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SYSTEMS APPROACH IN EDUCATION¹

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The systems approach, which is widely applied in business and industry, is beginning to appear more frequently in educational literature. This is probably due to the facts that the systems approach led to successful space adventures and moon landings, and increased emphasis on accountability. This article will describe the systems approach, discuss some educational systems, and demonstrate one technique from systems theory which could be used by teachers to aid them in planning.

What Is the Systems Approach?

The systems approach is not a method, a technique, or a set of techniques. It is a concept--a way of viewing a problem. The systems approach helps to view problems in their perspective context. The problems and solutions to the problem are always entertained in relation to total context. All important variables are given due considerations. Possible alternative solutions are explored. Thus, the problems are analyzed in this total environment.

To grasp the full meaning of the systems approach, it is necessary to describe the systems concept.

Systems Concept

One can think of a system "as an organized or complex whole, an assemblage or combination of things or parts forming a complex or unitary whole" (Kast and Rosenzweig, 1962). In other words, a whole which functions as a whole by virtue of the interdependence of its parts is called a system; e. g., the solar system. To restrict it in the realm of scientific thought, Hall and Fagen (1968) define a system as a set of objects together with relationships between the objects and between their attributes. The definition implies that a system

has properties, functions, and purposes distinct from its constituent objects, relationships, and attributes. Objects are simply the parts or components of a system. The objects may be physical, such as stars, men or equipment; or abstracts, such as mathematical variables, rules or laws. Attributes are properties of objects. For example, stars have properties of temperature, velocity, etc. The relationships are those that 'tie the system together.' It is, in fact, these relationships that make the notion of a system useful.

A system operates in a certain environment. The environment includes all things outside of the system under study. The environment influences the system and in turn the environment may be influenced by the system activities. For example, let us consider the vocational education system. The purpose of this system is to train people to the world of work, which is considered the environment to the vocational education system. The job situation influences changes in the vocational education system; for example, if job opportunities in a field decrease, the number of people trained in that field will also decrease. The graduates from the vocational education system change the composition of job market. This interactive phenomena between a system and its environment is called a 'feedback' loop. When there is an exchange of information and energy between a system and its environment, the system is called an open system. A system is closed if there are no such exchanges of energy and information with the environment. A system and its environment are separated by the criteria used in delineating the system. If the criteria are set so as to include all the interactions within a system, the system becomes closed. However, most of social systems are open system.

The definition of system and environment lead to the notion of subsystems; i. e., any system can be divided into subsystems. One subsystem may be considered as the part of the environment to another subsystem. For example, the educational system can be subdivided into instructional subsystem and administrative subsystem. A subsystem is commonly referred to as a component of the system.

Subsystems are interrelated. This relationship makes the system behave as a whole. The approach which aims at discovering how this relationship is brought about in the widest variety of systems is called the General Systems Theory (GST). The application of GST is generally called the systems approach. The starting point in the application of the GST is the definition of the system under study. As the term 'system' covers a wide range of phenomena, the careful delineation of the system under study is essential. The definition should explicate both those entities which should be included in the system, and those which should be excluded from it. Now let us attempt to define the system under study.

The System Under Study

For our purposes, we are interested only in those systems which display activities. Thus, we are concerned with 'behavioral' systems which are dynamic in time. Behavior is defined in terms of energy exchange within a system or between systems resulting in movements. The essential characteristic of a behavioral system is that it consists of parts, each of which displays behavior. We can further narrow the definition down to those dynamic systems which are controlled by human beings. Consequently, the solar system, for example, even though it is a behavioral system, is not a part of the subject matter of our system research. We are interested in only those systems where human beings are sine quo non.

Again, we are not interested in all systems where the humans are involved. Our concern is only with those systems that offer services to the society--satisfying the needs of the society. Further, we limit ourselves to those systems that are culturally based and maintained to provide differentiated services and/or to perform specialized functions for society, particularly the need for human resource potential development (Miller, 1968). This brings the educational system into sharp focus. The educational system is the one that satisfies the above mentioned criteria, while eliminating other societal systems such as health care, military systems and such others. Now we have defined the system under study; namely, educational systems. Everything outside of the system is its environment.

The educational system can be broken down into several subsystems. The focus of our interest is the instructional (sub) system.

Instructional System

The instructional system consists of several subsystems such as teacher subsystem, student subsystem, facilities subsystem, etc. The instructional system has the purpose of transmitting knowledge from one source (teacher and/or instructional materials) to another source (students), making students aware of the existence of information, and training students to perform certain skills. The society and other parts of educational system can be considered as the environment of the instructional system.

One major responsibility of an instructor is the development of the course plan, commonly called behavioral objectives. Several methods of the development of behavioral objectives can be found in the literature. See, for example, Gronlund (1971), and Mager (1962). All methods emphasize the systems approach. The development and use of behavioral objectives is often considered synonymous within the systems approach to instruction.

The development of behavioral objectives is based on the course content. The course content, particularly that of vocational education programs, is dictated by the environmental factors; e. g., nature and type of job openings, employers' expectations, and former students' attitudes and experience. Further, the limitations within the system, such as students' interest and abilities, instructional facilities and resources, teachers' motivation, interest, and ability, play important roles in the development of behavioral objectives. For these reasons, it is essential to examine carefully the 'ready made' behavioral objectives for suitability of their use in one's own classroom.

The set of behavioral objectives is not mutually independent. Some of them have to be taught before some others are taught. The question of sequencing brings up the Program Evaluation and Review Technique (PERT) and Critical Path Method (CPM).

Cook (1966) has examined the use of PERT and CPM in education. PERT is a methodology for planning diverse activities. It helps to schedule activities and estimate the time required to complete all the required activities. The activities are drawn in a diagram called a PERT chart.

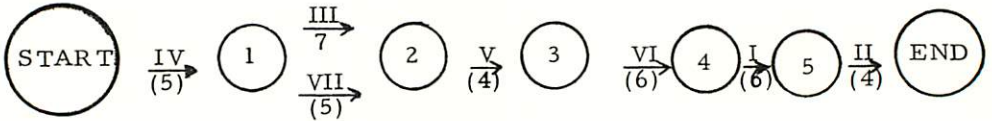
The following is a practical example of how PERT and CPM can be used to plan teaching of a set of seven objectives in Forestry.³ The seven objectives are given in Table 1. Beside each objective is the time (in days) estimated to teach it.

TABLE 1.

No.	General Objectives	Days
I	The student will understand the procedures used for measuring forest products.	6
II	The student will understand the procedures for marketing forest products for the greatest economic return.	4
III	The student will understand the procedures for forest reproduction.	7
IV	The student will know how to identify desirable and undesirable tree species.	5
V	The student will comprehend measures involved in fighting and protecting the forest from fire.	4
VI	The student will understand how to protect the forest from disease, insects and animals.	6
VII	The student will know how to apply ecological principles to the management of forest land.	5

What sequence of objectives should be used to teach the students? A professor trained in agricultural education provided one possible sequence, which is given in the following PERT chart (Figure 1).

FIGURE 1.



The Greek numerals refer to objectives, numbers in circles are activity integration points, and numbers in brackets refer to days required to complete an objective.

The PERT chart shows sequence of teaching the seven objectives and how many days are allotted for each objective. For example, objective number IV must be taught first. The chart also shows that objectives III and VII can be taught simultaneously, but only after objective IV has been attained. Now the question is, how many days are required to complete all objectives?

The chart has two paths: via objectives IV, III, V, VI, I, and II, and via objectives IV, VII, V, VI, I, and II. They take 32 and 30 days respectively. The course is completed in 32 days because that is the duration of the longest path. This path is referred to as the critical path. Any delay in the completion of the activities on the critical path will delay the entire course. The path involving objective VII is not critical. It has time (2 days) to spare. If this objective is delayed two or more days, it then will become 'critical,' assuming that the duration of the other path remains constant.

In this article the systems approach was exemplified with PERT and CPM techniques as aids in developing a course plan. However, the systems approach has much more to offer than what is shown in this article. It can be of great use, for example, to educational administrators in their decision-makings with the use of Program Planning and Budgeting System (PPBS) method. The successful use of systems approach always rests on the user's ingenuity and skill.

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FOOTNOTES

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²The author is an assistant professor in the Division of Vocational-Technical Education and working as a systems analyst for the Vocational Education Evaluation Project.

³These objectives were developed in connection with the Vocational Education Evaluation Project, Virginia Polytechnic Institute and State University. Gronlund's approach was used in the development of behavioral objectives. Only the general objectives are given here.

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