DOCUMENT RESUME

ED 078 694 EM 011 304

AUTHOR Resnick, Lauren B.
TITLE Open Education: Some Tasks for Technology.
INSTITUTION Pittsburgh Univ., Pa. Learning Research and Development Center.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
REPORT NO LRDC-1972/20
PUB DATE 72
NOTE 28p.; Reprint of a journal article
JOURNAL CIT Educational Technology; v12 n1 p70-76 Dec 1972

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS Discovery Learning; *Educational Change; Educational Objectives; *Educational Technology; *Individualized Instruction; Motivation; *Open Education; Social Change; Student Centered Curriculum; Student Evaluation
IDENTIFIERS Learner Controlled Instruction

ABSTRACT

While the open education movements and educational technology are often seen as mutually hostile, the challenge in education for the future is to find ways to develop the full range of each individual's capacities and of doing so while putting control of the learning process as much as possible in the learner's hands: for educational technology, the challenge is to apply technological discipline to the problem of developing such learner-controlled educational systems. The implications of learner control for six different aspects of educational systems are discussed in this paper--the choice and definition of educational objectives, the organization and sequencing of objectives, the problem of displaying educational alternatives to the learner, the provision of learner control within a given instructional episode, learner control of motivation, and evaluation of competence. (Author/SH)

LEARNING RESEARCH AND DEVELOPMENT CENTER

1972/20

OPEN EDUCATION: SOME TASKS FOR TECHNOLOGY

LAUREN B. RESNICK

OPEN EDUCATION: SOME TASKS FOR TECHNOLOGY

Lauren B. Resnick

Learning Research and Development Center

University of Pittsburgh

1972

Also published in Educational Technology, 1972, 12(1), 70-76.

The preparation of this paper was supported by a grant from the Ford Foundation and by the Learning Research and Development Center, supported in part by funds from the National Institute of Education, United States Department of Health, Education, and Welfare. The opinions expressed do not necessarily represent the position or policy of either sponsoring agency and no official endorsement should be inferred.

OPEN EDUCATION: SOME TASKS FOR TECHNOLOGY

Lauren B. Resnick

Learning Research and Development Center
University of Pittsburgh

The open education movement in America today is, by and large, hostile to technology and to "technological society." Educational technology, by extension, is often viewed as having little place in an open educational future. A close reading of the educational "protest" literature, however, reveals that, with some exceptions, open education theorists object not to technological methods but to technological ends in education. By technological ends they mean the use of education to produce skills required for technological productivity to the near exclusion of skills and knowledge pursued for self-fulfillment. They object, too, to the focus, in schools as in the rest of society, on efficiency as an end in itself. Further, they object to the tendency of schooling, as currently organized, to concentrate knowledge in the hands of a relatively narrow band of specially trained individuals.

Viewed in this way, it becomes clear that the heart of the open education challenge lies in the vision of an open society rather than in the organization of an informal classroom, or even a "school without walls." An open society requires open access to knowledge for all individuals at any stage of life. It also requires extensive degrees of self-determination with respect to what is learned, when it is learned, and how. For education, then, the challenge is to find ways of developing the full range of each individual's capacities and of

doing so while putting control of the learning process as much as possible in the hands of the learner himself. For educational technology, the challenge is to apply technological discipline to the problem of developing viable learner-controlled educational systems.

The term "educational technology" is used in its broadest sense here--to refer to the systematic application of the methods and findings of behavioral and social science to the design of educational systems. The term "educational system" is used to refer to the set of interrelated resources and events that together make education possible. A movement toward learner-controlled educational systems can be expected to pose a whole range of problems for educational design that have only recently begun to be considered. In this paper I will discuss the implications of learner control for six different aspects of educational systems: (1) the choice and definition of educational objectives; (2) the organization and sequencing of objectives--i.e., the design of curricula; (3) the problem of displaying educational alternatives to the learner; (4) the provision of learner control within a given instructional episode; (5) learner control of motivation; and (6) evaluation of competence. Of these six areas, all but one--the concern for displaying alternatives--have, in one form or another, been areas of concern for educational technology for some time. However, the decision to move toward open educational systems will, as I shall attempt to show, pose rather new problems for research and development activity in each of these fields.

The Nature of Educational Objectives in an Open System

An open educational system places two sets of demands on the direction of instructional development. The first is a broadening

of the range of objectives to which serious educational efforts are devoted. The second is intensive attention to the development of skills of learning itself--that is, of the skills that will enable people increasingly to learn on their own, without the need for highly systematic or carefully programmed instruction.

Broadening the range of educational objectives. One of the points of consensus of the open education movement is the concern for a less utilitarian and more humanistic set of goals for education. Thus, stress is placed in informal classrooms today on expressive activities such as art and movement, as well as on the traditional academic subjects. Further, as engagement in particular educational activities becomes increasingly voluntary, and as the relative amounts of time people devote during their lives to leisure as opposed to work activity continue to increase, it seems likely that a smaller and smaller percentage of educational activity will focus on traditional academic learning. Instead, there will be greater focus on expressive activities, and on special skills and knowledge, often pursued in considerable depth as a result of individual involvement and commitment.

Up to this time, relatively little work that is technological in nature has been done in domains of affective, artistic, or social development. However, a few exceptions can be noted as examples of the kind of development work that may be foreseen for the future. For example, Sara Smilansky (1968) has been developing means of teaching young children to engage in elaborated socio-dramatic play. In the aesthetic domain, a group at the University of Minnesota (Burris, Shaw, McIntyre, & Mast, 1971) is working on college level art education using principles of programmed instruction and technological design; while for younger children, one of the regional

educational laboratories has developed and is testing a program of aesthetic education (CEMREL, 1970a, 1970b). Lawrence Kohlberg (1971) is beginning to develop an integrated program of moral education based on the many years of research on the development of moral judgment in which he has engaged. The American Sociological Association has sponsored the development of instructional episodes for social inquiry which include explorations of beliefs, attitudes, and feelings and how they affect the social process (ASA, 1969). Other groups are also working on the problem of relating affective to cognitive development through the use of "encounter" and other expressive techniques (e.g., Brown, 1971; Jones, 1968). While much of this work does not yet incorporate any systematic evaluation of its own effects and thus is not strictly technological, the work does suggest the range of objectives to which educational development work is beginning to be addressed.

Attempts to apply principles of technology to domains of this kind are likely to run into greatest difficulty with respect to the problem of specifying objectives, and the related problem of evaluation. Many open education advocates, particularly those most concerned with the goals of affective and creative development, are profoundly mistrustful of formal statements of objectives and of any attempts to measure outcomes. These are seen as limiting educational endeavors to outcomes that are easy to measure, and further, as discouraging rather than encouraging the invention of new styles, strategies, or solutions by either student or teacher. These are serious concerns, and indeed many systematic attempts to deal with education in the less academic areas have limited themselves to imparting--and assessing--knowledge <u>about</u> some domain rather than skills and experience for participating <u>in</u> it.

Glaser (1967) has suggested the positive role that appropriate specification of objectives can play in meeting the broader goals of education. His examples are drawn from the domain of inquiry and investigation skills in science; but his basic points seem to apply as well to problems of affective, aesthetic, and social education.

> The fear of many educators that the detailed specification of objectives forces us to work with only simple behaviors which can be forced into measurable and observable terms is, indeed, an incorrect notion. The situation rather is, that if we do not attempt to specify the complex processes we want to see in the student, then we are in danger of omitting them and following the path of least effort toward teaching more easily observable and trivial behavior. We should specify, as best we can . . . that we are interested in such behaviors as reasoning skills, skill in selecting fruitful hypotheses, skill in formulating problems to be solved by scientific experiment, scientific patience and perseverance, tolerance for ambiguity and scientific curiosity. The challenge, then, is to find ways to recognize this kind of behavior in a student (and the recognition of its presence or absence is a kind of measurement), and to devise instructional situations which allow these objectives to be attained. The combination of the instructional background we provide in school plus the background that the student brings to school will determine whether these objectives are attained in minimal ways or ways that surprise us. At the very least, . . . objectives provide standards of competence which most students can reach and which many will surpass (pp. 2-3).

Developing learning skills. Those individuals who will be in the best position to control their own learning experiences are those who command the greatest range and depth of "learning skills." The more, that is, that individuals can organize bodies of knowledge, search texts or other presentations for useful information, and analyze new skills in order to "program" their own acquisition sequences, the more they will be able to learn independently of organized programs

and especially skilled teachers. Thus, with respect to choosing educational objectives on which major technological resources will be concentrated, the fundamental principle suggested is to give preference to those objectives that are "generative"--i. e., that give the learner some increment of power in learning something else (cf. Bruner, 1964).

The notion of teaching generative skills is different from the idea of teaching specific prerequisite knowledge for a higher level in a given curriculum. Generative skills are generalized skills in processing information or in using tools. The implications of an emphasis on generative skills can best be given through some examples of choices that the acceptance of this principle would lead to. In the domain of information processing, teaching strategies of learning from texts would take precedence over the design of a set of ideal instructional texts on certain widely studied topics. Similarly, teaching processes of organizing and grouping to facilitate memory would take precedence over preparing instructional programs which help students memorize specific bodies of knowledge. Tool using includes, among other things, those skills embodied in general literacy, and the teaching of literacy would thus take precedence over developing ways of "getting around" the need for reading and writing, as for example through the use of tape recordings and other audio-visual devices. In the same vein, teaching students to program computers might well take precedence over using computers to teach them specific mathematical algorithms. Each of these suggestions sets as an educational objective for the development of techniques of learning. Once in control of these techniques, the student is freed to some extent of dependence on externally controlled educational technology. Thus, as the learner becomes more sophisticated, techniques of learning come to take the place of technologies of instruction.

In psychological terms, what is proposed here is essentially the development of a technology for modifying learning abilities. Traditionally, abilities have been considered fixed or subject to modification only by gross environmental effects. Recently, however, psychologists and others have begun to explore the training of specific aptitudes, abilities, and cognitive styles as a means of adapting to individual differences in learning. A few investigations along these lines are worth mentioning, if only to give a sense of the range of processes that are now considered as possibly modifiable learning abilities. Meichenbaum (1971) has been successful in laboratory training of "reflective" learning styles--i.e., in inducing children to take time and consider alternatives more carefully in solving discrimination and similar problems. Rosner (1970, 1971) has shown substantial improvement in visual and auditory analysis and organization skills in young children as the result of intensive short-term instruction. Rohwer and his colleagues (Rohwer, 1971) have been investigating the training of memory skills. Flavell (1968) has reported some initial investigations of training communication skills. Blank and Solomon (1968, 1969) have had some success in training verbal reasoning skills in preschool children; and a number of other investigators have reported substantial gains in IQ and related measures as a result of intensive preschool programs of various kinds (e.g., Osborn, 1968; Weikart & Lambie, 1970; Palmer, 1972).

Curricula--The Organizing and Sequencing of Objectives

Learner control of education requires flexible curricula with many points of entry, many methods of instruction, and as many options as possible among objectives. This means that extensive sequential curricula which are difficult to use except as complete systems,

into which entry is difficult except at the "beginning," will have to give way to "modular" organizations in which relatively brief units of instruction stand relatively independent of one another.

Modular instructional systems and wide ranges of choice do not imply the abandonment of all sequencing of learning for instructional purposes. What they do imply is that: (1) no sequence requirements be specified that are not inherent in the structure of the material to be learned; (2) artificial sequences that are necessary because authors build in unusual and highly idiosyncratic vocabulary or the like should be avoided insofar as possible; and (3) prerequisites, where essential, must be specified in terms of necessary capabilities of the learner, rather than in terms of specific previous instructional experiences. The result of accepting this set of constraints ought to be the eventual provision of a wide variety of instructional units that "interlock" in various ways. The size of units may vary substantially, and overlap in material covered may not always be avoided. In such a system it should be easy to incorporate new and varied instructional materials and objectives as they are developed, so that the system itself becomes open-ended and responsive to shifts in the educational interests of both teachers and learners.

The crucial task for a science of instruction posed by the demand for open curricular structures is the development of good methods of distinguishing between true and arbitrary prerequisites for learning objectives. The work on learning hierarchies and task analysis that is taking place in a number of laboratories represents one attempt to deal with this problem. Scientific research on learning hierarchies must be distinguished, however, from the use of the term "hierarchical" to describe arbitrarily sequenced sets of instructional objectives. Among the more important distinctions is that the research

on hierarchies is concerned with recognizing independencies as well as dependencies among objectives--and these psychological independencies often contradict established belief and practice among subject-matter specialists. For example, in one of our own studies (Wang, Resnick, & Boozer, 1971), we found that counting is learned independently of the concept of one-to-one correspondence, despite the fact that in mathematical theory the concept of quantity is derived from the correspondence among members of sets.

Further, the existence of prerequisite structures among learning objectives does not necessarily imply that learning, for all individuals, must proceed step by step through a prescribed sequence. Indeed, individuals appear to vary widely in their ability to "skip" over prerequisites. Some seem able to acquire prerequisites on their own, in the course of learning some more complex or difficult task, while others need the cognitive or motivational support of early establishment of prerequisites. In providing instructional alternatives for different kinds of learners, this is one of the individual differences to which open educational systems will need to adapt. Ultimately, in fact, the concept of prerequisites will probably give way to the notion of component abilities and knowledge which are learned in various ways depending on task structure and personal characteristics ranging from cognitive competence to motivational styles.

Displaying Educational Options

As wide ranges of instructional alternatives become the rule rather than the exception in education, a new problem will be posed for educational technology: the adequate display of the alternatives, and the development of systems for guiding the learner among them

so that his choices will maximize his likelihood of meeting his own goals. The difficulties encountered in displaying alternatives vary markedly with the verbal sophistication of the learner (particularly his degree of literacy), and probably also to some extent with the nature of the instructional options and material.

For literate people, alternatives can be displayed in the form of written descriptions. The task then lies in collating, cross-referencing, and adequately characterizing the alternatives, and of course in making these alternatives available to the learner relatively freely and easily. The problem of collating and cross-referencing is essentially a problem in information retrieval; that is, in helping the learner find those components that should be considered for inclusion in his educational program. Just as computers are increasingly being used in complex information-retrieval systems, investigations are now beginning on the use of computers in displaying and suggesting educational options. One such project is underway at Carnegie-Mellon University, where Evans and Klahr (1971) have developed a computer-based system for generating an individualized curriculum using a wide variety of educational resources. The Evans and Klahr system translates learners' goal statements into a list of potential resources, and then attempts to match recommended instructional modules to the learner's current knowledge and abilities.

Efforts over the past several years to develop systems of computer-aided guidance represent attempts to build a technology explicitly designed to assist the learner in formulating appropriate goals. Tiedeman and his associates, for example, have developed an interactive guidance system which permits mutual querying by student and computer in an attempt to probe the student's interests and to offer clarifying information to help him eventually formulate a goal-statement

(see Ellis & Tiedeman, 1970). The system, as presently constituted, is geared to helping students choose among various post-high school training options rather than among flexible and modular instructional units such as are envisioned here. Thus, in its present form it might prove of limited usefulness in a system of open education. Nevertheless, it suggests some of the possibilities for the development of a technology for assisting individuals in clarifying their own interests and goals, and then providing information relevant to those goals.

The problems of display and guidance seem much more complex for young children than for literate adults and young people. Children cannot read or interpret lists of choices, nor can they interact easily with computers with respect to verbal material, since computers cannot yet respond to their oral productions. Equally as important, limited memory capacity, together with a limited range of prior learning experience on which to base judgments of the alternatives being offered, makes any kind of purely verbal attempts at display or communication unlikely to succeed unless the range of choices is very limited indeed. Children seem to require the opportunity to directly observe and to actually sample various learning options if they are to exercise choice sensibly. Thus, the open-stack or "browsing" model of library organization is probably a better analog for a display system for children than is the information-retrieval model.

Informal primary school classrooms, along with Montessori and certain other free-choice early education programs, have attempted to solve the problem of display by combining physical display of the learning materials with modelling of their use. The open display permits browsing and sampling. Modelling is accomplished largely by permitting children to watch each other at work, and thus to learn what activities are available for future activities of their own. The

heavy reliance on modelling probably accounts for the interest in both Montessori and informal classrooms in vertical age grouping (children of several ages together in a single classroom); older children in such classrooms provide natural models for younger ones.

Several assumptions underlie this aspect of the organization of informal classrooms. One is that children left alone are good at finding the right "match" of materials for their own abilities and learning styles as well as for their momentary interests (see Barth, 1969). A second is that teachers are intuitively good at helping the child make this kind of match. There has been virtually no serious empirical study designed to test either of these assumptions. One of the more pressing tasks for a technology of open education for younger children is solving the display-selection problem. A reasonable first step in seeking this solution would be careful analysis and evaluation of existing models for dealing with this problem and of the assumptions, such as those discussed above, on which they are based.

Learner-Controlled Instructional Materials--Some Possibilities and Some Constraints

We have considered up to now characteristics of an instructional system that is open. Little has been said, however, about the characteristics of the individual instructional components. We turn now to the implications of open learning technologies for the characteristics of instructional interactions themselves. I use the term instructional "interaction" to include any episode in which a learner becomes engaged with a person or with things (books, computers, games, programs, etc.) that have the capacity to teach, i.e., to change his performance capabilities in ways that are lasting.

In any instructional interaction, the individual may be assumed to acquire two things: some specific new content (the knowledge or skill that may be stated in a formal learning objective), and a process of learning. This statement should be construed as setting up a choice between process and content, for no such choice is possible. Both are always present in any instructional interaction, and it seems reasonable to assume that the processes that dominate learning episodes at any given point in a person's life will strongly influence the learning processes he will likely call upon in future situations of the same kind. For this reason, instructional materials and strategies for open education should favor learner-controlled methods to as great an extent as is possible.

Defining what is meant by learner-controlled methods in the context of a particular lesson or instructional episode is no simple task. However, some features that characterize, but do not necessarily exhaust, the domain can be mentioned. Where a concept or principle is to be learned, one way to foster learner control is to permit the learner to determine which examples will be considered at each point in instruction. Similarly, where a procedure or technique is to be learned, the learner might determine which of several problems he will solve during an instructional session. Where a skill is to be learned, learner control might consist primarily in letting the learner determine how much practice he needs to meet adequately displayed criteria, although it may also be possible to permit the learner to devise practice situations for himself, or at least to select among several alternatives. Similarly, he should be free to test different solution strategies within some appropriate limits of feedback and guidance. More generally, learner control suggests that whenever possible, the learner should question the tutor (or text or machine) rather than vice versa.

Having proposed these open and learner-controlled instructional strategies, it is now necessary to address some reservations. The principal drawback to strategies of this kind is that the learning of any particular content objective is likely, on the average, to take longer under learner control than under program or instructor control. This is because the learner, being by definition inexpert in the matter to be learned, is likely to explore a number of false avenues before hitting on the most productive ones for the problem at hand. Further, he can probably not sequence the material, prompt himself, nor diagnose his moment-to-moment successes and difficulties as well as a skillful instructor in good command of the content can. Therefore, in the interest of guaranteeing learning of specific objectives, before the learner's interest or the instructor's resources run out, it may at times be necessary to sacrifice some degree of learner control.

How, then, do we weigh the value of learner-controlled instruction, which develops the individual's capacity for increasingly instruction-free learning, as against the value of quick and efficient learning through instructor-controlled teaching? The answer lies, it seems to me, in the degree of "generativity" of the content toward which the instruction is directed. The decision in any particular case would depend on the answers given to the following questions: (1) Is the skill or knowledge being taught highly important to the learner's ability to control his environment or to engage in further learning? (2) If so, is the short-term loss of self-controlled activity worth the long-term gain in self-control that can be realized through temporary engagement in efficient externally directed instruction?

This dilemma is posed in perhaps its starkest form with respect to the acquisition of literacy. In "Way It Spozed to Be," James Herndon (1965) describes the behavior of four twelve-year-olds who

are incapable of reading their own names, and as a result can be manipulated by another member of the class into believing that their names are listed on the absence sheet the teacher is sending to the office. Unable to read, these children have no way to determine who is telling the truth, the teacher who assures them their names are not on the list or the classmate who assures them that they are. Since an unexcused absence invites various forms of punishment in school, the presence or absence of their names on the list is a matter of some consequence. The children's inability to determine their status in this regard thus constitutes a severe loss of control over their own lives. Herndon's vignette dramatizes the fact that in urbanized and industrialized societies there is probably no more important skill in gaining control over one's own life than reading and associated skills of literacy. If this is so, then "respecting" an individual's freedom to not learn to read actually means condemning him to a life of bondage.

These considerations suggest that a first priority of any educational system in this country should be making sure that all of its children acquire fluency in the skills of written communication that so dominate our lives. If these skills can be acquired through learner-controlled instructional techniques, then such techniques are to be preferred. If however, more directed instruction is required, it is important to recognize that its use does not constitute a defection from the goals of open education, but rather a considered means of helping individuals to achieve these goals.

Motivation in Open Educational Systems

In the domain of motivation a key assumption is shared by virtually all open education advocates. This is that children are by nature motivated to gain competence and to learn what is meaningful to them.

As a result, it is frequently argued, there is no need to be concerned with "motivation" as such; rather, if people are free to choose what they want to learn and if instructional materials are themselves interesting, motivation will take care of itself, and in any case, externally dispensed rewards will not need to be called upon. Various kinds of evidence are adduced in support of this assumption. These include: (1) observations of the play and learning of preschool children; (2) observations of sudden spurts of learning among older people as the result of high motivation, even under unfavorable teaching conditions; and (3) Piagetian and related theories of cognitive development which stress the role of self-motivated play (assimilation) and learning (accommodation) in the development and extension of new conceptual structures.

No easy assessment of the validity of these claims with respect to organizing education can be made. There seems to be little doubt that learning without apparent external motivation does take place at certain times and for certain individuals. The crucial question for educational design, however, is whether such motivation can be counted on to sustain the full range of learning activities necessary for the acquisition of a varied range of competencies. Let us allow that the "high" moments in learning are those during which the individual is completely absorbed in the learning process itself, moments during which external reward is not needed and might be disruptive. Even so, how many such high moments can we anticipate for a given individual? Will there be enough to sustain all of his learning, or must there be other forms of reinforcement available for the "low" times, which nonetheless contribute to the total learning process? Piagetian theory suggests that self-motivated learning occurs at the times just before and after acquisition of a new structure, and Elkind

(1970) has shown that such "assimilative" practice is sometimes so pervasive as to infiltrate unrelated activities during that period. Elkind and others have suggested, however, that when the particular material to be learned does not happen to perfectly "match" the individual's immediate state of cognitive development, then self-motivation cannot be counted on, and external rewards may be required. Further, it is not clear that observed self-motivated learning is really independent of external, particularly social, reinforcement. What happens, for example, to the child whose early, self-motivated learning activities receive no social support from parents or other adults? Do the learning attempts continue, or are they dependent in some way upon generalized social reinforcement of investigatory behavior?

Current theories of reinforcement are beginning to blur the lines between intrinsic and extrinsic reinforcement. A recent conference on the nature of reinforcement (see Glaser, 1971) included interpretations of reinforcement in terms of sensory variation, which is closely related to theories of curiosity and exploratory behavior (Fowler); informational feedback (Atkinson and Wickens); differential probabilities of an individual's engaging in particular behaviors (Premack); and self-reinforcement or observation of reinforcement given to others (Bandura). In line with this shift in psychological theory from exclusive emphasis on external manipulations to concern with internal processing of the reinforcing stimuli, it seems most useful with respect to education to ask, not how to avoid the use of external reinforcement, but rather how to arrange that reward, like other aspects of the educational process, will function primarily under learner control.

In his chapter in the reinforcement conference, Bandura (1971) reviews a body of literature on self-reinforcement practices, examining both how individuals acquire self-reinforcement standards and how

self-administered reinforcement supports and maintains specific performances. This research, although very little of it has been carried out with respect to education, may nevertheless provide a starting point for development of a technology of self-reinforcement in education. Among the questions that will have to be addressed in the course of such development two stand out as particularly important. The first concerns the kind of general social context necessary for self-reinforcement standards to maintain themselves; for example, what constraints, if any, are needed to insure that children do not "reward" themselves for incompleted tasks or for poorly executed performances? More generally, the question is raised concerning the possible role of a generalized external reinforcement structure in setting boundary conditions for the functioning of self-reinforcement. The second question concerns the informational feedback role that external reinforcement is known to play. It demands consideration of the ways in which this function of reinforcement can be most effectively met in a setting in which rewards are largely self-determined. The question is closely related to the problem of how people can learn to evaluate the quality of their own performances, a question that is considered in the next section.

Evaluation of Open Educational Systems

For many decades evaluation has been the best developed branch of educational technology. Standardized and normed tests of achievement and aptitude have served as the cornerstone of selection for educational programs, and often for jobs as well. IQ tests, beginning with the work of Alfred Binet, have been explicitly designed to predict academic achievement, and achievement tests themselves are designed to rank and order students as much as to test specific

competencies. In an open educational system, 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 the student's interests together with his command of specific prerequisite competencies. This does not mean, however, that there will be no role for evaluation, but rather that testing methods will be needed that are useful in making the kinds of educational decisions that will be required in an open system. What are these decisions and what kinds of testing might they lead to?

Perhaps the major requirement, hinted at in the preceding section, is for measures of competence that let the learner himself find out how he is doing--whether or not he is making progress toward his own objectives. Closely related is the need for measures of prerequisite learning, again measures of specific competencies that can help a student decide which specific objectives he may need to study to meet his educational goals. Both of these needs have been recognized in the increasing amount of work on "criterion-" or "domain-referenced" testing (see Glaser & Nitko, 1971). The important point about tests of this kind is that: (1) they directly sample the competencies identified as desirable; (2) they describe an individual in terms of his ability to perform, or not to perform, these specific competencies at the time tested; and (3) they attempt neither to compare the student with others (hence they are criterion- rather than norm-referenced) nor to predict his future ability.

Tests of this kind have an intrinsic character of openness as compared with most norm-referenced tests. In general, they can be examined in advance by both the students and teachers who will eventually use them; they serve then as a display of the competencies to be acquired. Similarly, the results need not be hidden, particularly

from the student himself, who can use his performance on such tests as a yardstick of his own developing ability. Finally, the tests are easy to understand once they are inspected, since the behaviors are not usually masked by incidental demands designed to increase the difficulty and thus the "discrimination power" of the individual items.

In addition to providing yardsticks of progress, an open educational system needs to provide the student with as much useful information as possible on which to base his decisions as to method of instruction once an objective is chosen. This issue is generally discussed as the problem of adapting methods of instruction to the learner, but most such discussions are concerned with adaptive choices to be made by the instructor rather than by the learner himself. At the present time, it is virtually impossible to indicate what kinds of tests are likely to prove useful for this purpose. This is because the past research on "aptitude treatment interactions," as this area has conventionally been termed, has been notably unsuccessful in turning up significant interactions--i.e., cases in which one method of instruction is better for individuals of one type and a second method is better for individuals of another identifiable type (see Bracht, 1970; Cronbach & Snow, 1969). If there are such interactive dimensions of individual difference, they have not yet emerged. Perhaps some of the new research that is developing in this area will change the picture in a few years. For the moment, however, it is probably the case that the learner himself, without formal assessments of his abilities, cognitive styles, or other characteristics, is the best judge of the teaching methods most compatible for him, provided that the options open to him are adequately displayed and he is permitted to sample them in order to determine how they work for him.

In the discussion of educational objectives at the beginning of this paper, I pointed out that one implication of the mergence of open educational models will be attention to a broader range of competencies. As was suggested, this enlargement of perspective can be expected to pose especially strong demands on the technology of educational evaluation. Many open education advocates have been opposed to measurement and evaluation activities in education. One reason for this stance has been the traditional use of tests in the service of the closed and selective educational system. A second reason, however, has been the nearly exclusive focus of educational measurement on a narrow band of academic outcomes. This emphasis in educational measurement matches the traditional emphasis in instructional program development, and as such reflects our traditional educational concern. It also reflects, however, a very real difficulty in developing measures of outcomes in the domains of affective development, creative thinking, social and moral development, and so on. Attempts to cast measurements in these areas in the conventional multiple-choice, machine-scored tests of educational measurement have often resulted in caricatures of the worst features of traditional testing. A more promising approach for many such outcomes lies in the use of direct observational methods, in both natural settings and settings designed specifically to evoke the behaviors of interest. The beginnings of a movement toward the use of such process-oriented measurement procedures in education can now be detected. This kind of work needs to be supported and expanded, despite a cost significantly greater than that of traditional approaches to evaluation.

Concluding Remarks

I have in this paper accepted the central goals of the open education movement and attempted to explore the implications of these

goals for the future development of educational methods and techniques. By using learner control as the defining criterion, I have tried to free the conception of open education from any particular set of current educational practices and to focus attention on a central social concern: increasing the degree of control the individual exercises over the shape of his own life. If open societies are possible at all, I believe that they are possible only with the help of a highly sophisticated educational technology--a technology that will eventually permit learning that is highly efficient when necessary and yet finely responsive to the interests, current abilities, and stylistic preferences of the individual. Without such an educational technology, open and informal education systems are likely to lead to more rather than less concentration of knowledge and skill; to increasing rather than decreasing educational privilege; and thus to diminished rather than enhanced self-determination for the majority of people.

The problems and questions posed here are among those the field of educational technology will have to address if progress in the direction of extensive open educational systems is to be made. None of them is likely to see quick solution, or widespread application in the very near future. Rather, I believe we should look forward to a period of heightened experimentation and developmental study. Further, we can expect the ultimate outcomes of such experimental efforts to produce forms of educational technology quite different from what is now available. What is presented here, in other words, must be viewed as a proposal for a direction of research and development in education, not as a prescription for today's schools.

References

American Sociological Association. Sociological resources for the social studies, Episodes in social inquiry series. Boston: Allyn & Bacon, 1969.

Bandura, A. Vicarious and self-reinforcement processes. In R. Glaser (Ed.), The nature of reinforcement. New York: Academic Press, 1971. Pp. 228-278.

Barth, R. S. Open education--Assumptions about learning. Educational Philosophy, 1969, 1, 29-39.

Blank, M., & Solomon, F. A tutorial language program to develop abstract thinking in socially disadvantaged preschool children. Child Development, 1968, 39(2), 379-389.

Blank, M., & Solomon, F. How shall the disadvantaged child be taught? Child Development, 1969, 40(1), 47-61.

Bracht, G. H. Experimental factors related to aptitude-treatment interactions. Review of Educational Research, 1970, 40, 627-645.

Brown, G. I. Human teaching for human learning: An introduction to confluent education. New York: Viking Press, 1971.

Bruner, J. S. Some theorems on instruction illustrated with reference to mathematics. In Theories of learning and instruction, Sixty-third yearbook of the National Society for the Study of Education, Part I. Chicago: NSSE, 1964. Pp. 306-335.

Burris, R., Shaw, R., McIntyre, M., & Mast, T. Coordinating resources for a systematic approach to instructional research and development: An illustration in art history. Symposium presented at the meeting of the American Psychological Association, Washington, D. C., 1971.

Central Midwestern Regional Educational Laboratory. Aesthetic education: A brief. St. Louis: CEMREL, 1970. (a)

Central Midwestern Regional Educational Laboratory. Aesthetic education: A social and individual need. St. Louis: CEMREL, 1970. (b)

Cronbach, L. J., & Snow, R. E. Individual differences in learning ability as a function of instructional variables. Stanford: School of Education, Stanford University, 1969. (Final Report, Contract No. OEC 4-6-061269-1217, United States Office of Education)

Elkind, D. Children and adolescents--Interpretive essays on Jean Piaget. New York: Oxford Press, 1970.

Ellis, A. B., & Tiedeman, D. V. Can a machine counsel? In W. H. Holtzman (Ed.), Computer-assisted instruction, testing and guidance. New York: Harper & Row, 1970. Pp. 345-373.

Evans, S., & Klahr, D. An educational assembly system for student executed educational design. Pittsburgh: Graduate School of Industrial Administration, Carnegie-Mellon University, 1971. (EAS/SEED Project Report No. 2)

Flavell, J. H. The development of role taking and communication skills in children. New York: Wiley, 1968.

Glaser, R. Objectives and evaluation: An individualized system. Science Education News, 1967, 1-3.

Glaser, R. (Ed.) The nature of reinforcement. New York: Academic Press, 1971.

Glaser, R., & Nitko, A. J. Measurement in learning and instruction. In R. L. Thorndike (Ed.), Educational measurement. Washington, D. C.: American Council on Education, 1971. Pp. 625-670.

Herndon, J. Way it spozed to be. New York: Simon & Schuster, 1965.

Jones, R. M. Fantasy and feeling in education. New York: New York University Press, 1968.

Kohlberg, L. The contribution of developmental psychology to education--Examples from moral education. Invited address presented at the meeting of the American Psychological Association, Washington, D. C., 1971.

Meichenbaum, D. H. The nature and modification of impulsive children: Training impulsive children to talk to themselves. Waterloo, Ontario: Department of Psychology, University of Waterloo, 1971. (Research Report No. 23)

Osborn, J. Teaching a teaching language to disadvantaged children. Monographs of the Society for Research in Child Development, 1968, 33(8).

Palmer, F. H. Minimal intervention at age two and three and subsequent intellective changes. In R. K. Parker (Ed.), Preschools in action. Boston: Allyn & Bacon, 1972. Pp. 437-465.

Rohwer, W. D. Prime time for education: Early childhood or adolescence? Harvard Educational Review, 1971, 41, 317-341.

Rosner, J. Visual analysis training and the copying skills of 4-year-old children. Unpublished manuscript, Learning Research and Development Center, 1970.

Rosner, J. Phonic analysis training and beginning reading skills. Pittsburgh: Learning Research and Development Center, 1971.

Smilansky, S. The effects of sociodramatic play on disadvantaged preschool children. New York: Wiley, 1968.

Wang, M. C., Resnick, L. B., & Boozer, R. F. The sequence of development of some early mathematics behaviors. Child Development, 1971, 42(6), 1767-1778.

Weikart, D. P., & Lambie, D. Z. Early enrichment in infants. In V. H. Denenberg (Ed.), Education of the infant and young child. New York: Academic Press, 1970. Pp. 83-107.