they are *not* observed in a new situation until the individual has knowledge about the content and context of the new situation. This might also account for their being less commonly found in employees than technical skills.

The educational system of this country has been criticized because graduates do *not* have salable skills in the world-of-work context. This criticism may indicate that the schools are *not* teaching the skills to the level required by the world-of-work. It may also be that the skills are taught at a level of abstraction such that transfer to a work situation is inhibited until the content and context are learned. In any case, it seems important that the educational programs strive for mastery of whatever skills are being taught and that they provide the opportunity to apply the skills with varied content and in a variety of work-like contexts.

QUESTION FOUR — ARE SOME BEHAVIORS MORE AMENABLE TO TRAINING THAN OTHERS?

The personality and attitudinal aspects of work are clearly important. Probably as many people succeed or fail in a job because of these aspects of behavior as because of technical skills. Furthermore, there is general agreement that attitudes and personality characteristics reflect learned behavior. If they are learned, then they should be amenable to training. The problem, however, is that school situations are probably *not* appropriate for this kind of training. Personality characteristics are quite enduring and stable. Change usually requires a long-term, clinically oriented program. Attitudes are more amenable to change, but even for these the settings needs to be appropriate. Few people change their attitudes by being told to do so, a practice that schools use over and over without much success.

CONCLUSION

We have attempted in this paper to explore the domain of occupationally transferable skills. In the introduction we argued that any skill by definition is transferable. Our opinion has *not* changed. While working on the paper we have asked ourselves, Is there a nontransferable skill? Our answer is *no*. A skill is the capability to do something and, once attained, it is not constrained by specifics. In any learning, stimulus and response generalizations should occur to some degree.

A rather detailed review of three studies on job and worker behaviors indicated that the kinds and levels of skill most commonly encountered in occupations are such as to conclude that a good education through high school will provide an individual with a good repertoire of skills for the world-of-work.

Finally, while this review did not allow them to be analyzed fully, several of the author's earlier beliefs and opinions have been reaffirmed. For example, the evidence on transfer of abstract and complex skills is equivocal. It is our opinion that training programs should be designed to teach specific skills very well and to allow for skill practice in a variety of situations after ensuring utility for one situation. We also believe that the person who has a high level of proficiency with a skill will likely be able to transfer that skill to another situation.

Success, whether in an occupation or in a multiphase career, is a matter of concern and merits continued study. Similarly the relationship between education/training and occupational success needs continued study. Increased understanding of this area will be useful. Our enthusiasm and expectations must be tempered, however, by the realization that there are many ways to achieve an end and many ends to achieve. Hopefully the research effort will *not* result in restrictive and inflexible prescriptions for the trainee or the training programs.

BIBLIOGRAPHY

Altman, J. W. *Research on general vocational capabilities (Skills and knowledges).* Pittsburgh: American Institutes for Research, March 1966.

Altman, J. W. *Transferability of vocational skills: Review of literature and research* (Info. Series No. 103). Columbus: The Ohio State University, The Center for Vocational Education, October 1976.

Ausubel, D. P. In defense of verbal learning. *Educational Theory,* 1961, *11,* 15-25.

Berlinger, D. C., & Cahen, L. S. Trait-treatment interaction and learning. In F. N. Kerlinger (Ed.), *Review of research in education.* Itasca, IL: F. E. Peacock Publishers, 1973.

Boese, R. R., & Cunningham, J. W. *Systematically derived dimensions of human work.* Raleigh: North Carolina State University at Raleigh, Center for Occupational Education, 1975.

Bruner, J. S. The act of discovery. *Harvard Educational Review,* 1961, *31,* 21-32.

Cofer, C. N. Reasoning as an associative process: III. The role of verbal responses in problem solving. *Journal of General Psychology,* 1957, *57,* 55-68.

Cunningham, J. W. *Ergometrics: A systematic approach to some educational problems* (Ergometric R&D Series Rep. No. 2). Raleigh: North Carolina State University at Raleigh, Center for Occupational Education, 1971.

Cunningham, J. W., Tuttle, T. C., Floyd, J. R., & Bates, V. A. *The development of the occupation analysis inventory.* Raleigh: North Carolina State University at Raleigh, Center for Occupational Education, 1971.

Department of Manpower and Immigration, Occupational and Career Analysis and Development Branch. *Generic science skills.* Ottawa, PQ: Author, 1977.

Ellis, H. C. *The transfer of learning.* New York: The Macmillan Company, 1965.

Fine, S. A., & Heinz, C. A. The functional occupational classification structure. *Personnel and Guidance Journal,* 1958, *37,* 680-792.

Fleishman, E. A. Toward a taxonomy of human performance. *American Psychologist,* 1975, *30,* 1127-1149.

Gagné, R. M. *The conditions of learning.* New York: Holt, Rinehart & Winston, 1965.

Guilford, J. P. Intelligence: 1965 model. *American Psychologist,* 1966, *21,* 20-26.

Guilford, J. P. Three faces of intellect. *American Psychologist,* 1959, *14,* 469-479.

Hofbauer, H., & König, P. Substitution potentials in the skilled occuaptions as judged by superiors (occupations involving a preliminary phase of instruction). LAB Communications (Nurnberg, West Germany), 1972, *2.*

Judd, C. H. The relation of special training and general intelligence. *Educational Review,* 1908, *36,* 42-48.

Kawula, W. J., & Smith, A. DeW. *Generic skills: Handbook of occupational information.* Prince Albert, SK: Department of Manpower and Immigration, Training Research and Development Station, 1975.

Kendler, H. H., Glucksberg, S., & Keston, R. Perceptions and mediation in concept learning. *Journal of Experimental Psychology,* 1961, *61,* 186-191.

Kibler, R. J., Barker, L. L., & Miles, D. T. *Behavioral objectives and instruction.* Boston: Allyn & Bacon, 1970.

Krech, D., & Crutchfield, R. S. *Elements of psychology.* New York: Alfred A. Knopf, 1958.

Krech, D., Crutchfield, R. S., & Linson, N. *Elements of psychology* (3rd ed.). New York: Alfred A. Knopf, 1974.

McCormick, E. J., Cunningham, J. W., & Thornton, G. C. The prediction of job requirements by a structured job analysis procedure. *Personnel Psychology,* 1967, *20,* 431-440.

Miller, A. R. *Occupations of the labor force according to the Dictionary of Occupational Titles* (Report to U.S. Department of Labor, Manpower Administration). Philadelphia: University of Pennsylvania, 1971.

Neeb, R. W., Cunningham, J. W., & Pass, J. J. *Human attribute requirements of work elements.* Raleigh: North Carolina State University at Raleigh, Center for Occupational Education, 1971.

Ortony, A. *Knowledge, language, and teaching.* Urbana: University of Illinois, 1 '75.

Osgood, C. E. The similarity paradox in human learning: A resolution. *Psychological Review,* 1948, *38,* 132-154.

Pass, J. J., & Cunningham, J. W. *A systematic procedure for estimating the human attribute requirements of occupations* (Ergometric R&D Series Rep. No. 11). Raleigh: North Carolina State University at Raleigh, Center for Occupational Education, 1975.

Posner, G. J., & Strike, K. A. A categorization scheme for principles of sequencing content. *Review of Educationai Research,* 1976, *46,* 665-690.

Rohwen, W. D., Ammon, P. R., & Cramer, P. *Understanding intellectual development.* Prince Albert, SK: Department of Manpower and Immigration, Training Research and Development Station, 1975.

Spearman, C. *The abilities of man.* New York: The Macmillan Company, 1927.

Taylor, C. W. *Climate for creativity.* Elmsford, NY: Pergamon Press, 1972.

Thorndike, W. L., & Woodworth, R. S. The influence of improvement in one mental function upon the efficiency of other functions. *Psychological Review,* 1901, *8,* 247, 261.

U.S. Department of Labor, Bureau of Employment Security. *Dictionary of occupational titles, Volume I* (3rd ed.). Washington, DC: U.S. Government Printing Office, 1965. (a)

U.S. Department of Labor, Bureau of Employment Security. *Dictionary of occupational titles, Volume* .. (3rd ed.). Washington, DC: U.S. Government Printing Office, 1965. (b)

Webster's new world dictionary of the American language (College ed.). New York: The New World Publishing Company, 1964.

Wiant, A. A. *Report on conferences to explore the nature of occupationally transferable skills.* Columbus: The Ohio State University, The Center for Vocational Education, in press.

REPORTS ON OCCUPATIONALLY TRANSFERABLE SKILLS

The following reports are published or in progress for the project on Occupationally Transferable Skills being conducted by The Center for Vocational Education. The reader is cautioned that many of the reports are not yet available, and that both titles and dates of availability are tentative and can change in the future. Announcements of availability and information for ordering copies of reports will be published in future issues of The Center's monthly newsletter, *Centergram*.

McKinlay, B. *Characteristics of jobs that are considered common. Review of literature and research* (Info. Series No. 102), October 1976, ($3.80). A review of various approaches for classifying or clustering jobs, and their use in (a) describing the elements of commonality involved when people make career changes, and (b) understanding better the concepts of occupational adaptability and skill transfer.

Altman, J. W. *Transferability of vocational skills. Review of literature and research* (Info. Series No. 103), October 1976, ($3.80). A review of what is known about the transferability of occupational skills, describing the process or the facilitators of skill transfer.

Sjogren, D. D. *Occupationally transferable skills and characteristics. Review of literature and research*, available Fall 1977. A review of what is known about the range of occupation-related skills and characteristics that could be considered transferable from one occupation to another, describing those transferable skills which are teachable in secondary and postsecondary career preparation programs.

Ashley, W. L. *Occupational information resources. A catalog of data bases and classification schemes*, available Fall 1977. A quick and concise reference to the content of 55 existing occupational data bases and 23 job classification schemes. Abstracts of each data base and classification scheme include such information as identification, investigator, location, documentation, access, design information, subject variables, occupation variables, and organization variables.

Wiant, A. A. *Report on conferences to explore the nature of occupationally transferable skills*, available Fall 1977. A report of the views expressed in nine meetings across the country by groups of local community and business representatives concerning the types of transferable skills required and useful in their work settings and how a better understanding of transferable skills could improve training and occupational adaptability.

Miguel, R. J. *Practical perspectives on occupational transferability of skills*, available Fall 1977. A report of clues and suggestions gained in the formal review of 13 existing training programs, with recommendations for practice which appear to have been successful in recognizing skill transfer and taking advantage of an individual's prior skills and experience.

Ashley, W. L., & Ammerman, H. L. *Identifying transferable skills. A task classification approach*, available Winter 1978. A report of an exploratory study designed to test the usefulness of three classification schemes in identifying the transferable characteristics of tasks in diverse occupations.

Moss, J., Jr., Freedman, M. K., & Taylor, C. W. *Report of the project's panel of consultants*, available Winter 1978. A report summarizing the major deliberations and recommendations for subsequent research and development evolved over six meetings throughout the course of the project.

Pratzner, F. C. *A study of occupationally transferable skills. Final project summary report*, available Winter 1978. An executive summary final report of the project, summarizing the recommendations for subsequent research and development growing out of each project activity and report.

INFORMATION CURRENT AS OF MAY 1977