Individuals and Learning: The New Aptitudes
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In this paper, I propose to show how certain developments in psychology have influenced present educational methods, and to show further how recent work in learning theory, developmental psychology, and psychometrics strongly suggests new directions for educational research and practice. I shall discuss this theme in the context of a central problem in education—the individualization of instruction or, in other terms, adapting educational environments to individual differences. I shall focus on the education of the young child in the pre-school and elementary school years, although what I have to say seems applicable to all levels of our educational system.

The problem obviously has been a persistent one; it has been recognized and proclaimed at least since the beginning of this century, three generations ago. Very early in the century, Edward L. Thorndike (1911) published a monograph entitled “Individuality.” His editor’s introduction summarizes the then current situation by noting that the teaching profession and education in general were showing signs of a violent reaction against the uniformity of method that for so long clutched and mechanized the schools. The deadening effects of uniformity needed to be recognized. Parents and students had been the first to notice this; now the professional consciousness was deeply penetrated because the teachers themselves realized that they were caught in the iron machinery of their own making. These turns of phrase were written in 1911, and throughout the twentieth century, the problem has been raised again and again. In 1925, a major effort appeared in the twenty-fourth yearbook of the National Society for the Study of Education entitled “Adapting the Schools to Individual Differences.” Carleton Washburne’s introduction states in forceful terms that the widespread use of intelligence and achievement tests has made every educator realize that children vary greatly as individuals, and “throughout the educational world, there has therefore awakened the desire to find some way of adapting schools to the differing individuals who attend them (Washburne, 1925).”

Shouts of alarm have been ubiquitous; many suggestions have been made a few sustained experiments have been launched. Nevertheless, it is now 1972, and time goes by with still only a recognition of the problem, and as yet, no directions towards solution realized. This is the situation that I would like to examine. I am encouraged to do so by the fact that work in the study of human behavior over the past 10 to 20 years now points to possible solutions. Unfortunately, I cannot point to new directions in a simple way by listing a few principles that ring with self-evident truth, although this is the fashionable road to current educational reform. The story is complicated, its roots are deep, and its complexities need to be examined.

An analysis of the problem involves the idiosyncracies of two major fields of psychology. As is known, the English and German traditions of the nineteenth century gave rise to two separate disciplines of scientific psychology: psychometrics and experimental psychology. It was the psychometrists with their emphasis on technology who had significant impact upon educational methods. Indeed, the major activity in educational psychology revolved around measurement and psychometric practice. Psychometrics emphasized the nature of individual differences and the utility of measuring these differences for education. Learning variables and modification of the educational environment, however, were not part of this field. Meanwhile, the experimental psychologists went into the laboratory to work on the basic foundations of their science, and concentrated on discovering and formulating general laws of behavior unencumbered by
the additional complication of individual differences. For the most part, individual differences became the error variance in experimental design.

The separation of these two fields, both of which are necessary for a complete conception of instructional theory, led to assumptions about individual differences uninfluenced by knowledge of learning and cognitive processes, and led to theories of learning uninfluenced by the effect of individual difference parameters. In this climate, characterized by the parallel, but not combined, labors of two major disciplines relevant to education, the search for an educational system that responds to individuality has been going on. To be as clear as I can, I will overstate the case by contrasting two kinds of educational environments. One I shall call a selective educational mode, and the other, an adaptive educational mode. It appears that we have produced a selective educational mode while aspiring toward an adaptive one.

A selective mode of education is characterized by minimal variation in the conditions under which individuals are expected to learn. A narrow range of instructional options is provided, and a limited number of ways to succeed are available. Consequently, the adaptability of the system to the student is limited, and alternative paths that can be selected for students with different backgrounds and talents are restricted. In such an environment, the fixed or limited paths available require particular student abilities, and these particular abilities are emphasized and fostered to the exclusion of other abilities. In this sense, the system becomes selective with respect to individuals who have particular abilities for success—as success is defined and as it can be attained by the means of instruction that are available. The effectiveness of the system, for the designers of the system and for the students themselves, is enhanced by admitting only those students who score very highly on measures of the abilities required to succeed. Furthermore, since only those students who have a reasonable probability of success are admitted, little change in the educational environment is necessary, and the differences among individuals that become important to measure are those that predict success in this special setting.

In contrast to a selective mode, an adaptive mode of education assumes that the educational environment can provide for a wide range and variety of instructional methods and opportunities for success. Alternate means of learning are adaptive to and are in some way matched to knowledge about each individual—his background, talents, interests, and the nature of his past performance. An individual's styles and abilities are assessed either upon entrance or during the course of learning, and certain educational paths are elected or assigned. Further information is obtained about the learner as learning proceeds, and this, in turn, is related to subsequent alternate learning opportunities. The interaction between performance and the subsequent nature of the educational setting is the defining characteristic of an adaptive mode. The success of this adaptive interaction is determined by the extent to which the student experiences a match between his specific abilities and interests, and the activities in which he engages. The effect of any election of or assignment to an instructional path is evaluated by the changes it brings about in the student's potential for future learning and goal attainment. Measures of individual differences in an adaptive educational mode are valid to the extent that they help to define alternate paths that result in optimizing immediate learning, as well as long-term success.

A selective educational mode operates in a Darwinian framework, requiring that organisms adapt to, and survive in, the world as it is; an alternative is that the environment can be changed. If we design only a relatively fixed environment, then a wide range of background capabilities and talented accomplishments might be lost from view because of the exclusive reliance upon selection for survival in a particular setting. What is learned and the way in which one learns, and learns to learn, may take on less importance or receive less emphasis in a setting that offers more options for learning.

When one compares a selective educational mode with adaptive educational possibilities, one asks whether the particular selective tests and sorting out devices that are part of present schooling fail to consider abilities and talents that might emerge as important in a more interactive setting where there is room for adjustment between abilities and modes of learning. In principle, and in contrast to traditional practice, there seems to be no reason why educational environments cannot be designed to accommodate more readily to variations in the backgrounds, cognitive processes, interests, styles, and other requirements of learners.

In any educational mode, then, the individual differences that take on outstanding importance are those that have ecological validity within a particular system. In our traditional selective educational mode, the individual differences that are measured in order to make educational assignments center around the concepts of intelligence and aptitude. This bears looking into.

Of the various attempts to measure intellectual ability that began at the turn of the century, Binet's work emerged strongly. It was a practical endeavor to predict school success. The Minister of Public Education in France supported Binet's attempts to determine what might be done to ensure the benefits of instruction to retarded children. It was decided that children suspected of retardation be given an examination to certify that, because of the state of their intelligence, they were unable to profit from instruction as given in ordinary schooling. Scholastic success in an essentially fixed educational mode was the predictive aim toward which this test was directed, for which its items were selected, and in terms of which its overall effectiveness was validated; although to be fair to Binet, his writings do indicate a great deal of sensitivity to
the possibilities for individual differential diagnosis. Nevertheless, the validation of a test is a very specific procedure in which individuals are exposed to particular kinds of test items that are constructed to predict a particular criterion measure. No test is simply valid in general, but for a specific purpose and a particular situation. The concept of Binet’s work has persisted, and as Cronbach points out in the 1970 edition of his well-known book on the essentials of psychological testing: “Current tests differ from those of the earlier generation just as 1970 automobiles differ from those of about 1920: more efficient, more elegant, but operating on the same principles as before (Cronbach, 1970).”

At the present time, our most respected textbooks on the subject (Cronbach, 1970; Tyler, 1965) carefully point out that if we base our conclusions about what intelligence tests measure on their most effective use—that is, their predictive validity—then the verdict is that they are tests of scholastic aptitude or scholastic ability; these tests measure certain abilities that are helpful in most school work, as it is conducted in present-day school situations. This same ideology has penetrated the entrance requirements of almost all institutions of higher education (vide Wing & Wallach, 1971), and strongly determines the character of primary and secondary school education. It is further to be observed that these tests of scholastic aptitude, when considered over all school levels, account for only 35 to 45 percent of the variation in school performance.

Being aware of this, we have not been remiss in attempting to probe deeper into the different facets of human behavior that might allow us to be more sensitive to individual differences. Some years ago, as a result of some dissatisfaction with the research on the IQ and together with the results of work on multiple factor analysis, there was a de-emphasis of the concept of general intelligence that led to the popularity of tests of differential aptitudes. At that time, in addition to an overall measure of “intelligence” or “general aptitude,” schools began to employ tests that provided measures on a variety of factors such as spatial, mechanical, and abstract reasoning aptitudes. More than predicting overall scholastic success, these test batteries attempted to predict differential success in school programs leading to different vocations which appeared to require different aptitude patterns.

In 1964, a careful analysis was done by McNemar of the validity coefficients of certain widely used, multi-test differential aptitude batteries. He argued from his analysis that “aside from tests of numerical ability having differential value for predicting school grades in math, it seems safe to conclude that the worth of the multi-test batteries as differential predictors of achievement in school has not been demonstrated (McNemar, 1964).” McNemar further concluded that “it is far from clear that tests of general intelligence have been outmoded by the multi-test batteries as the more useful predictors of school achievement.” In general, a simple, unweighted combination of tests of verbal reasoning and numerical ability predicted grades as well as, or better than, any other test or combination of more specific ability tests; and these tests of verbal and numerical ability were similar to what was measured in group tests of intelligence. More recent evidence reaffirms McNemar’s conclusion. For example, a 1971 technical report of the College Entrance Examination Board points out that there is certainly no reason why the Scholastic Aptitude Test (SAT) could not include measures from other domains in addition to the verbal and mathematical skills tested, and that research to identify these other domains has been an enduring concern. Yet, over the 40 years of the SAT’s existence, no other measures have demonstrated such a broadly useful relationship to the criterion of college achievement (Angoff, 1971).

All this suggests the following observation: Given the characteristics of our present educational system, certain general measures of the ability to manipulate numbers and words predict, to a limited extent, the ability to emerge victorious from the educational environment provided. However, any attempt to further differentiate specific ability patterns that relate to specific educational programs is, at best, no more successful than the usual general ability measures or intelligence measures. Why is this so, and what does it mean?

One clue to answering this question is to note that tests of general ability, intelligence, and aptitude follow the accepted practice of attempting to predict the outcomes of learning in our rather uniform educational programs. These tests make little attempt to measure those abilities that are related to different ways of learning. The generally used scholastic aptitude tests are designed for and validated in terms of predictions of the products of learning in a particular setting. They are not designed to determine the different ways in which different students learn best, to measure the basic processes that underlie various kinds of learning, nor to assess prerequisite performance capabilities required for learning a new task.

Psychologists and educational researchers, again, have not been insensitive to this state of affairs, and there has been a recent emergence of concern about the relationships between measures of individual differences and learning variables. To a large extent, this work was heralded by the 1957 book by Cronbach and Gleser entitled Psychological Tests and Personnel Decisions and its second edition in 1965. This book was concerned with the development of a decision-theory model for the selection and placement of individuals into various “treatments.” The word treatment was given a broad meaning, referring to what is done with an individual in an institutional setting; e.g., for what job an applicant should be trained in industry, what therapeutic method a patient should be assigned, and in education, to which particular education-
al program or instructional method a student should be assigned or given the opportunity to select. This theoretical analysis attempted to show that neither the traditional predictive model of psychometric work nor the traditional experimental comparison of mean differences was an adequate formulation for these practical decisions, including the kinds of decisions required for the individualization of instruction.

Cronbach and Gleser pointed out that aptitude information is useful in adapting to treatments only when aptitude and treatment can be shown to interact. In a non-technical way, this can be explained as follows: Given a measure of aptitude, and two different instructional methods, if the aptitude measure correlates positively with success in both treatments, then it is of no value in deciding which method to suggest to the student. What is required is a measure of aptitude that predicts who will learn better from one curriculum or method of learning than from another. If such measures can be developed, then methods of instruction can be designed, not to fit the average person, but to fit an individual or groups of students with particular aptitude patterns. Unless one treatment is clearly best for everyone, treatments should be differentiated in such a way as to maximize their interaction with aptitude variables.

Following up on this logic, educational psychologists have been active in experimentation and have searched deeply into the literature of their field. The line of investigation has been called the ATI problem (ATI standing for aptitude-treatment interaction). The intent of the work is different from that of the previously mentioned work on differential aptitude testing. In the differential aptitude testing research, emphasis was placed on determining the relationship between measured aptitudes and learning outcomes under relatively fixed educational programs. In the ATI work, the emphasis is on determining whether aptitudes can predict which one of several learning methods might help different individuals attain similar educational outcomes.

To be clearer, the earlier differential aptitude work assumed several different educational programs, each one leading to different careers, and attempted to select individuals with respect to their potential success in each program. The ATI work essentially assumes that if within each of these several programs there were different instructional options, then aptitude patterns might predict the option in which a student would be most successful.

Several recent comprehensive reviews report detailed analyses of ATI studies (Bracht, 1969; Bracht & Glass, 1968; Cronbach & Snow, 1969). In a review by Bracht, 90 studies were each carefully assessed for the significance of appropriate aptitude-treatment interactions. The results of his survey are quite striking. In the 90 studies, 108 individual difference-treatment interactions were examined; of these, only five were identified as being significant with respect to the kind of interaction required for the purposes I have outlined. An extensive and thoughtful analysis of many of the ramifications of the ATI problem also has appeared in an informal report by Cronbach and Snow (1969). The report is far ranging, discussing the relationships between individual differences and learning from many points of view. Their conclusion, with respect to ATI research, is similar to Bracht's: few or no ATI effects have been solidly demonstrated; the frequency of studies in which appropriate interactions have been found is low; and the empirical evidence found in favor of such interactions is often not very convincing.

This is an astounding conclusion; it implies that our generally used aptitude constructs are not productive dimensions for measuring those individual differences that interact with different ways of learning. These measures derived from a psychometric, selection-oriented tradition do not appear to relate to the processes of learning and performance that have been under investigation in experimental and developmental psychology. The treatments investigated in the ATI studies were not generated by any systematic analysis of the kinds of psychological processes called upon in particular instructional methods, and individual differences were not assessed in terms of these processes.

Perhaps we should have known all this, and not have had to learn it the hard way because I am reminded of Lee Cronbach's APA presidential address of 1957. In discussing these general concerns, he said: "I believe that we will find these aptitudes to be quite unlike our present aptitude measures." He went on to say, "Constructs originating in differential psychology are now being tied to experimental variables. As a result, the whole theoretical picture in such an area as human abilities is changing (Cronbach, 1957)." I believe that Cronbach was a moment or two ahead of his time in his address 15 years ago. But, I also believe that education and psychology have since moved in directions which make adaptation to individuals in educational settings more likely; research on cognitive processes, psychometric methodologies, deeper attempts at individualization, and the cultural Zeitgeist seem to offer enabling potentials. I shall go on to describe some of this, but first let me recapitulate the question that I am attempting to answer.

The general question takes the form of the following set of questions: (1) How can knowledge of an individual's patterns of abilities and interests be matched to the method, content, and timing of his instruction? (2) How can the educational environment be adjusted to an individual's particular talents, and to his particular strengths and weaknesses as defined in terms of social and personal objectives for education? and (3) The other way around—how can an individual's abilities be modified and strengthened to meet the prerequisite demands of available means of instruction and available educational opportunities?

The implications of my discussion so far appear to support the hypothesis that the human performances that we identify with the words "general ability," "scholas-
tic intelligence,” and “aptitudes” have emerged on the basis of measurement and validation procedures in an educational system of a particular kind. These intelligence and aptitude factors have taken on significance because of their correlation with instructional outcomes, and not because of their relationship to learning processes or different educational techniques. Furthermore, since our educational system provides a limited range of educational options for adapting to different individuals, these general abilities override the influence of any more specific abilities that might be additionally useful if alternate ways of learning were available.

The question now is: What are these “new aptitudes”? Current lines of research indicate that a fruitful approach is the conceptualization of individual difference variables in terms of the process constructs of contemporary theories of learning, development, and human performance. There is ample evidence to show that we can experimentally identify and influence a variety of cognitive processes that are involved in new learning, and it appears that the analysis of individual differences in performance can be carried out in terms of such processes (Melton, 1967). Some exemplary studies along these lines can be referred to as illustration. For example, it is known that learning to remember a list of words takes place more effectively when the learner is provided with, or provides for himself, some visual or verbal relationship between pairs of words. Presented with the words “boy” and “horse,” one pictures a boy riding a horse, or makes up a sentence containing these words. This process has been called “mental elaboration,” referring to the fact that individuals recode or transform materials presented to them by elaborating the content. William Rohwer has been particularly concerned with studying the developmental and individual difference aspects of this process. As children grow older, they begin to generate their own forms of mental elaboration; young children, however, profit from being prompted or encouraged in some way to engage in elaborative activity. Rohwer’s work suggests that individual differences, related to children’s backgrounds, influence the way in which they carry out cognitive processes of this kind. He further implies that since this kind of elaborative activity facilitates learning in general, it would be fruitful to train particular children in such elaborative techniques of learning; and there is evidence that this indeed can be done to extend the capabilities of young learners (Rohwer, 1970a, 1970b, 1971).

In another series of studies related to our work on individualized instruction at Pittsburgh, my colleague Jerome Rosner has studied perceptual processes that appear to be related to basic academic tasks in elementary school. He has studied individual differences in visual and auditory perceptual processes concerned with competence in organizing and extracting patterns of information presented in geometric patterns and in sound combinations. Rosner’s work indicates that competence in these processes is differentially related to academic achievement in arithmetic and reading; visual perceptual processes are more related to arithmetic than reading, and auditory processes more related to beginning reading than arithmetic. He has also shown that these processes themselves can be effectively taught to children, and the indication is that the effects of this instruction transfer to specific accomplishment in the beginnings of verbal and quantitative literacy (Rosner, 1972, in press).

Studies such as these support the promise of a line of research on individual differences in terms of cognitive processes. I would urge that studies attempt to identify the kinds of processes required by various tasks, and to characterize how individuals perform these processes. The conditions required to learn the task could then be adapted to these individual characteristics, or the individual might be taught how to engage more effectively in these processes.

Another sign of support for the theme of process concepts as individual difference variables comes from the work on cognitive styles or personality characteristics that influence learning and performance (Kagan & Kogan, 1970). Here, the influence of individual differences in non-cognitive domains on the cognitive processes involved in problem solving is being systematically studied. This includes research on the effects of cultural background on the dominance of visual, auditory, or tactile sense modalities; the relationship between anxiety and the quality of immediate memory; the ability to hold changing images in memory, what personality theorists have called “leveling and sharpening” and the degree to which an individual pauses to evaluate the quality of cognitive products in the course of problem solving, generally referred to as differences in reflection and impulsivity.

There have been some interesting attempts to modify cognitive style. For example, it has been shown that when first-grade children are placed with experienced teachers who have a reflective style, the children become more reflective during the school year than children who are placed with impulsive teachers (Yando & Kagan, 1968). The practical implication of this for school instruction is tailoring the tempo of the teacher to the tempo of the child so that, for example, the behavior of the impulsive child is influenced by the presence of a reflective teacher model. Another set of studies has investigated the controlling function of covert speech as a self-guidance procedure whereby impulsive children are taught to talk to themselves in order to modify their problem-solving styles (Meichenbaum, 1971; Meichenbaum & Goodman, 1969).

The processes that make up cognitive style are important to consider in the education of culturally disadvantaged children. As we know, early experience in a particular cultural environment provides the child with a set of values and a set of techniques and skills for learning to learn and for processing incoming information. It has been
pointed out that the middle-class child acquires these things so that they are continuous with what will be required of him in school. Whereas, what a lower socio-economic-class child acquires may be discontinuous with what school demands. In a non-adaptive environment for learning, "cultural deprivation" is defined in terms of a set of experiences that establishes a discontinuity between pre-school experiences and school requirements. An obvious example in the conventional school is that, explicitly or implicitly, the school requires the immediate acceptance of an achievement ethic with deferred future rewards, a characteristic most consonant with middle-class values. This discontinuity has a profound effect on the child's behavior towards school and on the school's behavior toward the child. In the adaptive educational environment that I envision, it would be assumed as a matter of course that the values, styles, and learning processes that the child brings to school are of intrinsic worth. These modes of behavior have, in fact, been extremely functional in the child's environment, and an adaptive setting would work with these assets of the child's functioning as a basis for a program of education (Getzels, 1966).

The work and theories of Piaget quite directly support and influence my theme of the importance of modifiable behavioral processes in adaptive education as opposed to notions of relatively fixed intelligence and aptitude. The stages of cognitive development described in the Piagetian theory of intelligence are thought to mark major qualitative changes in the modes of thinking available to the child, and consequently, changes in the kinds of specific learning of which he or she is capable. Adaptive education, as I have indicated, looks at this in two ways: the educational environment accommodates to the existing modes and processes of a learner, and it also can influence these processes through instruction. The stages described by Piaget thus provide individual modes of performance available to different children which would have to be considered in educational design.

Recently, Lauren Resnick and I (1972) carried out a detailed survey on the possible teachability of basic aptitudes and Piagetian processes. In our examination of operational thinking, particularly the acquisition of concrete operations, with which most studies have been concerned, we noted a significant shift, as compared with a few years ago, in the balance of evidence concerning the trainability of these processes. A number of studies have appeared which offer grounds for suggesting the possibility of developing operational thinking through instruction. As we completed this survey, we were struck with the fact that our search for work on the instructability of basic abilities uncovered far fewer studies on the training of psychometrically defined aptitudes and abilities than on the training of Piagetian and related concepts. This raises the question of why the Piagetian definition of intelligence has stimulated so much more instructional research than has the psychometric one.

One answer seems to be that Piagetian theory is not concerned with differential prediction, but with explanation of developmental changes in thought structures and the influence of these structures on performance. This emphasis suggests a variety of specific performances on which to focus instructional attention, and also suggests hypotheses concerning the optimal character and sequence of instructional attempts. In contrast, most psychometric tests of intelligence and aptitude consist of items chosen because of their predictive power rather than their relationship to observed or hypothesized intellectual processes. Thus, they offer few concrete suggestions as to what or how to teach. It appears, then, that successful attempts to adapt instruction to individual differences will depend upon a line of research emphasizing process variables in human performance.

There are other forms of evidence which contribute to our definition of the "new aptitudes" or processes for adaptive education. The fact that our concept of intelligence is undergoing significant change is obvious in the work of Piaget and in related work, but different areas of endeavor also show this clearly. There has been intensive activity in the field of comparative psychology on the intelligence of different animal species (Lockard, 1971). What used to be called general animal intelligence, and tested in the old experiments as general problem-solving ability, now appears to be an aggregate of special specific abilities, each ability evolving in response to environmental demands. Animals are "intelligent" in quite different ways that can be better understood in relation to the ecological demands of their particular environments than in terms of the older notion of a phyletic ordering of animals according to their intelligence. For example, because of their environmental demands, wasps are superior in delayed-response problems to Norway rats, and gophers are better at maze problems than horses and other open-range animals. Animals show a great many different talents evolved as adaptations to their different worlds. The older work in animal behavior appears to have over emphasized abstractions like general maze brightness as a criterion behavior for study. More recent work suggests that natural selection affects smaller mechanisms of behavior which permit the individual organism to perfect a behavior pattern adaptive to the detailed circumstances of the situation.

This fact of ecological validity, that is, that the demands of the environment influence behavior quite particularly, is apparent in another interpretation of intelligence. In a recent book on cognitive development by Olson (1970), intelligence is defined as the elaboration of the perceptual world that occurs in the context of acquiring skills with cultural media. Intelligence is developed through mastering and obtaining skill in the specifics of the prevalent media in society. Such an interpretation has been popularized by McLuhan (1964), who points out that we tend to con-
fuse skill in the medium that happens to be ascendent in our own culture with a presumed universal structure of intelligence. In this sense, intelligence is specific to the particular ways in which school subjects can be learned.

The rise of the "new aptitudes" is also forecast by the notion of interactionism whereby accommodative changes in an individual's performance occur in the course of encounters with environmental circumstances. This has been emphasized by such diverse points of view as Piaget's and Skinner's, and currently is well expressed by Bandura in his writings on social learning theory (Bandura, 1969, 1971). We know now that psychological functioning is a continuing reciprocal interaction between the behavior of an organism and the controlling conditions in the environment. Behavior partly creates the environment, and the resultant environment influences the behavior. This is clearly seen in social interaction, for example, where a person plays an active role in bringing out a positive or negative response in others, and in this way, creates, to some degree, environmental contingencies for himself through his own behavior. This is a two-way causal process in which the environment might be just as influenceable as the behavior it regulates. The actual environment an individual experiences can be a function of his behavior if the environment is an adaptive one.

Our penchant for a fixed educational mode arises in part from an old-fashioned psychology, from the scientific and social tendency to think in terms of fixed categories of human beings with consistent drives and dispositions (Mischel, 1969). We think this way, rather than in terms of human beings who are highly responsive to the conditions around them so that as conditions change or conditions are maintained, individuals act accordingly. Adaptive educational environments can take advantage of the fact that individuals show great subtlety in adapting their competencies to different situations, if the situation permits such adaptability. Although individuals show generalized consistent behavior on the basis of which we frequently characterize them, this does not preclude their also being very good at discriminating and reacting to a variety of experiences in different ways. The traditional measures of general ability and aptitudes err on the side of assuming too much consistency, and de-emphasize the capability of individuals to devise plans and actions depending upon the rules, needs, and demands of alternative situations. If, in our thinking about individual differences, we make as much room for the capability of individuals to adapt and change, as well as to be stable, and as much room for the capacity for self-regulation and self-development, as well as for victimization by enduring traits, then an adaptive notion of education must follow. An educational system should present alternative environments that enhance the ability of the individual for self-regulation in different possible situations for learning.

So far, I have tried to show that the state of our understanding of human behavior has in some sense precluded a fruitful approach to individualization and adaptive education. For the reasons I have outlined, we have been fixed on an essentially selective mode of education and on the concepts that underlie it. I have also attempted to indicate some directions that have been taken and some milestones that we seem to have passed that appear to make change toward our ideals for adaptive education more feasible than heretofore.

While I have so far stressed fundamental research understandings, progress will not occur by research alone. The design and development of operating educational institutions is also required. Throughout history, science and technology, research and application have forced each other's hands, and mutually beneficial relationships between the two are absolutely necessary for the development of new forms of education. The development effort with which I am most familiar is the work that my colleagues and I at the University of Pittsburgh have been carrying out for some years in the design of elementary school environments that are adaptive to individual differences. This work has been described and disseminated in a variety of ways (Bolvin & Glaser, 1971; Cooley, 1971; Glaser, 1968; Lindwall & Cox, 1969; Resnick, 1967). Now is not the time to go into it further, although I should say that we have had the privilege and opportunity not only to work with schools, but also to study and evaluate our efforts so that we might move in successive approximations toward understanding what an adaptive educational environment is, how it can be designed and built, and what is the nature of the cognitive and non-cognitive processes of young children that must be considered. At the present time, certain requirements are emerging that contrast the design of an adaptive educational environment with more traditional forms of education in the elementary school. Briefly stated, some of these appear to be the following:

1. The teaching of self-management skills and the design of educational settings in which learning-to-learn skills are fostered. The premise here is that children can modify an environment for their own learning requirements if they command the skills to do so. For this purpose, children can be taught how to search for useful information and how to order and organize it for learning and retention. In the selection of content for the elementary school, preference can be given to information and skills that maximize the possibilities for learning new things. The orientation and attending skills of children can be encouraged so that they learn to identify the relevant aspects of tasks and can attend to them with little distraction. With such information and skills, children can help guide the process of adaptive education.

2. The teaching of basic psychological processes. I have indicated this throughout my discussion. We have assumed for too long the stability of “basic aptitudes”; now we need to determine how these tal-
ments can be encouraged and taught. At the Olympic Games, young men and women joyfully exceed existing limits of human capability; in the intellectual sphere, this is also possible. The talents of individuals can be extended so that they can be provided with increased possibilities for education.

3. The design of flexible curricula with many points of entry, different methods of instruction, and options among instructional objectives. Extensive sequential curricula that must be used as complete systems and into which entry at different points is difficult will give way to more "modular" organizations of instructional units. This does not imply the abandonment of sequence requirements inherent in the structure of the material to be learned, but does imply that prerequisites, where essential, are to be specified in terms of capabilities of the learner rather than in terms of previous instructional experiences. A flexible curriculum avoids the necessity for all individuals to proceed through all steps in a curriculum sequence, and adapts to the fact that some individuals acquire prerequisites on their own, while others need more formal support to establish the prerequisites for more advanced learning. In such a system, it should be easy to incorporate new and varied instructional materials and objectives as they are developed in response to the changing educational interests and requirements of both teachers and students (Resnick, 1972).

4. Increased emphasis on open testing and behaviorally indexed assessment. In an adaptive environment, tests designed primarily to compare and select students can be expected to play a decreasing role, since access to particular educational activities will be based on a student's background together with his command of prerequisite competencies. Tests will be designed to provide information directly to the learner and the teacher to guide further learning. These tests will have an intrinsic character of openness in that they will serve as a display of the competencies to be acquired, and the results will be open to the student who can use this knowledge of his performance as a yardstick of his developing ability. These tests also will assess more than the narrow band of traditional academic outcomes. Measures of process and style, of cognitive and non-cognitive development, and of performance in more natural settings than exist in the traditional school will be required. Fortunately, this trend in process-oriented, broad-band assessment is now discernible in many new efforts.

In conclusion, it should be said that the nature of a society determines the nature of the educational system that it fosters, and educational systems tend to feed into the existing social practices. If this is so, then an adaptive educational system carried to its ultimate conclusion may be out of joint with the present social structure. An adaptive environment assumes many ways of succeeding and many goals available from which to choose. It assumes further that no particular way of succeeding is greatly valued over the other. In our current selective environment, it is quite clear that the way of succeeding that is most valued is within the relatively fixed system provided. Success in society is defined primarily in terms of the attainment of occupations directly related to the products of this system. School-related occupations are the most valued, the most rewarding, and seen as the most desirable. However, if an adaptive mode becomes prevalent and wider constellations of human abilities are emphasized, then success will have to be differently defined; and many more alternative ways of succeeding will have to be appropriate- ly rewarded than is presently the case.

Finally, basic analysis of what I have called the "new aptitudes" and the design of adaptive environments for learning is the work that is before us. The kinds of educational systems that we can consider most desirable will be drawn only from the fullest possible understanding of human behavior and from sustained, carefully studied educational innovations with the flexibility for successive incremental improvement. The traditional formulations of the nature of individual differences in learning and the traditional modes of education fail to provide enough freedom for the exercise of individual talents. We admire individual performance, but we must do more than merely stand in admiration; we must design the effective conditions under which individuals are provided with the opportunities and rewards to perform at their best and in their way.

Notes

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Compensatory Education: Still More Funds

BY JAMES WELSH

Our analysis is that in many cases compensatory education has not worked; but it also gives us reason to believe that many of these failures can be traced to thinly spread funds directed at too many children and too many purposes, and we further believe that the evidence supports our view that compensatory education properly managed and sufficiently funded can and will work."

So stated Elliott Richardson, Secretary of Health, Education, and Welfare, in a press release of April 23. The release accompanied the issuance of a document entitled "The Effectiveness of Compensatory Education" and subtitled "Summary and Review of the Evidence." This was some five weeks following the announcement by President Nixon that he would seek a freeze on federal court-ordered busing while simultaneously re-directing federal education funds into a compensatory education effort calculated at approximately $300 per child.

Richardson's style and tone pretty much reflect the style and tone of the document itself, which was prepared within HEW at the behest of the White House. It is cautious yet assertive, conclusive with qualifications.

Since its publication, the study has undergone a good bit of quietly critical appraisal. Among those who have been keeping up with the research on compensatory education and schooling the disadvantaged, as well as with the shifting of public policy on education, the reactions are somewhat mixed. Some look at the report in favorable terms, seeing it as an intellectually well-argued, defensible position, while others see it as a manipulative attempt at political advantage. Still others see in the report the worst kind of interpretation, plausible on the surface but internally untenable, an intellectual sellout that manipulates uncertain data to support preconceived, politically biased conclusions.

The report assumed that "if schools can produce improvements..."