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Cybernetic Educational Design: An Example

Recent advances in the design of electronic recording, transmission and display instruments have provided the educator with powerful tools for redesigning human learning environments. This increased ability to extend (and simulate) the functions of the central nervous system and sensory systems through electronic instrumentation calls for a continuous reexamination of learning principles and of educational designs in which learning occurs.

Underlying many training and educational designs is the assumption that learning is primarily a process of learner response. This assumption focuses attention on teaching, on *reac*tive processes in the learner and encourages the use of external guidance and motivational practices. Educational designs for the reacting learner stress reward, reinforcement, verbal persuasion, threat and punishment.

Learning environments which are designed for the *act*ing or *trans*acting learner are less frequently encountered. Such designs encourage choice, problem solution, and relevancy. In general, they emphasize the self-regulating characteristics of a learner. Arguments in support of principles of learning and educational design which incorporate inherent motivational and energizing properties of the learner are emerging from perceptual and transactional psychology, from experimental studies of exploration and curiosity, and from communications and cybernetics theory.

Perceptual theorists[1,2,3,4,5] give central importance to the self-governing characteristics of the individual. Gordon Allport[6,7] terms mental

[1]Combs, A., and D. Snygg. *Individual Behavior* (New York: Harper and Bros., 1959).

[2]Combs, A. (Ed.) *Perceiving, Behaving, Becoming: A New Focus for Education.* 1962 ASCD Yearbook (Washington, D.C.: Association for Supervision and Curriculum Development, 1962).

[3]Rogers, C. *Client-centered Therapy: Its Current Practice, Implications, and Theory* (Boston: Houghton Mifflin, 1951).

[4]Rogers, C. *On Becoming A Person* (Cambridge, Mass.: The Riverside Press, 1961).

[5]Allport, F. *Theories of Perception and the Concept of Structure* (New York: Wiley, 1955).

[6]Allport, G. *Pattern and Growth in Personality* (New York: Holt, Rinehart and Winston, 1961).

[7]Allport, G. "Psychological Models for Guidance," in Mosher, R., R. Carle and C. Kehas. *Guidance: An Examination* (New York: Harcourt, Brace and World, 1965), pp. 13-23.

set "the key to the edifice of psychology" and stresses the *act*ive rather than *re*active nature of human behavior. Berne,,[8] and Kilpatrick[9] call attention to *trans*actional rather than reactive properties of an individual.

Representative studies of exploration,[10] manipulation,[11] and activity[12] indicate intrinsic motivational properties of animals. In light of research into exploratory and curiosity behavior, White[13] has formulated an innate "competency" motive. Life systems are conceptualized as inherently active, exploring, curious, and seeking mastery over their own behavior as well as over components of the environment.

Cybernetics yields further evidence for viewing the learner as self-regulating.[14] The term cybernetics is derived from the Greek word, *kybernetes,* meaning "steersman," or "governor." The formal analogy comparing self-regulating properties of living and non-living systems was introduced by Wiener.[15] Cybernetics is defined as the science of control and communication in living and non-living systems. Non-living purposive systems are known as servo-mechanism.[16] These devices, utilizing feedback control operations, function to regulate temperature, guide missiles and planes, control traffic flow, etc. The feedback control operations can generate movement toward a goal (motivation), detect errors in movement, and use the error for self-correction (learn). If the analogy of common properties between living and non-living systems is accepted, then redefinition of the learner and learning environment using cybernetic principles is possible. The rest of this paper considers some of the principles involved in such a design and presents an example of a cybernetic educational design.

In behavioral cybernetic theory, it is assumed that the primary goal of the learner is to gain mastery over his own behavior as well as over elements of the environment. Energizing is intrinsic and the ability to

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[8]Berne, E. *Transactional Analysis in Psychotherapy* (New York: Grove Press Inc., 1961).

[9]Kilpatrick, F. (Ed.), *Explorations in Transactional Psychology* (New York: New York University Press, 1961).

[10]Nissen, "A study of exploratory behavior in the white rat by means of the obstruction method," *Journal of Genetic Psychology, 37,* (1930), pp. 361-376.

[11]Harlow, H., and G. McClearn, "Object manipulation learned by monkeys on the basis of manipulation motives," *Journal of Comp. Physiological Psychology, 47* (1954), pp. 73-76.

[12]Brant, D. and Kavanau, J., " 'Unrewarded' exploration and learning of complex mazes by wild and domestic mice," *Nature, 204* (1964), pp. 267-269.

[13]White, R., "Motivation reconsidered: The concept of competence," *Psychological Review, 66* (1959), pp. 297-333.

[14]Smith, K., and M. Smith. *Cybernetic Principles of Learning and Educational Design* (New York: Holt, Rinehart and Winston, 1966).

[15]Wiener, N. *Cybernetics* (Cambridge, Mass.: Technology Press, M.I.T., 1948).

[16]Rosenblueth, A., Wiener, N., and Bigelow, J. "Behavior, purpose and teleology," *Philosophy of Science, 10* (1943), pp. 18-24.

detect differences (learn) is a functional characteristic of the living system. To be alive is to be motivated. The commonly held views that most learners "need motivating" or "lack incentive" are the result of incorrect conceptualizing about the nature of the learner and learning.

From the cybernetic view, the concept of motivation is not particularly helpful. The learner is seen as more interested in doing things in his own way (that is, as he can control them) than he is in gaining an extrinsic reward offered for some other response.[17]. A primary design goal is to establish an educational environment which will enable the learner to establish his own patterns of control over tasks, skills and knowledge. Further, the cybernetic theorist is concerned with the *social utility* (relevance) of learning. If that which is being learned has no social utility to the learner, then he directs activities to other targets — asocial behavior, interpersonal conflict, discouragement, boredom, etc.

In summary, for the cybernetic theorist, the learner is self-initiating and is energized and directed at varying levels of organization by inherent feedback control systems. The educational design which implements cybernetic principles is one which 1) aims at increasing a learner's control over his own actions, 2) assigns high priority to intrinsic rather than extrinsic regulation factors, 3) gives attention to the degree of social utility accorded to the objects of learning by the learner,[18] and 4) pays attention to overloading *vs* underloading.[19]

Cybernetic learning designs are applicable to a wide variety of learning tasks. For example, handwriting skills can be developed in a learning design employing visual and kinesthetic feedback. The various motor skills needed to develop tennis or golfing abilities might well be efficiently learned through the application of a learning procedure employing visual feedback via videotape. Studies of teaching skills such as reinforcement, presentation skill, use of example, closure and questioning have been conducted at Stanford[20] using a training design which embodies several cybernetic principles. Also suited to learning through such a design are various counseling skills: questioning, clarification, prompting, test interpretation and reinforcement. In short there are a variety of verbal, social and motor skills which seem appropriate for learning through a cybernetic design.

Presented here for illustrative purposes is a design intended to provide counselor trainees an opportunity to develop two communication skills: questioning and non-interrupting behavior. To be effective, an interviewer must learn to ask questions in a fashion which encourages the interviewee to respond and also must learn to limit his interruptions of

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[17]Smith, K., and M. Smith, *op. cit.*

[18]*Ibid.*

[19]Senders, J., "Human performance," *International Science and Technology* (July, 1966), pp. 58-68.

[20]*Microteaching: A Description* (Stanford: Stanford University, 1967).

Table I

CYBERNETIC DESIGN FACTORS AND PRINCIPLES

Design Factor	Principle
1. The trainee is given oral and written instructions about the specific skill to be learned. He is shown cues to watch for when viewing his own behavior on video-tape.	1. Built-in instructions are provided.
2. The trainee conducts a brief interview with focus on single skill. The interview is video-taped.	2. By analyzing interviewing into component parts, the level of complexity is held down to a level acceptable to a limited capacity system.
3. Immediately following the interview, the trainee is again given written cues to assist observation of his own behavior in the transactional situation (on video-tape).	3. Again, built-in instructions are used.
4. The trainee views video-tape without instructor's presence.	4. This illustrates immediate feedback principle and blame-free atmosphere.
5. The trainee has a brief rest. He may ask for the instructor's comments but this is not compulsory.	5. Blame-free atmosphere, with rest allowing for integration.
6. Cycle 2, 3, 4, 5 is repeated but with different client.	6. All above principles operating plus practise under varied stress (different client).
7. Cycle 2, 3, 4, 5 repeated but with different client.	7. All of the above.

the interviewee's talk. These skills are quite specific and are assumed to be learned skills. The learning design is presented in simplified form intentionally to show how the five selected cybernetic principles can be implemented. Needless to say, in most learning situations, a more complex and detailed design would be required to meet the requirements of the skill being learned and the situation in which the learning occurs.

The cybernetic learning principles implemented in the design are:

1) built-in instructions are used — that is, instructions implicit in the task,

2) built-in feedback is provided to permit continuous regulation of the skill being learned,

3) the learner is considered to be a limited-capacity system and is not over-loaded at any level of learning,

4) the instructor is regarded as a resource person who can be approached for help in a blame-free atmosphere and does not intervene with external guidance,

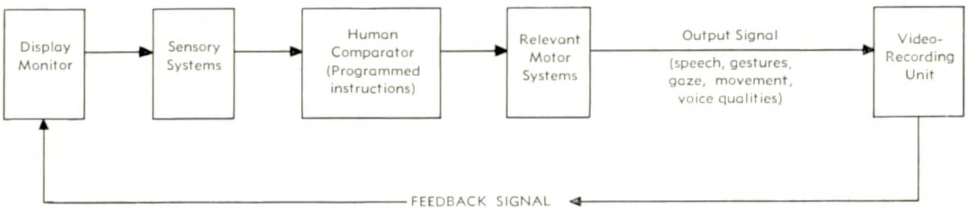
5) there is provision for skill practise under varying conditions of stress.

In this design a trainee is programmed with written and oral instructions specific to the task to be accomplished. He then conducts a brief interview which is videotaped. Following the interview he immediately views his own efforts via replay of videotape on a monitor. Thus he is in a closed circuit training design which supplies immediate visual and auditory feedback which can be used for self-regulation.

This cycle is repeated several times within a short period. The instructor is brought into the training cycle only upon the trainee's request and then takes a supportive, resource role rather than an evaluative one. The feedback control system employed by this design is shown in Figure 1.

Fig. I.

FEEDBACK CONTROL SYSTEM



In summary, the specific training design described here applies cybernetic principles to an area of learning having social utility for the learner. Emphasis is placed on the importance of self-regulation which is determined intrinsically by the interaction of sensory processes, comparator and relevant motor systems. This particular learning design was constructed to develop communication micro-skills and has been presented to demonstrate the implementation of cybernetic learning principles. With this design elaborated as required by the complexity of the skills to be learned, a wide range of skills could be required — from quite specific skills such as verbal reinforcement, and motor skills to social skills such as discussion leader roles, interviewing, public speaking and various teaching functions.