A Systems Approach to Optimizing Learning Environments for Adult Education

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ABSTRACT

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This thesis addresses the problem of determining optimal learning environments for adult learners. The optimization criteria are; 1) student preferences for selected categories of activities based on Frank's (1971) scheme of pedogogical dimensions, 2) administrative constraints, and 3) expert opinion on factors influencing implementation.

This optimization problem is addressed through a systems model which accepts data easily obtained from questionnaires or interviews. In this case, the questionnaires were administered to three levels of decision makers; students, educational administrators, and subject matter experts. From this data, a value or utility is calculated for each of four types of learning environments. This utility reflects students preferences as well as the ease or difficulty with which environments and activities can be implemented.

The model was tested for validity using three strategies: 1) test data with predictable results was fabricated to

validate the mathematical manipulations and test the Fortran program, 2) actual questionnaires were administered, and 3) the opinions of a panel of judges was sought to attest to the face and content validity.

Results of the fabricated test data showed no computational errors in the mathematics. Results of actual responses to the questionnaires yielded four types of values indicating differences in learning environments and educational activities for each student in the sample and the total sample population. Each judge attested to the face and content validity of the model.

This model is coded in Fortran V and will run inexpensively on many systems. Sufficient flexibility is incorporated into it as to allow the model to be tailored to varied user specifications.

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CONTENTS

CHAPTER 1
RATIONALE

1. Introduction

Educational technology, as a field of study and practice, is concerned with the application to education and training of processes and principles found outside the field of education. A few such examples are communication and information systems, psychology, systems analysis and quantitative methods.

This study presents an application of some processes developed in the field of systems analysis, system modeling and adult learning to the field of education. It synthesizes concepts found in these areas with some concepts, principles and practices found in education, more particularly in adult education, to develop a tool which can be used for planning and organizing in education and training.

Practioners in the field of educational technology might find this a useful tool in making decisions concerning the allocation of resources to a learning situation. Researchers might see this as a model with potential for further inquiry and elaboration.

RATIONALE

Chapter 1

Professionals working in a variety of contexts have customarily relied upon two approaches for planning, developing, and adapting educational and training programmes and their learning environments: 1) needs assessment and 2) evaluation. Both of these approaches are similar in that they are based on the identification and analysis of learner preferences or discrepancies between what exists and some defined standards. Both are information-gathering tasks, sometimes involving the use of similar information-gathering instruments. Both seek to answer a question. Needs assessment is governed by the normative question of "what should be done?"; evaluation is governed by the efficiency question of "how well was something done?". While needs assessment and evaluation have yielded partial solutions, they do not address themselves to many of the issues and concerns of those responsible for fiscal, administrative and pedagogical decisions.

The purpose of this thesis is to develop a model which will expand the information base from one to three levels of decision makers in the domain of adult education. Then, planners could make more rationale and systematic decisions based on easily obtainable data such as questionnaires and interviews, and evaluate the usefulness of alternatives based on learner preferences, administrative constraints, and

opinions of subject matter experts, regarding factors which influence the implementation of these alternatives.

This Chapter will present an overview of the problem and a proposed alternative to needs assessment and evaluation for decision making in the context of adult education.

2. Needs Assessment

For the needs assessment approach the basic questions revolve around the discrepancies between where the adult learner is and where he wants to or ought to be (Kaufman, 1981; Knowles, 1970; LeSage, 1980; Misanchuk, 1981; Misanchuk & Scissons, 1978). Needs assessment can be defined as a process in which educational needs are articulated and prioritized (Monette, 1977). The main task appears to be in identifying the "need". The literature is replete with controversay on what is a 'legitimate' need for defining educational goals, and by implication, for designing learning systems (Kaufman, 1981; Monette, 1977).

In his exploration of the concept of need in education, Monette (1977) offers several classifications. The first of these is a classification put forth by McKinley (1973) proposing three 'families' of need: two pertaining to the individual and one pertaining to systems (societies,

communities and institutions).

At the level of the individual, the classification is similar to Knox's (1968) debate between 'real' and ''felt' needs. Felt needs is used interchangeably with interests, wants, or desires. McKinley calls the identification of these needs the Individual Self-Fulfillment Models. The approach is to discover these wants or interests, with the aim of developing financially self-supporting programmes geared to filling individual learners wants. These programmes are usually developed ad hoc and unsystematically. These are typically, special interest, leisure and cultural programmes.

The second category of individual need, according to McKinley, focuses on presumed needs of a segment of population and is loosely akin to Knox's "real" needs. The approach for identifying these needs is by the Individual Appraisal Models. The term "real need" refers to some lack in the individual, a gap in knowledge, attitude, or skill. These are typically addressed in Adult Basic Education courses. This type of need exists outside the individual and is identified according to some external criteria. This may involve a value judgement which would imply the questions:

who establishes the criteria? Is it valid for all learners? For all educators? At all institutions?

The third category of needs in McKinley's classification is at the level of social systems: societies, communities, institutions. The approach, in this instance is the Systems Discrepancy Model. This approach to needs assessment is very similar to Kaufman's (1981). Need in this instance is a term used to describe the discrepancy between what is and what ought to be in a given political economic system. These needs typically give rise to Manpower Training courses, professional training, and general education.

Systems discrepancy models aim at diagnosing and solving systems problems or at attaining some desired, stated end-state. The former leads to the development of programmes which are remedial in nature and are related to the diagnosed difficulties in the client system. The latter leads to the development of programmes whose focus is general improvement. The premise is that systems have needs which have to be assessed and fulfilled. It is the individuals within the systems who have the needs. Systems can be ordered by coalitions of individuals, to perform in a responsive way. If the performance of a system is to improve, it can only do so through the negotiated action of individuals within that

system.

This leads us back to responding to needs at the level of the individual and the original debate around the concept of need. Is it "real" or "felt"? The importance in distinguishing between the two kinds of needs relates to the types of programmes which would be instituted in order to accommodate these needs. Felt needs might be accommodated through self-supporting programmes; real needs through publically or corporately sponsored programmes. But there are other questions: what about the availability of resources, the practicality of implementation, the constraints on the learning system, the interaction between individuals, and the limitations and resources of the educational system? These important considerations for programme planning, development, and adaptation are either ignored or given token consideration in many needs assessment models. The emphasis is placed instead on learner preferences or perceived need.

Three models of assessing educational needs are presented in the following sections. These are by no means comprehensive nor exhaustive. They are meant only to illustrate a current trend for diagnosing educational needs.

They are all discrepancy models.

2.1 Needs Assessment Models

Model 1

McNeil defines an educational need as ". . .a condition in which there is a discrepancy between an acceptable state of learner behaviour or attitude and an observed learner state" (1977:74). According to McNeil, educational goals are articulated by accumulating preferences from concerned people, such as students and staff. He postulates a four stage process of educational needs assessment. During the first stage, data is accumulated from the literature in the form of broad goal statements. Stage two accumulates data on preferences from concerned people such as students and staff in order of priority among goals. This is done by the ranking of stated goals from stage one, according to frequency of stated preferences. In step three, learner status on each goal is measured against some predetermined criteria using assessment devices on a representative sample. If a discrepancy is found between an acceptable level and actual student performance, a need is said to exist. Goals are then prioritized according to the widths of these discrepancies. The fourth step consists of translating those preferred goals for which a need has been identified, into curriculum plans.

Model 2

Kaufman and English (1979) define needs assessment as a process of identifying and justifying the gap between what is and what should be. Their model considers current and future societal requirements in order that the organization may be useful and efficient. The authors describe an organization as having five related elements: inputs, processes, products, outputs, and outcomes. Their view of needs assessment revolves around identifying discrepancies between what is and what should be in any of these elements. These discrepancies then form the basis for the derivation of institutional or organizational goals and objectives.

Kaufman (1979) argues that while it is important for a subsystem, such as an organization, to meet its goals, this must be done with consideration of the suprasystem, the society in which the organization nests. This philosophy is consistent with a systems approach to decision making (Van Gigch, 1978). Application of Kaufman's model would entail the determination of "what is" in all the five elements. This current condition would serve as the baseline." . . .In order to determine 'what should be' reversing the order of consideration of the elements by moving from outcomes, to outputs, then to products, processes, and inputs" (Kaufman,

1979:7). Although this model does consider many elements including societal requirements, it is fundamentally a discrepancy model.

Model 3

Another approach to needs assessment is through the analysis of the required competencies. LeSage (1980) operationalized his definition of need by asking individuals to respond to each externally selected skill by identifying their competence (ability to perform each task) and the relevance of the task for their particular job. Misanchuk and Scissons' (1978) model of needs assessment adds a third dimension to LeSage's model: how much does the learner desire to improve his/her skills? Misanchuk and Scissons have argued that the highest need exists for those skills for which individuals express a high relevancy to their jobs, a low competence in performing those skills, and a high desire to improve their skills. In these two models, the discrepancies relate to perceived competence and relevancy to job requirements with the addition of the dimension of motivation.

2.2 Limitations of the Needs Assessment Approach

While all the approaches to needs assessment cited above can be useful in assisting decision makers to plan

educational or training programmes, their usefulness is limited. The limitations lie in the scope and nature of the information collected and used for the planning effort. In the models cited above 'need' is based on the gap between what exists and some preestablished external criteria or norm. As an initial step to programme planning, this can be justified and useful. In the best of all possible worlds, where resources for education and training are unlimited, perhaps one could imagine planning curriculum based on the perceived needs of concerned people. Clearly, this is an important consideration.

Present economic conditions require planned rationalized spending. With increasing budget stringency, educational institutions and training departments are being asked to be creative in the allocation of their decreasing resources. This means putting political economic pressures ahead of students' perceived needs. Fiscal limitations and efficient use of human and nonhuman resources must be considered. For information on these issues, data must be accumulated from the people who have been entrusted by society with the responsibility to carry out what the public has not rejected as illegitimate: educational administrators and experts in the field. Needs assessment models currently in use fall short, limiting information available to decision makers on

important factors.

3. Evaluation

The evaluation approach to programme planning, development, and adaption is preoccupied with similar discrepancies between learner or programme performance and defined standards. There are also discrepancies between information needed, provided, and used (Larkin, 1974).

In order for the results of evaluation efforts to be useful, decision makers must be provided with adequate and useful feedback. Furthermore, this feedback must be used. Larkin suggests that one of the reasons that the Evaluation-by-Objectives Model fails is because it does not provide adequately useful feedback. Evaluation-by-Objectives is basically a Tylerian Model and is discussed below.

Evaluation seeks to answer questions of selection, support, adoption, and worth of educational materials and activities (Worthen and Sanders, 1973). Evaluation implies valuing or judging something. This is underlined as a major goal of evaluation, in contrast to descriptions of contexts or monitoring of processes. A multitude of evaluation models seek ways of gathering information in order to provide decision makers with a rational base for their valuing.

Several major models will now be presented. These will serve to illustrate the current trend in educational evaluation and are by no means exhaustive nor comprehensive. Popham's (1975) classification of evaluation categories will be used as a format. There are three main descriptive categories: Goal Attainment Models, Judgemental Models, Decision-Facilitating Models.

3.1 Evaluation Models

Goal Attainment Models

One of the earliest recognized evaluation models used was one developed by Ralph Tyler in the early 1930's and is commonly known as a Goal Attainment Model. Tyler was one of the first in his field to recognize the importance of well stated behavioural objectives for educational purposes. The main thrust of Tyler's evaluation model is to measure student performance with stated objectives and to determine the extent to which these objectives are actually being realized. The degree of success of a programme is directly related to student behaviour vis-a-vis behaviourally stated objectives. The value and danger in using this model lies in its narrow focus, ignoring achievement of unstated goals and objectives, and the quality of the stated goals. It does not address issues such as the value and quality of the goals attained or

the value of the unintended outcome.

Judgemental Models

A second classification is the Judgemental Models (Popham's term). The major thrust of these approaches to evaluation is the emphasis on professional judgement. Major models in this classification are those proposed by Michael Scriven, (1967).

Scriven deals with the issue of quality control as opposed to goal definition positioned under the Tylerian Models by insisting that attention be paid by professionals to appraising the quality of goals as well as whether or not the goals have been achieved. In his Goal-Free Evaluation Model, Scriven reverses the evaluation process of the goal-based models. Project goals are not disclosed at the onset of the evaluation effort as they are in the goal-based models. The major emphasis is on results, not intentions. Goal-free evaluation focuses on the outcomes of programmes, intended, unanticipated, at the primary, secondary and tertiary levels. This is difficult to accomplish because it is the role of the evaluator to discover just what the effects of the programme were without knowing what the programme contained in the first place. This forces the

professional evaluator to be attentive to all outcomes.

Scriven offers the Goal-Free model as a check and balance to the tunnel-vision effects often found in goal-based evaluation not as a replacement. By appraising the quality and degree of attainment of goals, and by being attentive to a wider range of programme outcomes, intended and unanticipated, Scriven brings to the field of evaluation a broader scope to conduct the evaluation effort.

Another major contribution to the field by Scriven is his Formative-Summative distinction. The major difference between these two is in the decision making task. In Formative evaluations, decision making is done to improve programmes while still under development and is aimed mainly at the producers of educational activities and materials. Summative evaluations determine merits of programs already completed, and are aimed primarily at the client or consumers decision to operate or participate. (It has been likened to a 'Consumer Report' (House, 1978).)

Scriven suggests that goal-based evaluation may be useful for formative evaluations, conducted internally using professionals from within, while goal-free evaluations be conducted externally, by professional evaluators from outside

the organization. A problem and limitation to this approach is who decides what is "good" or "worthwhile", and how it is to be measured and justified?

Decision-Facilitating Models

A third classification used by Popham is the Decision-Facilitating Models. The most prominent of these is one put forth by Stufflebeam et al (1971). It is a model which looks at four different types of evaluation addressing four different decision situations: context, input, process and product. The model is commonly known as the CIPP Model, an acronym representing the four types of the evaluation effort they propose; Context, Input, Process, Product.

Context Evaluation relates to decisions concerning the setting of goals and objectives to be served by an educational programme. Examining this approach it appears to be more akin to a needs assessment than an evaluation since it is customarily conducted at the planning stage of a programme and appears to be more a description of context than an evaluation, or valuing of something.

Input Evaluation deals with the process of selecting support resources to meet the needs of the programme. It

involves identifying and assessing the capabilities of the organizaiton with respect to the design of the intended programme. It is cost/benefit oriented. To the degree that Input Evaluation answers the questions of selection, support, adoption, and worth it is a bona fide evaluation effort.

Process Evaluation, on the other hand, deals with monitoring conduct; of student performance, system performance, and materials. It attends to the potential sources of failure of a programme; staff, interpersonal relationships, logistics, etc. It can be a useful source of information for formative evaluations. Speaking of context and process evaluation, Worthen & Sanders (1973:24) state, ". . .they are a means of accomplishing a comprehensive evaluation, and not an evaluation in and of themselves."

Product Evaluation is used to determine the effectiveness of the programme in terms of relating outcomes to goals. Decisions at this level deal with implementing, modifying, or refocussing the programme. Product Evaluation is similar to Scriven's summative evaluation and the Tylerian Behavioural Objectives Models.

The CIPP Model is widely used in education today because of its concept of evaluation for different decision

situations. Yet, as pointed out, all of the types of inquiries in this model are not bona fide evaluation efforts.

3.2 Limitations of the Evaluation Approach

The models presented here for illustration purposes are utilitarian in nature. That is, they propose to address the issue of "maximizing happiness" in society (House, 1978). Maximizing happiness is a measurement used to assess the worth of an activity. Surrogate measures are used for the 'happiness' scale. In education, this is usually test scores. The evaluation models just examined, for the most part, use a measure of outcomes over objectives to arrive at a 'happiness' indicator. And all the models are subjective in that, in the first instance, someone or somebody is called upon to set standards against which the evaluation effort will be measured.

4. Proposed Model For Decision Making

While needs assessment and evaluation have yielded partial solutions, they do not account for input from various classes of concerned decision makers or using Miller's (1978) term, the decider subsystem. In contrast, a systems approach is presented here as a viable alternative with several distinct advantages. It offers a method capable of 1) simultaneously examining many facets of the learning

environment, 2) synthesizing many sources of information from multiple levels of decision makers, and 3) analyzing the relationships of the different levels of decision makers, in terms of their interdependence. This makes it possible to identify or develop adaptive structures with which to choose the "best" learning environments and instructional activities for a defined population, and/or a specific learner.

The purpose of this research was to develop a model, based on a systems approach, which would extend the information analysis to serve not just one but three levels of decision makers. This approach therefore takes into account more than just learner's preferences or discrepancies between what is needed and what is available. In general, the problem addressed was the design of a model that would enable educational planners to make systematic and rational decisions by choosing optimally among sets of alternatives. The goal was to develop a model which would, on the basis of easily obtainable data such as questionnaires or interviews, evaluate the usefulness of alternatives based on learner preferences, administrative constraints, and opinions of subject matter experts regarding factors which influence the implementation of the alternatives.

For this study, the choices among sets of alternatives

were defined as considerations of 1) learning environments and 2) instructional activities appropriate for adult learners in a postsecondary formal educational setting.

A version of the model has been encoded in Fortran V and in its present configuration will run inexpensively on many systems. Sufficient flexibility has been built into the model as to allow it to be tailored to a variety of user specifications.

5. The Importance of Systematic Decision-Making to the Survival of Educational Institutions

Van Gigch (1978:592) defines a systems approach as, ". . .an approach that predicates solving the larger systems problems with solutions that satisfy not only the subsystems' objectives, but also the global systems' survival."

Consider for a moment the Quebec CEGEP system as representing a global system of postsecondary nonuniversity formal education. The subsystems in this case would be comprised of the student body, the subject matter experts, the administrators, the funding agencies, the physical plant personnel, and so on.

CEGEPs were founded in 1967 to upgrade the level of education for those students going on to university, and to create career options for those students who were not. As such, CEGEP's were constituted primarily for the 16-19 year old age group holding a certificate of secondary studies (Ministere de l'Education, 1979). The structure of the CEGEP in terms of curricula and support services, addressed the imagined needs of this student population.

Consider also some changes in the CEGEP's student body. Enrolment of adults has risen from 8,000 in 1967-1968 to 32,800 in 1970-1971, and to 56,000 in 1980-1981 (Gouvernement du Quebec, 1981).

This group of students in heterogeneous in composition and includes, ". . .former CEGEP students returning to school after an interruption in their studies, secondary graduates resuming their studies after a few years in the labour market, CEGEP graduates taking improvement courses, and people of all ages enrolled in general courses, degree programs, or retraining programs" (Ministere de l'Education, 1978:68).

As the CEGEPs clientele shifted to include more adults,

new programs have been introduced. These programs were implemented to respond to community requests, sometimes on an ad-hoc basis, sometimes as a result of popular demand. Responding to private demand is a democratic and reliable guide to what is needed, but unsatisfactory if used as the only source for programme planning.

Forecasts and trends for the next decade indicate that mature re-entry students will form the largest pool of students for the community colleges (Glazer, 1973; Gouvernement du Quebec, 1981). Full-time enrolment of adults in nonuniversity, postsecondary Canadian educational institutions rose from 19.6% of the student body in 1975-1976 to 24% in 1977-1978 (Ministere de l'Education, 1979). This includes Canadian Employment and Immigration Commission (Manpower) sponsored courses but does not include educational activities purchased by business and industry separate from those sponsored by CEIC. The inclusion of those trainees would swell these statistics considerably. There are 46 different adult education services in the CEGEPs (Gouvernement du Quebec, 1981).

CEIC programs, as presently constituted, attempt to respond to projected manpower needs by stressing skills training. These are now in place in the community. Research

has shown that skills training, whether in formal educational institutions or on-the-job, is necessary but not sufficient to move workers into the primary labour sector (Hagerman, 1979; Piore, 1970). This sector is characterized by, among other things, stable employment, a skilled labour force, career-related training programmes, and high wages (Doeringer and Piore, 1971). The skills training must be accompanied by supportive public and private policies augmented by guidance and training in attitudinal and behavioural traits congruent with jobs requiring a high degree of motivation and career commitment. Courses dealing with this content are not available in most postsecondary curricula.

Vocational education has partially responded to projected manpower needs in the community through programmes delivering skills training only. A systematic approach to where, how and what to deliver in the way of vocational training, leisure studies and general education programmes for adult learners has not been undertaken.

Furthermore, instructional delivery systems for adult learners, whatever their goals, appear to offer enrolment accommodation inadequate to meet the present demand. With the present high rate of unemployment, the need for upgrading

and retraining of skills is an important societal consideration. More unemployment means more people desperately trying to take courses to train for the dwindling and changing job market.

Considering the influx of adults into CEGEP's, the real need for retraining to capture changing and declining job opportunities, and the ever decreasing resources available to educational institutions resulting from government cutbacks, rational decision making appears to be a priority. The global systems' survival may well be determined by the way in which it responds to the source of its growing student population; the adult learner. However, responding to student preferences alone no longer works. Financial and pedagogical considerations must be investigated and made part of the decision making process. Financing must not be overlooked because of constraints on public and private budgets. Pedagogical considerations must be explored because of the changes in the composition of the student body, in this case an ever increasing proportion of adult learners.

Adult learners differ from each other in their ability to learn, their rates of learning, motivation, interests, and experiences (Grabowski, 1980; Knowles, 1970). In addition, adult learners differ in their cognitive skills, from each

other and from children (Lewis, 1980). Their differences affect instructional systems, for ". . .no single method or technique of instruction will effectively reach all learners" (Grabowski, 1980). Moreover, different learning activities foster different personal capabilities which support a variety of goals. These activities are, in turn, differentially supported by a variety of communications media (Boyd, 1976).

This individual diversity implies the need for a certain 'requisite variety' of instructional methods and opportunities. Glaser (1977) suggests a new adaptive philosophy of education to accommodate this diversity. He calls this 'adaptive education', and defines it as an educational environment which assumes different ways of succeeding, and many goals available from which to choose. Adaptive education places no greater value on one way of succeeding over another.

The key concept to Glaser's adaptive philosophy focuses on the educational process as partly controlled by the learner. This is consistent with the literature on adult learners (Knowles, 1970; Knox, 1968) which supports the view that decision making and responsibility for learning should

be shared by the learner, the instructor, and whoever pays the bills. In a training situation, the ways of succeeding may be more narrowly defined than for a leisure and recreation programme. Notwithstanding the narrower focus of a training situation, adult learners require innovative approaches to learning opportunities geared to their specific educational interests, needs, and learning abilities (Lowe, 1975).

6. Thesis

Mindful of the current shift in the student population of educational institutions to a higher proportion of adult learners, resulting from environmental changes and the unique requirements of this cohort, the following hypothesis was formulated for this study.

A model can be constructed to provide educational decision makers with useful information for planning, implementing, and modifying learning environments for adults. This can be accomplished by systematically identifying critical variables, and then implementing a method of optimizing the interaction amongst these variables. Success in such a task will be determined by, a) logical consistency and b) application of the model to a real case with structured information which decision makers need to

facilitate rational decision making.

The purpose of this study was to develop a model which would serve as a tool for educational decision makers, enabling them to collate information from learners, instructors, and administrators, in order to make systematic and rational choices from the various alternatives available. A systems approach was adopted because it met these requirements. The next Chapter will detail the development of the systems model proposed in this study.

CHAPTER 2
THE DECISION MAKING MODEL

1. Introduction

This section will present an overview of the decision making model, the theoretical framework upon which the model was based, the process for systematically identifying and selecting the variables, and the rationale for the questionnaire format. The model was developed in three parts; theory, data collection instruments, and a computer-based program to manipulate the data, encoded in Fortran V. It was then pilot tested with artificial data to see if anticipated trends were reflected in the outcomes. The results of this pilot test indicated that the model was workable. A field test, for validation and demonstration was then conducted using real data. These results are reported, in part, in Chapter 4.

The main thesis as stated in Chapter 1 is that a workable model can be constructed. Success in this endeavor will be determined by:

a) logical consistency

b) application of the model to a real case with the structured information

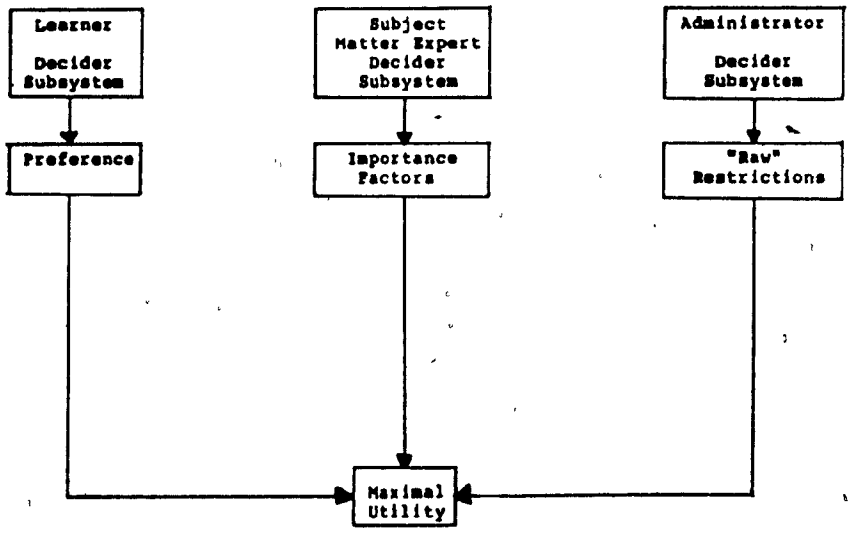
which decision makers need to facilitate rational decision making.

2. Overview of the Model

In general, the goal was to design a model capable of assisting decision makers in identifying maximal values among a given set of alternatives. In this instance, the sets of alternatives were comprised of four learning environments appropriate for adults, and selected components of these environments. The model accepts as input, data from three levels of decision makers: 1. students, 2. experts in the field, that is teaching faculty and educational technologists, and 3. educational administrators (Figure 1).

FIGURE 1

SIMPLIFIED FLOW CHART OF THE MODEL

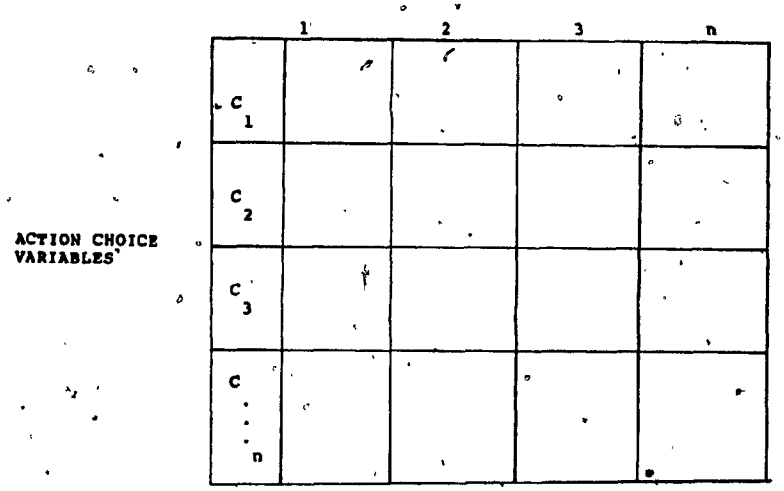


2.1 Matrix Variables of the Model

In the field test of the model, input was obtained on two sets of variables related to learning situations: the controllable or action choice variables, and the constraining variables (Figure 2).

FIGURE 2

INTERRELATED VARIABLES OF A LEARNING SITUATION



Legend: Constraining Variables
Student Preferences
Alternative Learning Environments
Administrative Restrictions

Action Choice Variables
Components of an Instructional Delivery System

The action choices were components of the learning environment, such as content structure, feedback mode, and study skills; the constraining variables were the criterion variables, such as the preferences, appropriateness, and manageability of these action choices. These were all systematically derived from the literature and are cited below.

Data were collected from the three levels of decision makers using three forms of the same questionnaire (Appendix II, III, IV). The action choices were the same for all three questionnaires.

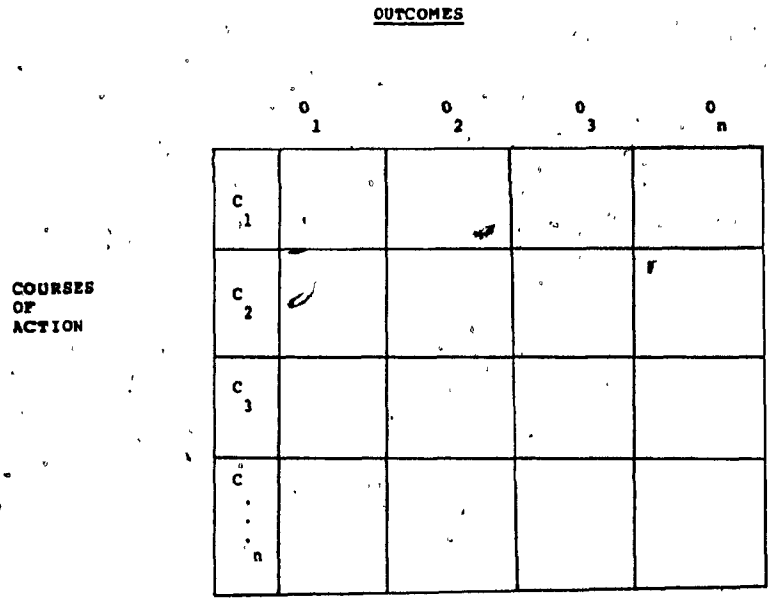
The rationale for the questionnaire format is as follows: Ackoff and Sasieni (1968) describe three types of problems in systems analysis: certainty, uncertainty, and risk. Certainty and uncertainty situations are limiting cases in which one has either complete knowledge or complete ignorance of outcomes. Risk situations assume alternative outcomes, the probabilities of which are known or can be determined. The problem at hand was a risk type problem. That is, given four alternative learning environments, what was the probability that any outcome would have a greater utility value than any other outcome.

To graphically represent risk type problems Ackoff and

Sasieni suggest using a matrix such that the action choices are listed along the rows and the alternative outcomes along the columns (Figure 3).

FIGURE 3

MATRIX OF THE QUESTIONNAIRE FORMAT
(after Ackoff & Sasieni, 1968)



Legend: Outcomes
Student Preferences
Subject Matter Experts Opinions on Learning Environments
Administrative Restrictions

Courses of Action
Components of an Instructional Delivery System

The questionnaire used by the students was two-dimensional, rating each action choice on a 5-point scale. The questionnaires used by the experts and administrators were three-dimensional rating each action choice in each constraining variable on a 5-point scale. Results of a pilot test showed that a three-dimensional matrix was confusing for the students sampled.

The action choice variables were components of an instructional system such as scheduling, presentation of course material, study skills, and special courses for mature learners. The alternative outcomes or constraining variables were different for each of the three classes of subjects. For the students it was the preferences for the action choices (Figure 4), for the experts it was the four learning environments (Figure 5), and for the administrators it was four administrative considerations such as operating and capital costs (Figure 6).

Selection criteria for experts were derived from a symposium sponsored jointly by the United States Office of Education and the National Institute of Education, (Harrison & Stolurow, 1973). These consist of four specific and unique types of learning environment: 1. Grouped and Bounded; 2. Individualized and Bounded; 3. Personalized

and Open; and 4. The Workplace (Figure 5). The nature of these environments is discussed in the next Chapter.

FIGURE 4

PREFERENCE VALUES ASSIGNED BY STUDENTS

Action Choice Variables	Constraining Variables					
	Highly Desirable	Desirable	No Preference	Undesirable	Highly Desirable	I Need More Information
Scheduling of Courses						
Time of Day						
Setting						
Physical Arrangement						
Presentation of Course Material						
Learning Progress Reports						
Study Skills						
Special Courses for Mature Students						
Media						
How You Learn Best, Generally						
Learning Location						

Legend: Constraining Variables
Student Preferences for an Action Choice

Action Choice Variables
Components of an Instructional Delivery System

FIGURE 5

IMPORTANCE VALUES ASSIGNED BY SUBJECT MATTER EXPERTS

Action Choice Variables	Constraining Variables			
	Grouped and Bounded	Individualized and Bounded	Workplace	Personalized and Open
Goals				
Time Constraint				
Scheduling (course)				
Scheduling (time of day)				
Setting				
Format				
Content Structure				
Feedback Mode				
Content-Study Skills				
Content-Non-Academic				
Media				
Learning Mode				
Location				
	Weighting Factor	Weighting Factor	Weighting Factor	Weighting Factor

Legend: Constraining Variables
Four Alternative Learning Environments

Weighting Factor
Importance of a Component of an Instructional Delivery to a Learning Environment

Action Choice Variables
Components of an Instructional Delivery System

FIGURE 6

CONSTRAINT VALUES ASSIGNED BY EDUCATIONAL ADMINISTRATORS

Action Choice Variables	Constraining Variables: Capital Costs	Operating Costs	Union Collective Agreement	Boundaries of Mandate
Goals				
Time Limitation for Completion of Program				
Scheduling of Courses				
Time of Day				
Setting				
Streaming				
Content Structure				
Feedback Mode				
Study Skills				
Student Services				
Media				
Learning Mode				
Learning Location				
	Weighting Factor	Weighting Factor	Weighting Factor	Weighting Factor

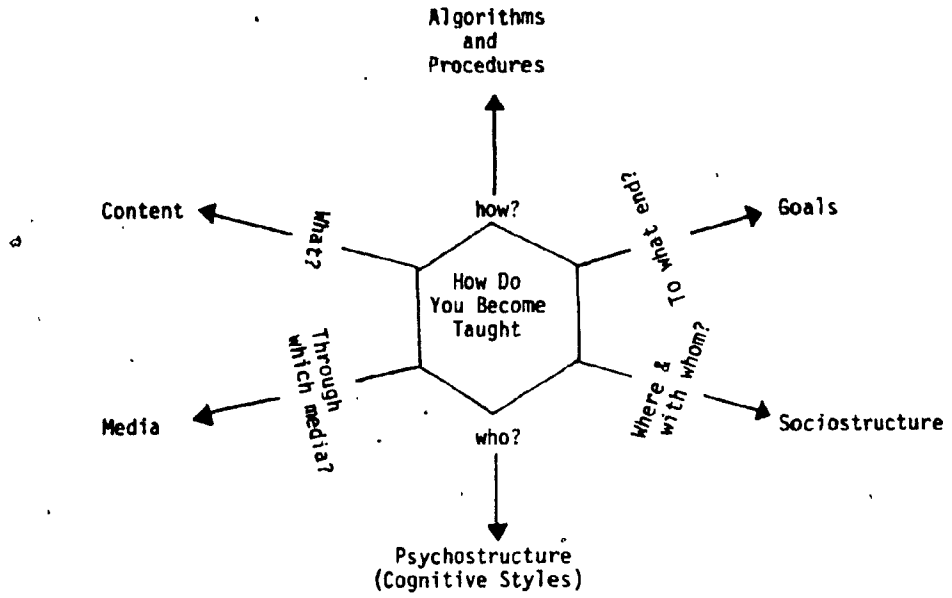
Legend: Constraining Variables
Four Administrative Constraints

Weighting Factor
Degree of Difficulty to Implement a Component of an Instructional Delivery System Based on an Administrative Constraint

Action Choice Variables
Components of an Instructional Delivery System

FIGURE 7

SIX COMPONENTS OF A PEDAGOGICAL SPACE
(after Helmar Frank, 1971. English Translation courtesy of Dr. Gary Boyd)



The selection criteria for the administrators consisted of some constraints which managers, administrators and planners must consider before implementing educational and training programs.

The concepts seen as constraints to the implementation of programs by Stufflebeam, (1971) and Van Gigch and Hill (1971) were verified by frontline administrators at a local college in Montreal to determine their validity for that institution and institutions of a similar nature. These general concepts were operationalized into four major

categories: 1. Capital Costs; 2. Operating Costs; 3. Union Collective Agreement; 4. Boundaries of the Mandate (Figure 6).

3. Theoretical Framework: Systems Analysis Approach

For the purpose of this study, the variables in the functional relationship U = f(X,Y) are defined as follows:

U = the value of each of four alternative learning environments

X = components of the instructional delivery system (Action Choice Variables)

Y = a) the preferences and characteristics of the learners

b) the importance of each action choice to each learning environment as determined by the experts (Importance Factor)

c) the constraints on the administration (Constraining Variables)

f = the linear relationship between U, X, and Y

To state the above equation in familiar form, the decision regarding the "best" learning environment, was based on learner or student preferences for various action choices, experts opinions on how important those action

choices are to a particular learning environment, and administrators' judgements on the difficulties of implementing each of those action choices. This decision was reached by mathematically manipulating the selected information from the questionnaires to obtain values representing optimal results from the available alternatives.

3.1 The Notations

Using systems analysis notations following Ackoff & Sasieni (1968), the present model was based on a functional relationship between utility, on the one hand, and controllable and uncontrollable variables on the other. Ackoff & Sasieni describe this functional relationship as follows:

$$U = f(X,Y)$$

where U = the utility or value of a decision or outcome

X = the variables of the environment that can be controlled

Y = the variables and constraints that are not controlled by the decision maker directly but affect U

f = the relationship between U, X, and Y

The task of a systems analysis model, is to determine the trend of Y, in order to select X, so as to be able to

maximize U (Rivett, 1968). For the model presented here, the goal was to determine the trend of student preferences, expert opinion, and administrative constraints, in order to select the various components of the instructional delivery system. Rational and systematic decisions from among alternatives presented could then be made, and maximal results regarding learning environments appropriate for adults could then be attained.

This model, as a problem solving tool, is applicable to any educational and training situation. One need only modify the action choice and constraining variables to make them applicable to the particular participating audience.

According to Ackoff & Sasieni (1968) the underlying structure of systems analysis models can be represented by the functional relationship, $U = f(X,Y)$. This structure has other notations. Thierauf & Grosse (1970) use the notation $E = f(X,Y)$ where:

E = the effectiveness of the system

X = the variables of the system subject to control

Y = the variables not subject to control

Thierauf & Grosse, (1970:19) in discussing the

application of this equation, state, "The extraction of a solution from such a model consists in determining the value of the control variable, X, for which the measure of effectiveness is maximized." In maximizing or optimizing the measure of effectiveness or performance of a system the problem is to find the best decision among many alternatives. For this type of decision making a criterion is required. According to Thierauf & Grosse (1970) the criterion will be the course of action that will produce the highest profit to the client. This profit may be measured in terms of dollars, increased production, or preferences. It can also be measured in terms of minimizing some value, for example, minimizing lost opportunities (Ackoff & Sasieni, 1968).

Decision making in an educational or training milieu thus becomes a matter of formulating the problem in terms of systems analysis.

3.2 The Problem Formulation

In order to address the problem of ensuring logical consistency in the model, it was necessary to identify variables critical to this model. This was accomplished by examining the conditions under which problems exist according to Ackoff and Sasieni, and extrapolating from

these conditions critical variables for the model.

Ackoff & Sasieni (1968) in their discussion on problem formulation describe five conditions necessary for the existence of a problem. These are:

Condition 1

AN INDIVIDUAL OR GROUP OCCUPYING AN ENVIRONMENT TO WHOM A PROBLEM CAN BE ATTRIBUTED

The group to whom a problem may be attributed is defined here as the population of potential and actual learners, subject matter experts, and educational administrators. For many, access to educational activities poses no problem. Delivery systems as constituted today in formal or nonformal learning institutions are within reach of many adult learners. However, for a significant number, this is not the case. Educational services elude the homebound, the rural dweller, the physically handicapped, and those at the lower echelons of the socioeconomic ladder, resulting in lost opportunities. Business and industry have their own special requirements for training personnel. Frequently the quick response they demand in course delivery is unrealistic in terms of the requirements for research, materials development, presentation, and evaluation.

Delivery systems specifically designed to meet the needs of the adult learners are not widely used. Present postsecondary institutions typically instruct adult learners using methods appropriate for adolescents and learning environments designed for a younger population. To make matters worse, subject matter experts and administrators are faced with budget cutbacks, forcing more careful allocation of resources. Since adults are now forming a larger part of this student body, and forecasts indicate this trend will continue, a systematic approach to this problem appears to be indicated. These institutions presently service a variety of adult learners, including those from business and industry, those seeking midlife career changes and those seeking personal development. How they can best be served is the challenge of teaching institutions today. On the other hand, with shrinking enrolment of the adolescent population, these institutions must seek to attract a new source of students. The adult population appears to be a most promising source if their needs can be met.

Condition 2

AT LEAST TWO COURSES OF ACTION FROM WHICH TO CHOOSE

This model presents 13 categories of possible action

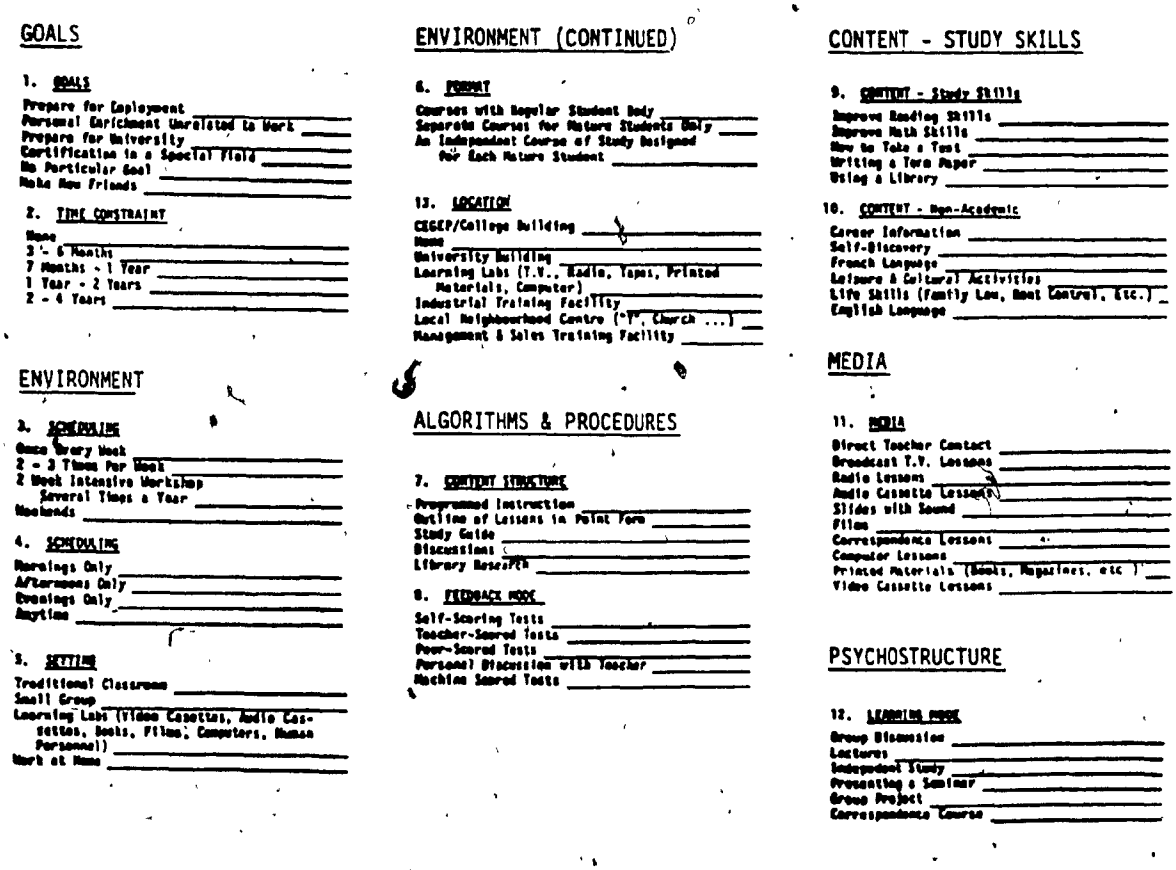
choices for the components of an instructional delivery system. These categories represent the operationalization of the six dimensions in Frank's (1971) teaching/learning process. These are as follows: 1) goals, 2) content, 3) media, 4) algorithms and procedures, 5) sociostructure (environment), and 6) psychostructure (cognitive styles) (Figure 7).

These six categories were expanded to thirteen types of action choices and operationalized into sixty-seven controllable aspects of the learning environment based on definitions and descriptions found in the literature (Boyd, 1976; Harrison and Stolurow, 1973; Gagne and Briggs, 1974; Holden, 1975; Mehrens and Lehmann, 1973; Romiszowski, 1974) (Figure 8).

Because part of the sample population for this study consisted of adult learners enrolled at a local college in Montreal, an effort was made to determine the specific components critical to their activities and educational opportunities through interviews with administrators, faculty, and students. In addition, the literature was searched to determine the perceived and actual educational needs and preferences of adults (Steele, 1974; Richards, 1976; Klinge, 1977; DePauw & Heft, 1980; Gouvernement du Quebec, 1981; Cross, 1983).

FIGURE 8

RELATIONSHIP BETWEEN FRANK'S 6 COMPONENTS OF A PEDAGOGICAL SPACE AND VARIABLES ON THE QUESTIONNAIRES AND ITEM NUMBER



The categories of action choices identified and selected as components of the instructional delivery system are:

1. Goals
2. Time constraints
3. Scheduling Yearly
4. Scheduling Daily
5. Setting
6. Format/Streaming
7. Content Structure
8. Feedback Mode
9. Content Study Skills
10. Content Non-Academic
11. Media
12. Learning Mode
13. Location

While not exhaustive, these action choice variables represent a reasonably comprehensive array of alternatives for the X portion of the equation $U = f(X,Y)$.

Although these categories were designed primarily for a postsecondary formal educational institution, they can be modified to include categories appropriate for business and industry, government, the military, or any training or

educational institution in the private sector.

Condition 3

AT LEAST TWO POSSIBLE OUTCOMES OF THIS CHOICE, ONE OF WHICH IS PREFERRED

To meet the requirements in Condition 3, the particular identified group or individual must have more than one outcome from which to choose, and must prefer one over the other(s). The population under consideration in this present study was adult learners returning to a formal instructional system. As stated in Chapter 1, adult learners differ from each other in their ability to learn, their rates of learning, motivation, interests, and experiences (Grabowski, 1980), and in their cognitive skills (Lewis, 1980). In addition, adults differ in their cognitive skills from children (Lewis, 1980).

In order to accommodate this heterogeneous group, a requisite variety of instructional activities would be essential. Moreover, a variety of communications media and methods of instruction would be needed to differentially support these activities (Boyd, 1976).

Insofar as it was designed for adolescents graduating

from secondary school, the CEGEP's environment is grouped and bounded, that is, grouped by content and bounded by space, time, and resources (Harrison and Stolurow, 1973). Recently nontraditional learning environments have been developed. These include teleteaching, teletutoring, and teleseminars (Daniel & Keating, 1978; Ellis, 1980; Jordanoff, 1983). These techniques will tend to add to the limited repertoire of learning environments that are not grouped and bounded. That is they will increase the number of alternatives available in the other three categories considered here: individualized and bounded, personalized and open, and the workplace.

Condition 4

THE COURSES OF ACTION AVAILABLE MUST PROVIDE SOME CHANCE OF OBTAINING THE PREFERRED OUTCOME, BUT THEY CANNOT PROVIDE THE SAME CHANCE.

Condition 4 is satisfied by obtaining weights on the student preferences and administrators restrictions on all the action choices by means of an Importance Factor obtained from the experts in the field. This weighting factor has implications for the relative usefulness and efficiency of the alternative learning environments, designating some higher, therefore preferred; and some lower, therefore

counterindicated.

To state this condition another way, students indicate preferences on action choices according to their perceived needs. These preferences are then weighted according to the Importance Factor which reflects the opinions of the teaching faculty and educational technologists regarding the appropriateness and compatibility of these action choices in each one of four learning environments. Finally, educational administrators indicate their views on the possibility of implementing these same action choices. The administrators evaluations are also weighted by the experts Importance Factor to determine their impact on the utility of a learning environment.

The Student questionnaire is a two-dimensional matrix; the Experts Form and Administrators Form, are each a three-dimensional matrix. For the Student questionnaire, the two dimensions are the action choices and preferences on a five-point scale. For the Experts Form, the three dimensions are the action choices, the constraining variables (four learning environments), and a weighting factor assigned by the experts for each action choice. For the Administrators Form, the three dimensions are the action choices, the

constraining variables (four administrative constraints), and a measure of constraint on implementing each action choice.

For example, while students rated the items in action choice "Non-Academic Content" along a 5-point rating scale which reflected their preferences, the administrators and experts expressed their opinions regarding these items in terms of the degree to which each action choice was influenced by their concerns.

Condition 5

AN ENVIRONMENT WHICH CONSISTS OF ALL FACTORS WHICH CAN AFFECT THE OUTCOME AND WHICH ARE NOT UNDER THE CONTROL OF A DECISION MAKER

The environment of a system is defined by Van Gigch (1971:7) as ". . .all those systems outside the boundaries of the one under consideration." They are taken as givens and are ". . .beyond the direct control of the designer." The determination of a system's environment is important since this identifies those variables which are not controllable by the designer but which influence the performance of the system in question.

Churchman (1968:62) defines the environment of an input-output system as ". . .a set of conditions relevant to but not under the direct control of the manager." These are expressed in part as constraints on the system. They can be viewed as the ". . .characteristics of the demand for the output," as well as the characteristics of the systems input. In this instance, these constraining variables are comprised of students with preferences, experts opinions, and administrative constraints influencing implementation of choices reflecting students preferences.

In order to determine whether some variable is part of the system's environment it is necessary to ask two questions - - "Can I do anything about it? Does it matter relative to my objectives?" If the answer to the first question is "No" but to the second "Yes" then the variable forms part of the environment (Churchman, 1968:36).

In the present model the environment includes social, economic, political, and technological changes resulting in changes in the composition and perceived needs of the student body of adult learners. Early retirement, the changing roles of women and men in society, equal opportunity legislation, and the effects of the proliferation of technology have resulted in a need for

upgrading and retraining of skills and capabilities as well as a perceived need for personal development in a variety of areas. These factors, while greatly affecting the educational and training institutions, are not directly under the control of those who manage these institutions. They are, therefore, considered part of the environment.

By examining a postsecondary educational system in light of the questions suggested by Ackoff & Sasieni, some critical components of that system and the environment in which it operates were identified. These were operationalized into variables for the present study.

4. THE DECIDER SUB-SYSTEM: ECHELONS OF DECISION MAKING

In complex real-life systems, such as educational/training organizations, the constraining variables are derived from many levels within the organization and are in effect separate subsystems of that system.

Miller (1978) delienates 19 subsystems which are critical to an organization; nine of these process information. For example, the decoder subsystem is responsible for translating codes, foreign languages,

technical or scientific findings and anything that needs to be interpreted to the organization. Obviously, these subsystems are composed of people and/or machines carrying out the functions for which that particular subsystem is responsible.

The memory subsystem, another example, is responsible for processing information concerning bookkeeping departments, filing, libraries, curatorships, and computer data. In effect this memory subsystem acts as a data bank containing data needed by various decision makers concerned with information which requires a memory function.

To Miller, the decider subsystem is the most critical in an organization. Its function is to process information which it receives from all the other subsystem in the organization as input, and transmit to them information as output. The decider subsystem does this by receiving and selecting data from among the various alternatives available, and transmitting what appears to be "the optimal solution for the problem before it" (Miller, 1978:68).

One of the characteristics of modern organizations, according to Miller, is the structuring of the decider subsystem into echelons, or levels. In the CEGEP system, at

least three levels of a decider subsystem can be identified: students; educational administrators; and subject matter experts. The present model collects data concerning critical choices from all three echelons of the decider subsystem. These echelons are not necessarily hierarchical.

Because the echelons of deciders increase as systems become more complex, it is possible to have input for decision making from several echelons. Van Gigch and Hill (1971:14) state that the students are ". . .the direct recipients of the schools' conversion process and therefore they should be consulted about the content of the courses to which they are subjected, particularly as they mature. . ." Others identified as decision makers by Van Gigch and Hill are members of the management system of the organization since they participate in and work with the programs and activities of the system. It is also at this level of decision making that certain constraints and limitations to the system may be identified. For example, a suggested solution which is seen to be feasible by the administration will be favoured over an alternative which is seen to be impractical by this same group. This may be due in part to the fact that at this level, responsibility and authority for the implementation of solutions are to a large extent

under the control of the administrators. Hence, the perceptions of the administrators regarding alternative solutions can be viewed as constraints and limitations to the system.

In the present model, a third echelon of decision makers identified is the subject matter experts. While decision making at the two former levels revolve around preferences and administrative considerations, decision making for the experts level revolves around the pedagogical and technical concerns.

The function of the decider subsystem is to process information and resolve conflicts. The four stages of the deciding process, according to Miller (1978:68) are:

1) establishing purposes and goals for the system by conflict resolution and bargaining techniques when necessary;
2) analyzing information concerning relevant aspects of the situation including what adjustment processes and alternative solutions are available;
3) synthesizing this information in order to diminish the available alternatives;
4) implementing the processes selected in the

synthesizing stage.

The method used for facilitating decision making in the present model addressed three stages of the deciding process in this manner.

1) Purpose and goals were established by simultaneously polling three levels of the decider subsystem; students, experts, and educational administrators on their various concerns.
2) Information was analyzed by decoding the data.
3) The data was synthesized through mathematical manipulation and various values for the learning environments were obtained in order to diminish available alternatives.

It was beyond the scope of this study to implement the results of the process. This would be the task of the decision makers within the educational institutions. The model can supply these decision makers with structured, systematically obtained information for more rationale decision making.

To recapitulate, the participants in the system are those who should be properly served by the system: the learner,

the subject matter experts, and the administrators. Data concerning the preferences and requirements of the clients ". . .provides the base in terms of which the decision making ought to occur in the proper design of a system. Therefore, (the learner) is the decision maker in an indirect sense" (Churchman, 1968:184). The second echelon of deciders are those who have some ability to change the system and much of the responsibility and authority to effect those changes: the administrators. One may argue that educational policy for public schooling occurs at the governmental level and as such institutional administrators merely carry out prescribed government policy. To a degree this is so. However, within the scope of that mandate, decisions are made partly from the perspective of the institutional administrators regarding the implementation of government policy.

A third echelon of deciders are those with the pedagogical and technical expertise. Data from those decision makers will have implications for the pedagogical imperatives and technical limitations on the system. Pedagogical considerations are critical to planning programs for adults since they represent a heterogeneous group of learners in terms of cognitive styles, reasons for participating, experience, and motivation (Knowles, 1970).

CHAPTER 3
CONCEPTUAL FRAMEWORK OF THE MODEL

1. Introduction

This Chapter will present a discussion on the elements of the model and the process used to systematically identify and select the variables for the questionnaires. The mathematical structures and formulations will also be presented.

2. Rationale For The Constraining Variables

2.1 Learning Environments Currently in Use

Three types of learning environments have been identified in the literature (Harris and Stolurow, 1973). To these three a fourth, the workplace, was added. This was suggested in interviews with training specialists in industry. These four types are:

1. Grouped and Bounded
2. Individualized and Bounded
3. Personalized and Open
4. The Workplace

1. A Grouped and Bounded learning environment is defined as the traditional on-campus setting with the traditional

modes of learning; that is, lectures, labs, print, student/teacher-student/student interaction. These are supported by man/machine interactions such as audio-tutorials, and CAI as well as auxiliary materials on film, slides, and cassettes. This learning environment is bounded by time and space, and grouped by course content and presentation format. That is, it is a relatively inflexible delivery system.

2. Individualized and Bounded learning environments have similar time and space constraints but are more flexible in terms of content. There is greater flexibility in the time the student takes to cover the prescribed materials.

This delivery system relies heavily on a learner-centered, individualized mode of a delivery system utilizing human as well as electronic teachers. Time-shared Interaction Computer-Controlled Information Television (TICCIT) at Brigham Young University and PLATO at the University of Illinois are two such examples.

Personalized Systems of Instruction (PSI) at the University of Texas at Austin is another example of an Individualized and Bounded learning environment. In this mode the emphasis is on unit criterion performance

acheivement before proceeding to the next unit and is self-paced. Lectures are used as a vehicle for motivation rather than as sources of critical information. Written communication between student and teacher and the use of student proctors for testing, immediate feedback on achievement, and tutoring are essential characteristics of the PSI and Keller Plan technique. Course material is in print form and contains reading assignments, study questions, collateral references, study problems, and introductory and explanatory materials.

3. The third learning environment, Personalized and Open, is characterized by its ability to bring the instructional materials to where the learner is rather than vice versa. The British Open University, Chicago's T.V. College, T.V. Ontario and Athabasca University, are such systems. They make extensive use of an open broadcast based delivery system via mass communication facilities such as radio, television, and telephone lines. In addition postal packages of home study materials are used. Local off-campus study centres and teleconferencing link home-based students with each other and with faculty. Chicago's T.V. College (Chicago) and Carlton University (Ottawa), both videotape on-campus lectures, complete with in-class questions and discussion, for delivery

to industry, thus supplying a delivery system at The Workplace. These videotapes are supplemented by written materials and periodic personal visits from the instructors. The T.V. College makes education available to students confined to homes or hospitals, and to inmates in penal institutions.

The British Open University augments its home-based components with student/student/faculty interaction through the provision of local study centres and short residential summer school. The study centres are equipped with electronic and printed hardware and software as well as human resource personnel.

4. At the suggestion of training specialists in industry, a fourth alternative learning environment, The Workplace, was added. Although The Workplace could accomodate any one of the three environments mentioned above, it is a unique environment in many ways. Courses are typically job-specific; time-frame for courses or programmes are defined by the external constraints, particularly for production, for in-house training, or training which occurs during the work day. Motivation to participate is provided by the organization by means of promotion or upgrading of marketable skills, or as a reward by means of selection for inclusion in

a course or programme. Since business and industry have become more cognizant of the need to upgrade and train their own personnel in order to ensure the organization of an adequate manpower supply, more organizational resources have been dedicated to the Human Resource Development function. Course material typically is delivered in-house occasionally supplemented by an on-campus component. The medium for delivery of course material ranges from lectures, to print, to film, and audio-cassettes. This system relies heavily on prepackaged, off-the-shelf instructional materials. The exception to this is large companies such as Bell Canada and the Royal Bank which have the resources to develop their own materials.

These four learning environments comprise the four alternative outcomes for the model presented in this paper.

2.2 Future Trends

Some Ontario Colleges are delivering on-site courses to The Workplace using teleconferencing and/or videotaped lectures, complete with question and answer periods and in-class discussion from point of origin. Some postsecondary institutions are also using a work/study "sandwich" format providing students with a semester of courses alternating with a semester of work in the field.

Some Canadian universities presently using some form of telecommunications to deliver instruction are: Carleton and Ottawa Universities, University of Calgary, Athabaska, Tele-University, and Memorial University in Newfoundland. "Ninety-seven postsecondary courses are presently being taught throughout Canada by [audio-] teleconferencing" (Jordanoff, 1983).

Interactive video communication is one possibility for course delivery to remote sites. Dr. Kjell Samuelson, at Stockholm University and Royal Institute of Technology in Sweden has developed a multiway video communication group display, which is interactive, in real time among multiple sites. At the present time this communication system is used for live communication for between four and about one hundred persons at four to sixteen locations. The operation is used in doctoral seminars simultaneously between four university regions (Samuelson, 1981).

These newer delivery systems may be more appropriate to the diverse needs of an adult population. The newly formed Canadian Association for Distance Education is now calling for a preliminary paper on the state of the art of distance

education in Anglophone Quebec. Research into their utilities in reaching adult learners would seem appropriate.

These represent some possible future trends for ways of bringing instruction to the adult learner. Traditional environments are often too restrictive for a group of learners whose primary social role is not that of a student.

This present model could be used to choose whether to stay with traditional environments or invest in some less traditional environment such as tele-education which may provide the flexibility needed by adult learners.

3. Rationale for the Action Choice Variables

3.1 Introduction

Frank's (1971) six dimensions of the pedagogical space (Figure 7) were elaborated by the author into the category constructs action choice variables which were used on all questionnaires as the components of the instructional delivery system. They were expanded to 67 items using definitions and descriptions found in the literature on instructional design, adult learners, and from interviews with educators and mature learners (Figure 8).

To determine the importance of each of these 67 items, as

components of an instructional delivery system to each of the four learning environments described above, the opinions of a panel of experts was sought. Items concerning these dimensions were subsumed under Content, Algorithms and Procedures, Goals, Media and Environment. Learner characteristics were gathered from actual learners (Student Questionnaire I, Appendix I). Student Questionnaire I gathered data on student characteristics relevant to their learning needs, demographics and educational background.

The variables under these categories were designed primarily for a postsecondary formal educational institution. Depending upon the audience using this model, these variables can be modified, completely changed, or utilized per se. The model was designed to accept any category for pedagogical problem solving. Selection of these should, however, reflect the nature of the education/training situation, and the sophistication of the audience of learners, administrators and experts. Although not exhaustive, Frank's six major categories establishes sound pedagogical parameters within which modification can take place.

3.2 Elaboration of the Major Categories

3.2.1 Subject Matter or Content

Items for the CONTENT category were suggested in the literature on mature learners (Richards, 1976; Mahone, 1977; Cross, 1983). Content will depend very heavily on the situation to which this model will be applied as well as on the student audience being served. Training for industry or government, for example, will clearly require content considerably different from a community leisure programme for retired adults. Since the field test of the model was set in a formal educational institution, with academic content in place and relatively fixed, some nonacademic subjects were included to broaden the construct.

3.2.2 Goals

The GOALS category was elaborated with the help of research literature cited in the Discussion section. In addition, information was obtained from personal interviews with adults wishing to return to school. Boyd (1976) suggests two levels of goals; societal and personal, which can be served in a learning process. These goals can be supported by personal capabilities which are fostered by learning activities and communications media necessary for these activities. The personal goals include wisdom, status, and motivation. These concepts were operationalized to yield the various dimensions of the GOAL category.

3.2.3 Environment

The ENVIRONMENT deals mainly with the types of groupings for study purposes; small groups, independent study, and so on. It seemed reasonable to investigate, at the same time, the questions of scheduling, format, and meeting place for these groupings.

Groupings, (Setting on the questionnaire) was suggested by Lowe (1975). Although classroom groupings still dominate adult education practice, the learner working alone or in small groups are alternatives. Furthermore, one can imagine the usefulness of groups which ". . .assume a distance between the media employed and the learner" (Lowe, 1975:08).

A number of scheduling choices were derived from present practice at universities, community centres, and industry. These are obviously congruent with the operation of these types of institutions and diverse enough to accommodate most lifestyles.

Format items were supplied by the administrators at a local CEGEP, as typical of those in use at the present time at most institutions of higher learning. The term "Streaming" is customarily used by these administrators and was, therefore, adopted for the Administrators Form of the

questionnaire.

The choices for Location were derived from the three learning environments described by Harrison & Stolorow (1973) and are further described under Rational For Constraining Variables.

3.2.4 Psycostructure

The PSYCHOSTRUCTURE category of a pedagogical space concerns the characteristics and cognitive styles of the learners. It was assumed that an individual's psychostructure would be reflected in his/her preferences. Research on mature learners attests to the relationship between demographic variables such as age, sex, level of income, highest level of education attained, age of children, and preference for choice of courses, study time available, and place of study. Persons re-entering or wishing to re-enter the workforce generally return to educational institutions for preskills training, career information, and personal development (Mahone, 1977; DePauw & Heft, 1980). This group of learners has special needs in terms of location, duration of courses, and scheduling of classes (Cross, 1983).

3.2.5 Media

Items in the MEDIA category were suggested by Boyd (1976), Harrison and Stolurow (1973), and Romiszowski (1974). Boyd suggests communications media such as books, broad-band telecommunications, and machines as support for various learning activities. Romiszowski presents a classification of "presentation media" according to the sensory channels they use and amount of "teacher control" desired with respect to content, rate of presentation, sequence, etc. Harrison and Stolurow present a state of the art document containing a variety of articles describing the available media presently utilized universally. These range from the use of paperback books to the PLATO system; from correspondence course material, to broadcast, and videotaped television material.

3.2.6 Algorithms and Procedures

Content Structure, Feedback Mode, and Learning Mode constitute the choices for ALGORITHMS and PROCEDURES. Content Structure items were suggested by Holden (1975:3) in which he states "This is the single most critical variable in the design of any type of learning sequence and hence becomes equally critical in the selection of appropriate media." Holden's term for content structure is defined ". . .as the extent to which we wish the end product, the behaviour change, to be consistent between students and to reach a

given standard of measurement." Gagne and Briggs (1974:195) in their discussion on instructional components for adult learners, state "Materials for learning may be highly structured, as in programmed text; semi-structured, as in an outline or laboratory guide; or unstructured as would be the case when the student does library research on a topic."

Items on Feedback Mode were suggested by Mehrens and Lehmann (1973) in which a variety of testing situations are discussed in detail.

Items for Learning Mode were suggested by Romiszowski (1974:195) in his discussion on media selection in which he states ". . .the type of learning task facing the student will also eventually influence the media choice. . ." He includes group discussion and one-directional medium of presentation in this discussion. Gagne and Briggs (1974) in their brief discussion on alternative learning environments state the following possibilities for learning modes for a public school education; classroom, laboratory, large groups, small groups, lectures, and individualized study. Correspondence courses were excluded from the public school domain but remain as a possibility for home study.

4. Rationale for Administrative Constraints

Van Gigch and Hill (1971:32,37) state that in order to make choices regarding resources to be allocated to the implementation of programmes, priorities must be set. "Setting priorities is a process by which relative weights of alternatives are expressed. . . .These weights can be expressed in terms of. . .facilities, manpower, or time." They further elaborate on the nature of resources which can be devoted to programmes to include operating costs, capital costs, and salaries.

Stufflebeam et al (1971:129) classify six categories of educational data used in decision making situations. These are learner, curriculum, staff, finance, facility, and community. These are considered by the authors as resource availabilities and ". . .occur as constraints and/or alternatives . . .for input into the . . .data elements related to the decision situation."

The concepts outlined as constraints to the implementation of programmes by Van Gigch and Hill concur with those of Stufflebeam et al. These were discussed with front-line administrators at a local CEGEP to determine their validity for that institution and institutions of a similiar

nature. No discrepancies were found between what the literature identified as constraints and what practitioners were experiencing as constraints. Therefore, these general concepts were operationalized into four major categories: Capital Costs, Operating Costs, Union Collective Agreement, and Boundaries of the Mandate of the administration.

In Quebec, policy level decisions for public educational institutions are made by governmental agencies, leaving school administrators responsible for decisions at the operating level. This means that certain decisions regarding allocation of resources may be beyond the jurisdiction of the school administrator. This imposes limitations on the scope of their mandate and further restrains resource allocation. For this reason "boundaries of the mandate" was included as a possible constraint on the implementation of instructional delivery systems.

The categories of constraints, will depend upon the situation for which the model is used as well as the nature of the responsibility of the administrator concerned. For example, the banking industry may well have specific legal constraints within which the administrator must operate. This model permits changes of that nature within the

parameters of the constraint dimension.

5. Rationale for the Distribution of the Questionnaire Items

Since the learning environment of the sample used to test the model was Grouped and Bounded, several factors were accepted as givens. Academic or training content and the goals of the institutions are more or less fixed and prescibed by the system and difficult to change in the short run. Therefore a very limited number of items were devoted to those categories.

Furthermore, the literature suggests a number of possibilities in regard to the choice of goals to be maximized. Van Gigch and Hill (1971) suggest cost/benefit goals. Ackoff and Sasieni (1968) suggest minimizing lost opportunities as goals. Thierauf and Grosse (1970) suggest maximization of dollars, production, or preferences of the client. It was felt that the particular goals of the learners as expressed by their preferences would be of great interest because adult learners are more or less free to choose whether or not they enrol in such programmes. Secondly, it was felt that time constraints would be a major concern for adults returning to school, especially those

holding jobs and/or raising children. With this in mind, the categories (1) Goals, and (2) Scheduling were formulated.

Finally, it was felt that most changes in the components of an instructional delivery system could be made in the areas related to algorithms and procedures, media and the environment or sociostructure. These would be the areas in the system most amenable to change. Therefore the majority of the questionnaire items were devoted to these categories.

6. The Mathematical Model

6.1 Rationale

In his discussion of mathematical models, Karplus (1977) contrasted two different modeling methodologies based on the utilization of two different types of information. The two types of models are deductive and inductive. Deductive models use insight about the system being modeled, whereas inductive models use experimental data consisting of observations of the system's inputs and outputs.

Deductive modeling is used in instances where laws and principles determine the system's behaviour. The process of modeling then involves transforming these laws of behaviour into mathematical expressions. The application of these laws

and principles permits the derivation of differential and algebraic equations (Karplus, 1977). Examples of deductive models are electric circuits, dynamics, aircraft control and mechanical systems.

Inductive models, on the other hand, are much more uncertain. There are no fundamental laws and principles from which to derive relationships. Inputs and outputs are observed, measured, and recorded. The mathematics are inferred from these observations, which may be obtained actively or passively. Active observation involves specifying some inputs to the system, applying these inputs to the system under study, and observing the outcomes. Passive observations are employed where inputs cannot be specified. Available input/output data must be accepted in these cases.

Because inductive models cannot rely on fundamental laws and principles, and the elements of the system are poorly defined in terms of behaviour, there exists a large number of models satisfying the observed input/output relationships. Variety and uncertainty revolves around the mathematical representation of the system. For these reasons, additional assumptions and constraints must be imposed to help select the optimum model.

Economic, social, and political models fall under the inductive model paradigm. "Here even basic laws governing dynamic processes, not to mention the relevant constituents of the system, are open to question and controversy" (Karplus, 1977:6). For inductive modeling, Karplus (1977:9) suggests mathematical models ". . .comprised of systems of simultaneous algebraic equations."

The model presented in this study is an inductive model according to Karplus' description. Assumptions were made with respect to what constitutes the system's elements and their interrelationships. For example, it was assumed that the selected components of the instructional system, student preferences, administrators' restrictions, and opinions of subject matter experts formed part of the system. It was further assumed that these preferences, restrictions, and opinions were linearly related. This assumption was based on the premise that student preferences impact on offerings presented by educational institutions, that there are some administrative restrictions to the implementation of these offerings, and that the opinions of subject matter experts impact on both student preferences and administrative restrictions to a greater or lesser degree.

In order to transform these observations into useable data four algebraic equations were formulated (see Chapter 4).

6.2 Objectives of the Mathematical Model

The general objectives of this model are twofold. First, to quantitatively evaluate the efficacy of a set of learning environments based upon a series of student preferences, opinions of subject matter experts, and administrative constraints. Second, having identified the environment with the greatest overall suitability, to refine it within the confines of the constraints and preferences in such a manner as to lead to its optimization.

The first objective has been realized and will be discussed within this paper. Recommendations as to how the second phase of this model may be implemented are discussed in the Discussion section under Future Considerations.

6.3 Theory of Operation of the Mathematical Model

To realize these objectives, the model, as currently implemented, accepts as data input from three separate populations: students, subject matter experts, and educational administrators. Student data ascertains the

degree of suitability of the various education elements (action choices) of the learning environments, to the students personal goals and educational preferences. Opinions of subject matter experts provides data on the importance or degree of incompatibility each of these elements posesses with respect to each of the alternative learning environments. Administrative data concerns the administrative ramifications of implementing each of the action choices.

In theory, the model is straight forward, and the reader, with some reflection may be able to anticipate the basics of its operation.

A utility is calculated for each learning environment which reflects the requirements of the student as well as the ease or difficulty with which the environment is implemented. This is accomplished by summing both negative and positive contributions from the preferences and constraints after the importance of each of these is related to the various learning environments via multiplication by an Importance Factor. The Importance Factor is arrived at by weighting each action choice according to its importance in each learning environment by subject matter experts. Those

learning environments obtaining the highest value of utility are predicted by this model to be most suitable. After these learning environments have been identified, their implementation may, as a second step, be modified as to reach an optimal balance between student preferences and administrative constraints while still preserving those attributes crucial to the effective implementation of that learning environment. This can be done by eliminating those action choices having a low weighted preference and a high weighted restriction in a particular learning environment. In this second phase, the identified learning environment is refined so as to include only those elements of value to both students and administrators.

6.4 Mathematical Formulations

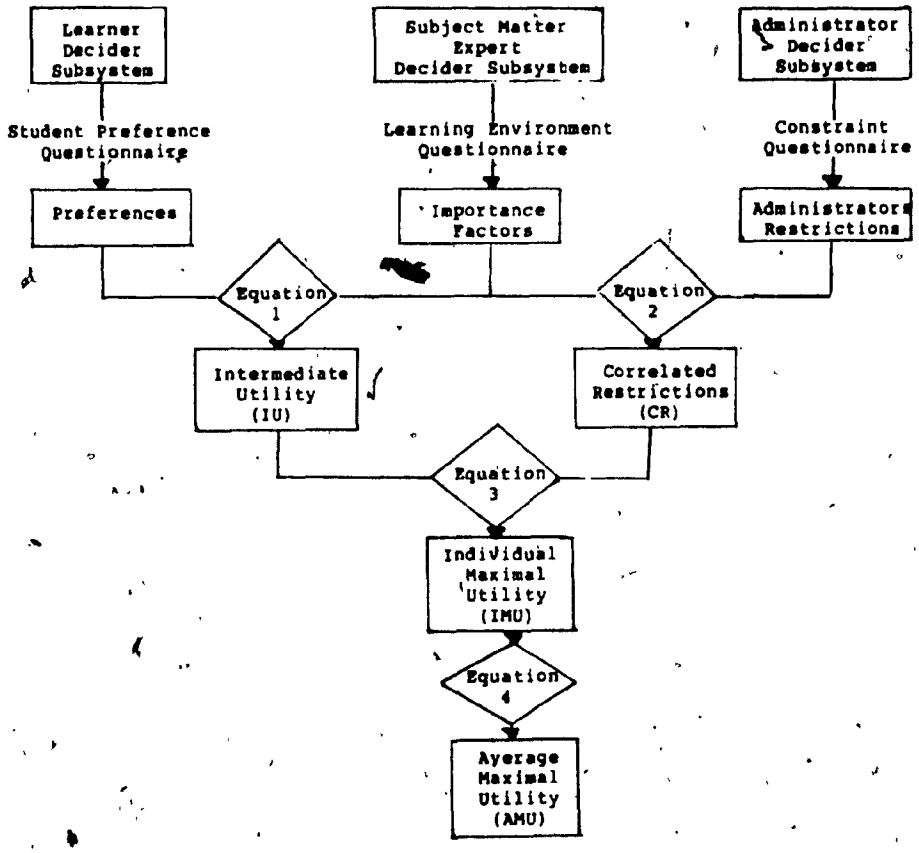
Figure 9 summarizes the Data Flow involved in determining a utility for each of the learning environments. Each of the equations is described in below.

Intermediate Utility

Equation 1 is used to generate values for Intermediate Utility. Intermediate Utility is in essence a weighting of student preferences for a given action choice by the importance of that action choice to a given learning environment.

FIGURE 9

DATA PATH, EQUATIONS, AND MODEL STRUCTURE



$$IU(L,K) = 1/J' \left(\sum_{J=1}^{J'} Pref(J,K) * Impf(J,L)\right) \qquad \text{Equation 1}$$

where:

IU(L,K) is the Intermediate Utility of learning environment L for student K. Intermediate utilities reflect student preferences but do not reflect administrative constraints.

Pref(J,K) is the preference of action choice J by student K, determined directly from student data.

Impf(J,L) is the importance of action choice J to learning environment L, as determined by averaging all the data from subject matter experts.

Equation 1 sums over all J action choices.

J' is the total number of action choices.

Clearly the procedure is to weight student preferences for various action choices by the importance of the action choice to various learning environments. An Intermediate Utility for each student and Learning Environment is then obtained by summing these weighted preferences over all action choices.

Correlated Restrictions

Analogous to the previous equation, Equation 2 calculates Correlated Restrictions, (Colres), which is the sum of the restrictions upon the implementation of learning environment L, taking into consideration the restrictions upon each of the action choices and the importance of the action choice to the learning environments.

$$Colres(L) = 1/J' \left(\sum_{J=1}^{J'} Rawrsc(J) * Impf(J,L) \right) \qquad \text{Equation 2}$$

where:

Colres(L) is the accumulated correlated restrictions upon the implementation of learning environment L.

Rawrsc(J,) are the administrative restrictions upon action choice J, determined from administrative data by adding all the restrictions on action choice J and averaging the data from all administrators.

(Note: Equation 2 is valid in cases where Impf <> 1. If Impf =1, student preferences will be used as a weighting factor.)

Individual Maximal Utility

Equation 3 calculates the Maximal Utility for each of the learning environments for each student.

$$IMU(L,K) = IU(L,K) - wf*Colres(L) \qquad \text{Equation 3}$$

where:

IMU(L,K) is the Maximal Utility of learning environment L for student K.

wf is a weighting factor specified by the administrator, which establishes the relative importance of administrative constraints to student preferences.

IU, Colres as before.

wf = defaults to 1 if no specifications are defined.

The meaning of IMU is then self-explanatory. The weighted sum of Student Preferences (IU) contribute positively and the restrictions detract from IMU.

Wf may be either greater or less than 1. For example, if the administrative restrictions are considered to be of greater concern than the student preferences, wf will be greater than 1.

Average Maximal Utility

IMU(L,K) gives utilities for each student. Often what is required is an average utility for the entire population polled, or some subset of it. Equation 4 calculates this average.

$$AMU(1) = 1/K' \left(\sum_{K=1}^{K'} IMU(L,K) \right) \qquad \text{Equation 4}$$

where:

AMU(L) is the average group utility for learning environment L.

Summation is carried out over K students.

K' is the total number of students.

6.5 Discussion

Though the model is fairly straight forward there are certain subtleties which should be highlighted in order to bring to light both the scope and limitations of the model.

It should be noted that values of IU (Intermediate

Utility) may be either positive or negative. Recall

$$IU(L,K) = 1/J' \left(\sum_{J=1}^{J'} Pref(J,K) * Impf(J,L)\right)$$

Each of the factors Pref(J,K), Impf(J,L) may be either positive or negative. Both Pref(J,K) and Impf(J,L) are permitted to take only the values +5, +3, +1, -3, -5. In the case of Pref(J,K) large negative values indicate a low desirability of action choice J by student K. Large positive values indicate a high degree of desirability for that action choice. Similarly large negative values for Impf(J,L) indicate action choice J is incompatible with learning environment L. Large positive values indicate action choice J is essential for the implementation of learning environment L. The value of IU(L,K) will be positive if both Pref and Impf are of the same sign.

The rationale for this is as follows. If both are positive, that is, an action choice is preferred and is important to the learning environment, this should contribute positively to IU. In a parallel fashion if an action choice is deemed undesirable by a student and this action choice is also incompatible with a particular learning environment, IU is also enhanced. This is the case where both Pref and Impf are negative. The multiplication of two negatives results in

the positive value expected.

A negative contribution to IU results when the signs of Pref and Impf differ. This would happen when either a student desired a particular action choice (Pref is positive) and that action choice is incompatible with the learning environment (Impf is negative) or in the opposite case where an action choice is undesirable but is essential to a learning environment. Thus, Equation 1 yields results which are intuitively sound.

Another point to be clarified is the calculation of Colres. Equation 2 is valid for those conditions where Impf is either negative or positive. However, in the case where Impf is neutral, that is, the action choice is neither incompatible nor essential to the learning environment, the probability of implementing that action choice depends upon student preferences. Hence, in this case it is more appropriate to weight the restrictions by student preferences (Pref J,K) than by the Importance Factor (Impf).

This Chapter discussed the conceptual framework of the model. The following Chapter will deal with the implementation of these concepts for the model.

CHAPTER 4
IMPLEMENTATION OF THE MODEL

1. Introduction

To validate the model as well as to offer a demonstration of its application, a field test was performed at a local CEGEP. It was not the intention of this study to conduct an in depth analysis of the mature learners or programmes at the CEGEP.

This Chapter will discuss the field test. An explanation of the input data, the subjects, the rating scale, construction of the questionnaire, and a description of the methodology will be presented.

2. Operationalization of the Systems Analysis Notations

As previously noted, the present model was developed on the functional relationship of $U=f(X,Y)$ where:

U= the utility or value of a learning environment.

X= the components of an instructional delivery system (action choice variables).

Y= the preferences of students and concerns of subject matter experts and educational administrators (constraining variables).

IMPLEMENTATION OF THE MODEL Chapter 4

For the purpose of this study, U is defined as the value or utility of a learning environment. Four alternative learning environments have been identified: Grouped and Bounded, Individualized and Bounded, Workplace, Personalized and Open.

The X variables are operationally defined as the action choices or components of an instructional delivery system. These represent selected elements, such as structure of content, content, and feedback mode, over which the decision makers can exercise some measure of control. They fall into thirteen categories containing 67 unique variables which represent the expansion of Frank's (1971) six dimensions of the pedagogical space described in the previous Chapter. These six dimensions are:

1. Goals
2. Content
3. Psychostructure
4. Sociostructure
5. Media
6. Algorithms and Procedures

The Y variables, are operationally defined as the cognitive styles, characteristics and preferences of the

students, the opinions of the subject matter experts (educational technologists and teaching faculty), and the administrative constraints. These are called the constraining variables. These variables represent those elements over which the decision makers have little or no control, and are accepted as the boundaries of the educational system. These were described in the previous Chapter.

3. Input Data

Data for the action choices were obtained from questionnaires from three groups of people and served as the main input to the model.

1. Data on action choices from students or trainees wishing to pursue a sample education/training programme were sought to ascertain their perceived needs and preferences (Student Questionnaires).
2. Data on action choices from educational administrators were sought to determine administrative restrictions upon the implementation of those action choices (Administrators Questionnaire).
3. Data on action choices from subject matter experts were sought to determine their evaluations on the importance of and compatibility with those action choices to each of the learning environments (Experts

Questionnaire).

4.Construction of the Questionnaires

4.1 Student Questionnaire I

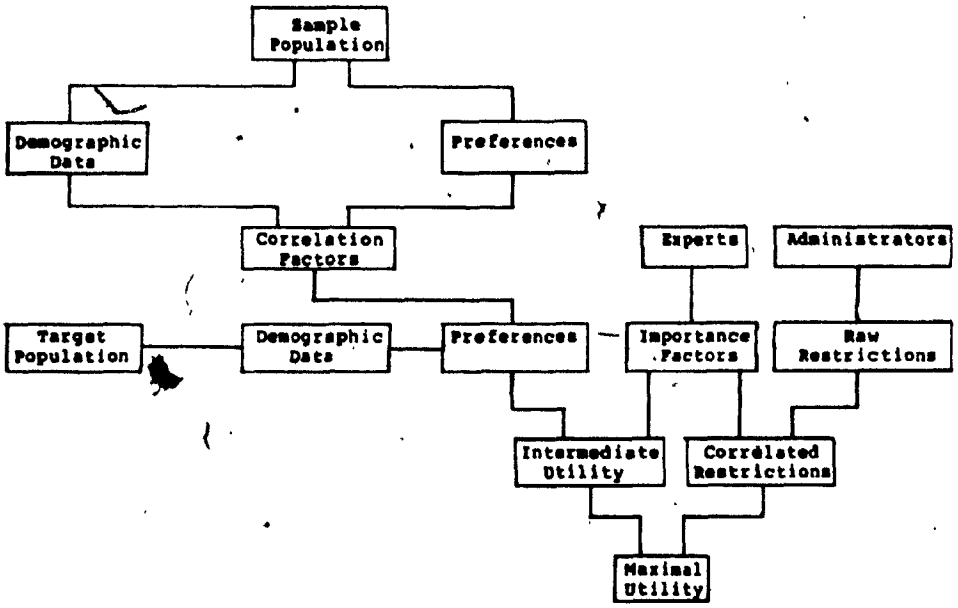
Student Questionnaire I (Appendix I) collects demographic and background information on learners. Many items on this questionnaire yield data similar to those which can be easily obtained from census tracts or personnel files. Items on this questionnaire were derived from studies on mature learners (Lyman-Viera and Boggs, 1967; Richards, 1976; Steele, 1974). This form uses a forced-choice format and presented no problem when pilot tested on a group of adult learners at Concordia University. Minor modifications were made in sequencing the items.

The purpose of Student Questionnaire I was to develop a source of data for situations where first hand information on learner preferences was not easily available. It was felt that since the literature cited above confirms positive correlations between selected demographic data and learner preferences on selected action choices, Questionnaire I could provide input for a Predictive Model (Figure 10). That is, one could enter the model by arriving at a prediction of the Intermediate Utility using only data from census tract or

personnel files. The Predictive Model is presented as a concept for future development and is not demonstrated in this study. Additional research would be required to establish correlation factors with a large sample before the Predictive Model could be evaluated. Data from Student Questionnaire I, with the exception of items 1 and 2, was not used for the present study. It is presented here as a first step in the development of the Predictive Model.

FIGURE 10

DATA PATH AND MODEL STRUCTURE
OF
THE PREDICTIVE MODEL



The categories 'Goals' and 'Time Constraints', were embedded in Student Questionnaire I in order to obtain a forced-choice response. These are items 1 and 2 of the Student Questionnaire I. Data from these constructs were included in the formulation of the equations.

Three forms of the same questionnaire were designed with assistance from Dr. Gary Boyd and Dr. Chris Petersen, as data collection instruments from different population samples; 1) students, 2) subject matter experts, and, 3) educational administrators on the variables previously discussed. The questionnaires were pilot tested on appropriate subjects and modified accordingly.

4.2 Student Questionnaire II

This questionnaire (Appendix II) was designed with assistance from Dr. Gary Boyd and Dr. Chris Petersen using constructs suggested in the literature (see details in Chapters 2 and 3). The categories for the action choice variables, components of an instructional delivery system, are the same for all three groups of respondents: students, experts and administrators. The constraining variables vary with each group.

Student Questionnaire II was originally designed in a 3 dimensional matrix format collecting data on two unique sets of variables. The row variables of the matrix contained the action choices after Frank's (1971) 'didactic variables'. The column variables of the matrix contained the alternative learning environments suggested at a symposium sponsored jointly by the United States Office of Education and the National Institute of Education (Harrison and Stolurow, 1973). Students were to be asked to rate their preference on each action choice with each learning environment, thus adding a third dimension to the matrix.

This questionnaire was pilot tested on mature learners at Concordia University. The three dimensions proved to be too complex for the subjects to handle, causing frustration and confusion. It was therefore modified to a two-dimensional matrix, obtaining student preferences on action choices only. Preferences were guaged by a 5-point scale ranging from 'Highly Desirable' to 'Highly Undesirable' (see Chapter 2). A sixth point was added: 'I need more information'. The purpose of this was to separate the 'No Preference' responses from those with insufficient information on a variable.

Data from Student Questionnaire II served as input for Equations 1, 3, and 4.

4.3 Experts Questionnaire

This form of the questionnaire was designed with assistance from Dr. Chris Petersen (Appendix IV). The structure differs from Student Questionnaire II in that it retains the three dimensional matrix. The row variables are the 67 action choices; the column variables are the four alternative learning environments: 1) Grouped and Bounded, 2) Individualized and Bounded, 3) The Workplace, 4) Personalized and Open. The third dimension is formed by the degree of importance and compatibility each action choice is in each environment, assigned by subject matter experts.

This form was pilot tested on faculty in the Educational Technology Programme, Concordia University. Modifications revolved around the rating scale. Initially, no category was included for action choices which were incompatible with a learning environment. This was added to the final version of the questionnaire. In addition, the original 3-point scale was expanded to a 5-point scale.

The Experts' Questionnaire provided weightings of each action choice for each learning environment. The data collected on this instrument served as input to all four

equations. Weights on a 5-point scale ranged from 'Very Important to the Learning Environment' to 'Incompatible with the Learning Environment', and is more fully described elsewhere in the paper.

4.4 Administrators Questionnaire

This form was designed with assistance from Dr. Chris Petersen (Appendix III). The dimensional structure is the same as Experts' Questionnaire. The row variables, or action choices are the same as those found in Student Questionnaire II and the Experts' Questionnaire. However, the column variables contained the following four constraints suggested by Van Gigch and Hill (1971) and Stufflebeam (1971):

1. Capital Costs
2. Operating Costs
3. Union Collective Agreement
4. Boundaries of the Mandate

These variables were verified by administrators of a local CEGEP as being relevant to their own concerns. The Questionnaire was pilot tested on several administrators from the Mature Learners Program, Concordia University. Modifications entailed replacing a 3-point scale with a 5-point scale, ranging from 'A Major Constraint to the

Implementation of a Component' to 'Action Choice is Very Feasible'. Data from this questionnaire served as input to Equations 2, 3, and 4.

5. Quantification of Input Data

In order to facilitate mathematical manipulation, responses on a 5-category scale were quantified as follows, (note that although only 5 categories were used, the numbers assigned ranged from +5 to -5).

Student Preferences

+5 = Action Choice highly desirable

+3 = Action Choice desirable

1 = Action Choice not a consideration

-3 = Action Choice undesirable

-5 = Action Choice highly undesirable

Importance Factor

+5 = Action Choice is very important to the Learning Environment

+3 = Action Choice is important to the Learning Environment

1 = Action Choice is neutral to Learning Environment

-3 = Action Choice is incompatible with the Learning Environment

-5 = Action Choice is very incompatible with the Learning Environment

Administrators Constraints

+5 = Action Choice is a major constraint

+3 = Action Choice is a minor constraint

1 = Action Choice is neutral for implementation

-3 = Action Choice is feasible

-5 = Action Choice is very feasible

6. Subjects

6.1 Distribution of Classes of Subjects

Highly formalized organizations contain many echelons; informal organizations contain few. Furthermore, ". . .the deciders of organizations are commonly described as being pyramidal in shape, with many components at the lowest echelon and fewer at each higher one" (Miller, 1978:643). An organization, such as a CEGEP, may be considered a highly formalized organization, pyramidal in shape in terms of the various decision makers.

For this study, the three levels of decision makers in the decider subsystem selected were; 1) the students, 2) the teaching faculty and educational technologists, (subject matter experts), and 3) the educational administrators. The educational administrators and subject matter experts

represented the upper portion of the pyramid, with fewer numbers; the students represent the lower portion of the pyramid, with greater numbers. This was reflected in the distribution of the input data.

6.2 Description of Subjects

The students used in this study were registered in the Adult Learners Programme at John Abbott College, Ste. Anne de Bellevue, Quebec. Of the 83 students in the programme, 65 received questionnaires; 43 questionnaires were completed and returned. By chance, all respondents were female.

Teaching faculty in the Adult Learners Programme at the same college, and faculty in the Educational Technology Programme, Concordia University, served as subject matter experts for the Experts Form. Of the 8 questionnaires distributed, 5 were completed.

Four administrators at John Abbott College served as administrators. They included the Academic Dean and Director of Continuing Education under whose aegis the Adult Learners Programme falls. All four questionnaires were completed.

7. Methodology

7.1 Rating Scale

IMPLEMENTATION OF THE MODEL Chapter 4

For functional utility, a Likert-type scale was designed. The purpose of this scale was to rate the action choices according to the constraining variables; preferences, experts' opinions, and administrative constraints.

Respondents used symbols such as ✓ and X to rate their action choices. A legend was provided to explain the symbols. Numerical values were assigned to each of the various symbols for transforming the data. The values were arbitrarily chosen, although the two outside limits represented the maximum and minimum values which the subjects could assign to a particular action choice. Values on all scales ranged from +2 to -2. The number 0 was assigned to 'Need more Information' and missing values. While the data is ordinal, it is treated as interval. Precedent for this procedure in education and psychology has been established in the literature (Tuckman, 1972).

Various prototype forms of the rating scale were tried. Trials included ratings on a ±1 scale containing 3 points, +1, 0, -1, which subjects found too narrow; a 3-point scale with positive values only, +3, +2, +1, which would not reflect positive and negative utility, and values assigned by numbers by subjects, which were often too difficult to read.

The final questionnaire contained a 5-point Likert rating scale, with ±2 category of choices. In order to keep a positive and negative sense of utility, the ordinal numbers, +5, +3, 1, -3, -5; were used on the rating scale.

Negative values were assigned because of the way in which the mathematics of the model handles the sign conventions. This is treated in greater detail under the Mathematical Structures section.

7.2 Student Questionnaires I and II

With permission from the Academic Dean, two questionnaires with a covering letter were distributed to adult learners at John Abbott College, Ste. Anne de Bellevue, Quebec. These were personally handed to each subject after class time. Because of the Union Collective Agreement, distribution of questionnaires was not permitted during class time. This proved to be a constraint on data collection since students happened to be on their lunch break and were reluctant to volunteer free time. Questionnaires were collected by hand upon completion.

Students were asked to complete Questionnaire I by

circling the number beside the answer that best applied to respondent. Students were asked to complete Questionnaire II by rating each action choice according to their preferences on a 5-point scale discussed previously.

Data from Student Questionnaire II served as input to Equations 1, 3, and 4. (See Mathematical Structures for detail of all equations.) Data from Student Questionnaire I can be used for a Predictive Model discussed above.

Data from ten arbitrarily selected student questionnaires was used as input data for field testing and validating the model. Similarly, data from fifteen of the sixty-seven action choice variables were arbitrarily selected for examination on all 3 forms of the Questionnaire.

7.3 Experts Questionnaire

Questionnaires were personally distributed to teaching faculty at John Abbott College and faculty in the Educational Technology Programme, Concordia University. These completed forms were then returned by mail to the author. A covering letter and explanation of each learning environment were attached. The purpose of this explanation was to avoid confusion or personal interpretation on those variables. Experts were asked to rate action choices in four learning

environments on a 5-point scale. Data from this questionnaire yielded the Importance Factor. This data served as input for all four equations.

7.4 Administrators Questionnaire

Questionnaires were distributed to four educational administrators at John Abbott College by the Academic Dean. A covering letter was attached to the Questionnaires. Completed questionnaires were returned to him and forwarded by mail to the author.

Administrators were asked to rate the degree of difficulty in implementing the action choices according to four administrative constraints. Rating was on a 5-point scale. Data from this questionnaire served as input to Equations 2, 3, and 4.

This Chapter discussed the implementation of the concepts and structures upon which the model was based: the input data, subjects, rating scale, questionnaire construction, and procedure. The next Chapter will deal with the data analysis and results of the study.

CHAPTER 5
RESULTS

1. Introduction

Data was collected from adult learners at John Abbott College, subject matter experts at Concordia University and educational administrators at John Abbott College for demonstrating and validating the model. One purpose of this study was to demonstrate the usefulness of data derived from the model in decision making. To do this, data on a limited set of action choices (X=15) from a limited number of students, (N=10), subject matter experts, (N=5), and educational administrators, (N=4), was arbitrarily selected from the total sample.

Four mathematical equations were formulated to manipulate the data collected on the three forms of the questionnaire. A computer programme, encoded in Fortran V, was then developed to handle the mathematical structures.

2. Tables

2.1 Overview

This programme yielded 5 types of tables. These are:

1) Table showing the Importance Weightings of each Action Choice in each Learning Environment as determined by the

Subject Matter Experts, generated by Equation 1 (Table 1),

2) Table showing Constraint Weightings on each Action Choice by Educational Administrators, generated by Equation 2 (Table 2),

3) Table for each student showing Student Preferences and Administrative Constraints after consideration of the opinions of Subject Matter Experts, generated by Equations 1-3 (Table 3),

4) Table summarizing the Utility of each Learning Environment for the Population sampled, generated by Equation 4 (Table 4),

5) Table summarizing the Utilities for each Student in each Learning Environment, generated by Equations 1-4 (Table 5).

Equation 1 had as input data from students and experts to yield an Intermediate Utility of a Learning Environment.

Equation 2 had as input data from experts and administrators to yield Correlated Restrictions on a Learning Environment.

Equation 3 had as input the Intermediate Utility of a Learning Environment and the Correlated Restrictions to yield

a Maximal Utility of a Learning Environment for each student.

Equation 4 had as input the Maximal Utility of a Learning Environment for each student and the total number of students reported to yield an Average Maximal Utility of a Learning Environment for the total population reported. The flowchart in Figure 9 graphically illustrates the operation of these equations.

2.2 Discussion

Table 1 is a matrix of the four learning environments by each action choice. The values generated by Equation 1, represent frequency of choice for each cell across three dimensions: action choices and learning environments, weighted by the opinions of the subject matter Experts. In essence, the values represent the experts' opinion on the degree of importance each action choice bears to each learning environment. The possible range of values is +5 to -5 with 1 representing a neutral point. To illustrate the use of this table, examine the construct Study Skills (Reading Skills to Using a Library). Writing a Term Paper yields a high positive value in two learning environments, Grouped and Bounded (4.2) and Individualized and Bounded (3.8). However, this same action choice, in The Workplace

yields a very low negative value (-.2) and a moderately positive value in Personalized and Open environment (2.6), indicating the inappropriateness of including the Study Skill, Writing a Term Paper, for the learning environment in The Workplace.

TABLE 1

TABLE SHOWING THE IMPORTANCE WEIGHTINGS OF EACH ACTION CHOICE IN EACH LEARNING ENVIRONMENT AS DETERMINED BY THE SUBJECT MATTER EXPERTS

IMPORTANCE FACTORS

LEARNING ENVIRONMENTS

ACTION CHOICE	GROUPED AND BOUNDED	INDIVIDUALIZED AND BOUNDED	THE WORKPLACE	PERSONALIZED AND OPEN
Programmed Instruction...	2.2	4.2	3.8	3.8
Lessons in point form....	1.6	1.3	1.0	1.3
Study guide.....	3.5	4.2	3.2	4.2
Discussions.....	4.2	2.6	3.2	2.6
Library research.....	3.8	3.8	.4	4.2
Self-scored tests.....	1.2	4.0	2.2	3.8
Teacher scored tests.....	4.6	3.8	4.2	4.2
Peer scored tests.....	.6	-.6	.4	-.6
Discussion with teacher..	4.2	4.6	3.8	3.0
Machine scored tests.....	2.6	1.4	1.6	2.2
Reading skills.....	2.8	3.6	2.2	2.8
Math skills.....	3.8	3.8	2.8	3.4
Test taking.....	2.8	2.8	-1.2	2.8
Writing a term paper.....	4.2	3.8	-.2	2.6
Using a library.....	3.4	3.8	2.6	3.8

In a similar manner the construct Feedback Mode can be analyzed. Teacher-Scored Tests yields relatively high values in all four learning environments (4.6; 3.8; 4.2; 4.2) while Peer-Scored Tests, yields very low values in all four learning environments (.6; -.6; .4; -.6). Further examination of the action choices under the construct Feedback Mode indicates that Discussion with Teacher yields relatively high values across all four learning environments (4.2; 4.6; 3.8; 3.0). This would indicate a general consensus among the experts in this sample on the importance of including Teacher-scored tests and Discussion with Teacher in all four learning environments as a Feedback Mode for the population tested.

On the other end of the scale, Peer-scored tests and Machine-scored tests yield relatively low values in all four learning environments. (.6; -.6; .4; -.6; and 2.6; 1.4; 1.6; 2.2), indicating their relative unimportance or inappropriateness to all four learning environments.

These values do not reflect administrative restrictions or student preferences.

This type of table may be useful where decision making

involves choices among specific actions in a specific learning environment. Academic and training planners may gain some useful information from this type of table with respect to programme details. This information can be of assistance to decision makers in curriculum planning, programme planning, and human resource development when considering the feasibility of the pedagogical and technical aspects of specific learning environments.

Table 2 displays the value for each action choice across all four administrative constraints. The values generated by Equation 2, represent the sum of the frequency of choice for each cell across three dimensions: action choice, administrative restrictions, and the degree of difficulty in implementing these action choices. In essence, the values represent the impact of administrative constraints on each action choice. The range of values is +5 to -5 with 1 representing a neutral point.

In this case negative values indicate lesser degrees of constraint while positive values indicate definite administrative constraints upon the implementation of a specific action choice.

To illustrate, under the category Study Skills, Using a

Library yields a value of -.4 indicating fewer administrative restrictions than Reading Skills which yields a positive value of .3. In other words, these administrators say that it is easier to include courses in "Using a Library" than in "Improving Reading Skills" for the population in this study.

TABLE 2

TABLE SHOWING CONSTRAINT WEIGHTINGS ON EACH ACTION CHOICE BY EDUCATIONAL ADMINISTRATORS

ADMINISTRATORS RESTRICTIONS

ACTION CHOICE	AVERAGE RESTRICTIONS
Programmed Instruction	-.6
Lessons in point form	-.4
Study Guide	.3
Discussions	-.4
Library research	0.0
Self-scored tests	-.4
Teacher scored tests	-.4
Peer scored tests	-.4
Discussion with teacher	-.3
Machine scored tests	.6
Reading skills	.3
Math skills	.4
Test Taking	-.1
Writing a term paper	-.4
Using a library	-.4

RESULTS Chapter 5

Tables 1 and 2 represent the utility that Experts and Administrators associate with each of the fifteen action choices. For the Experts, utility is a matter of pedagogical or technical appropriateness; for the administrators, utility is a matter of budgetary or managerial appropriateness.

Table 3 is a sample of a table which is produced for each student and summarizes the results of the analysis. It displays two major utilities: Weighted Preference and Weighted Restrictions. Weighted Preference reflects student preferences for a specific action choice in a particular learning environment weighted by the importance of that action choice (Importance Factor) to the learning environments. The Importance Factor are responses to the questionnaire generated by the experts and summarized in Table 1. Weighted Restrictions reflects the degree of administrative constraint placed upon implementing an action choice in a particular learning environment, and uses the Importance Factor for weighting. For each student a summary of data is displayed under the individual values described above. This summary displays, the Intermediate Utility, Correlated Restrictions, and Maximal Utility by each of the four Learning Environments.

The Intermediate Utility (IU) reflects the value of Student Preferences weighted by the Importance Factor averaged over all action choices in a particular learning environment, for a particular student (Equation 1).

Similarly, Correlated Restrictions (CR) reflect the value of the Administrative Restrictions weighted by the Importance Factor averaged over all the action choices in a particular learning environment for a particular student (Equation 2). The Individual Maximal Utility (IMU) displays the utility of implementing a learning environment for a particular student. It has been obtained by evaluating the difference between Intermediate Utility and Correlated Restrictions.

This table presents, then, in a quantitative fashion the appropriateness of each learning environment to each student (IMU). This was the primary purpose of the analysis.

Student 4 (Table 3) can be used to illustrate how these data can be further analyzed. Under the category Content Structure, Discussions is relatively high in all four learning environments, (21; 13; 16; 13) and has few administrative restrictions (-1.6; -1.0; -1.2; -1.0). A distinction can be made between these values and those for

Lessons in Point Form. The values displayed in the case of the latter are relatively low (8; 6.2; 5; 6.2) with moderately negative values for the administrative restrictions (-.6; -.5; -1.9; -.5).

It can be infered from this data that, for this particular student, the structure of the course content should include a large component of discussion. Lesson outlines might be presented ancillary to discussions to serve as guidelines. In fact, this student appears to prefer a structure which would facilitate self-directed learning.

In a similar manner, the data for the various categories can be analyzed. In this way decisions regarding the "best" action choice for each construct for a particular student may be made. This information might then be used as a counselling tool for that student as well as an aid to programme planning. Furthermore, by examining all cases, in light of selective considerations such as those presented above, decisions could be made regarding curriculum planning and revision, student remediation and counselling, and budgeting and resource allocation.

TABLE 3

TABLE FOR EACH STUDENT SUMMARIZING STUDENT PREFERENCES AND ADMINISTRATIVE CONSTRAINTS AFTER CONSIDERATION OF THE OPINIONS OF SUBJECT MATTER EXPERTS

Student #4

ACTION CHOICE	GROUPED AND BOUNDED		INDIVIDUALIZED AND BOUNDED		THE WORKPLACE		PERSONALISED AND OPEN	
	WEIGHTED PREFERENCE	WEIGHTED RESTRICTIONS	WEIGHTED PREFERENCE	WEIGHTED RESTRICTIONS	WEIGHTED PREFERENCE	WEIGHTED RESTRICTIONS	WEIGHTED PREFERENCE	WEIGHTED RESTRICTIONS
Programmed Instruction...	11.0	-1.2	21.0	-2.4	19.0	-2.1	19.0	-2.1
Lessons in point form....	8.0	-.6	6.3	-.5	5.0	-1.9	6.3	-.5
Study Guide.....	17.5	.9	21.0	1.1	16.0	.8	21.0	1.1
Discussions.....	21.0	-1.6	13.0	-1.0	16.0	-1.2	13.0	-1.0
Library research.....	19.0	0.0	19.0	0.0	2.0	0.0	21.0	0.0
Self-scored tests.....	3.6	-.5	12.0	-1.8	6.6	-1.0	11.4	-1.7
Teacher scored tests.....	13.8	-2.0	11.4	-1.7	12.6	-1.8	12.6	-1.8
Peer scored tests.....	1.8	-1.1	-1.8	-1.1	1.2	-1.1	-1.8	-1.1
Discussion with teacher..	12.6	-1.1	13.8	-1.2	11.4	-1.0	9.0	-.8
Machine scored test.....	7.8	1.5	6.2	.8	4.8	.9	6.6	1.2
Reading skills.....	14.0	.9	18.0	1.1	11.0	.7	14.0	.9
Math skills.....	19.0	1.7	19.0	1.7	14.0	1.2	17.0	1.5
Test taking.....	14.0	-.2	14.0	-.2	-6.0	0.0	14.0	-.2
Writing a term paper.....	21.0	-1.8	19.0	-1.7	-1.0	-2.2	13.0	-1.1
Using a library.....	17.0	-1.5	19.0	-1.7	13.0	-1.1	19.0	-1.7
Intermediate Utility	13.4		13.9		8.4		13.0	
Correlated Restrictions	-.5		-.6		-.7		-.5	
Maximal Utility	13.9		14.5		9.1		13.5	

The information presented in this table may also be employed in the optimization of the learning environments. An attempt may be made to drop action choices flagged by low or negative preferences or high restrictions. In this way a "best" learning environment can be constructed for a particular student.

Table 4 represents the Individual Maximal Utility for each learning environment averaged over all students (Equation 4). It is an indication of the appropriateness of the learning environments to the student population as a whole. The information displayed here would suffice if decision making revolved around the efficacy of affecting a particular learning environment for a total student population where learning environments are well constrained or not open to further optimization. This would have application in cases where a general overview of the "best" learning environment for the total population was needed. Decisions concerning installation of training or educational facilities for a large population, such as a town or district, or for vocational training programmes are examples of such cases.

TABLE 4

TABLE SUMMARIZING THE UTILITY OF EACH LEARNING ENVIRONMENT FOR THE POPULATION SAMPLED

POPULATION AVERAGED RESULTS

LEARNING ENVIRONMENT	MAXIMAL UTILITY
Grouped and Bounded	7.0
Individualized and Bounded	6.9
The Workplace	5.2
Personalized and Open	6.2

Table 5 displays a summary of the Intermediate and Maximal Utilities and the Correlated Restrictions for each subject in each learning environment. This information can provide planners and managers with a quick overview of these values for consideration and prioritizing before implementing any learning environment, and for the formulation of groupings of adult learners.

TABLE 5

TABLE SUMMARIZING THE UTILITIES FOR EACH STUDENT IN EACH LEARNING ENVIRONMENT

SUBJECT	LEARNING ENVIRONMENT	INTERMEDIATE UTILITY	CORRELATED RESTRICTIONS	MAXIMAL UTILITY
STUDENT 1	Grouped and Bounded	3.8	-.5	4.3
	Individualized and Bounded	2.4	-.6	3.0
	The Workplace	.4	-.7	1.1
	Personalized and Open	2.0	-.5	2.5
STUDENT 2	Grouped and Bounded	1.9	-.3	2.2
	Individualized and Bounded	3.2	-.4	3.6
	The Workplace	4.2	-.6	4.8
	Personalized and Open	2.3	-.3	2.6
STUDENT 3	Grouped and Bounded	8.5	-.3	2.2
	Individualized and Bounded	7.9	-.4	8.3
	The Workplace	4.0	-.6	4.6
	Personalized and Open	7.5	-.3	7.8
STUDENT 4	Grouped and Bounded	13.4	-.5	13.9
	Individualized and Bounded	13.9	-.6	14.5
	The Workplace	8.4	-.7	9.1
	Personalized and Open	13.0	-.5	13.5
STUDENT 5	Grouped and Bounded	-.4	-.3	-.1
	Individualized and Bounded	-1.1	-.4	-.7
	The Workplace	2.0	-.3	2.3
	Personalized and Open	-.7	-.3	-.3
STUDENT 6	Grouped and Bounded	.9	-.3	1.2
	Individualized and Bounded	1.3	-.4	1.6
	The Workplace	-.7	-.4	-.3
	Personalized and Open	1.1	-.3	1.4
STUDENT 7	Grouped and Bounded	9.9	-.6	10.5
	Individualized and Bounded	9.2	-.7	9.9
	The Workplace	6.9	-.7	7.6
	Personalized and Open	8.1	-.6	8.7
STUDENT 8	Grouped and Bounded	10.4	-.6	11.0
	Individualized and Bounded	10.4	-.7	11.1
	The Workplace	8.7	-.9	9.6
	Personalized and Open	8.9	-.6	9.6
STUDENT 9	Grouped and Bounded	7.6	-.5	8.1
	Individualized and Bounded	7.2	-.6	7.8
	The Workplace	4.8	-.8	5.7
	Personalized and Open	7.3	-.5	7.8
STUDENT 10	Grouped and Bounded	9.4	-.6	10.0
	Individualized and Bounded	9.2	-.7	9.9
	The Workplace	6.6	-.9	7.4
	Personalized and Open	8.4	-.6	9.0

3. Summary of Results

The data showed that for the Experts certain action choices were more appropriate in some learning environments than in others. For example, the use of Programmed Instruction was rated more appropriate for Individualized and Bounded, and Personalized and Open Environments than for Grouped and Bounded. Alternatively, Writing a Term Paper was a more appropriate action choice for Grouped and Bounded and Individualized and Bounded than for the Workplace or Personalized and Open environments. Teacher-scored tests and Discussion with Teacher were rated appropriate feedback modes in all four learning environments, while Machine-scored tests and Peer-scored tests were not.

Few administrative restrictions were found for Using a Library, Programmed Instruction, Self-scored tests, Teacher-scored tests, Peer-scored tests and Writing a Term Paper. Math and Reading Skills and Machine-scored tests were examples of action choices having a greater degree of administrative restrictions.

To summarize the analysis of the case presented in this Chapter, the student preferred a content structure well suited for self-directed learning; Discussions, Programmed

instruction and Lesson Guides. Library Research was preferred in all learning environments except The Workplace. Contrary to the assumptions made about adult learners (Knowles, 1970) this student did not show a preference for self or peer evaluation but preferred evaluation by the teacher.

The most preferred learning environments for the individual students, as well as for the entire population sampled, were Grouped and Bounded and Individualized and Bounded. The least preferred was The Workplace. There were two exceptions and in these cases The Workplace was the most preferred learning environment. In both cases the subjects were working and found attending classes inconvenient.

This Chapter discussed the structured information in the form of tables produced by the model and the way in which the information may be used for decision making in educational planning. The next Chapter will discuss the validation of the model as well as future applications.

CHAPTER 6
DISCUSSION

1. Introduction

The purpose of this study was to develop a model, based on a systems approach, that would enable educational planners to choose optimally among sets of alternatives. For this study, the problem of choosing among learning environments and instructional activities appropriate for adult learners in a postsecondary formal educational setting was selected for a concrete demonstration of the model. Data was collected using questionnaires from 43 students, 5 subject matter experts, and 4 educational administrators. The students rated 67 instructional activities, according to their own preferences, on a 5-point scale. The subject matter experts rated these same instructional activities on a 5-point scale according to their importance to or compatibility with four defined learning environments. Finally, the educational administrators rated these same instructional activities on a 5-point scale, according to the degree that four administrative constraints would impede these activities.

An initial phase in modeling a system consists in separating that system from the general environment. The

definition of the system's boundaries is a critical step in modeling (Churchman, 1968; Karplus, 1977). The assumption is that of all possible interactions that a system is capable of, only a small subset is relevant in a modeling activity (Boyd, 1980). This is especially true for inductive models, such as social systems, where a multiplicity of relationships is possible and where no fundamental laws or principles guiding these relationships are discernible (Karplus, 1977). This subset is an abstraction, but in the modeling process, represents that aspect of reality under investigation.

In the present study, the postsecondary educational institution was isolated from its general environment and formed the boundaries for the system under investigation. The portion of "reality" selected for enquiry was the interaction among 3 client groups, learning environments, and instructional activities. Each of the client groups was viewed as decision makers differing in their interests and concerns. The learning environments and instructional activities were systematically identified and examined in light of the interests and concerns of these client groups.

The working thesis was that a model could be constructed to provide decision makers with useful information for

planning, implementing, and modifying learning environments for adult learners. This would be accomplished by systematically identifying critical variables, and then implementing the model using those variables. Success in such a task would be determined by, a) logical consistency, and b) application of the model to a real case with structured information which decision makers need to facilitate rational decision making.

2. Testing the Model

2.1 Logical Consistency and Structured Information

The logical consistency of the model was assured by basing all constructs on educational analysis available in extensive literature. An application of the model and structured information was described in Chapter 5. Validity and credibility of the model to decision makers is discussed below.

Field testing was effected by questionnaires addressed to 3 levels of decision makers in a specific educational environment. In order to efficiently analyze the data from the three questionnaires, four mathematical equations were formulated and a Fortran programme was developed. The computer programme produced four types of values to assist decision makers: 1) an Intermediate Utility (IU) based on

data from students and subject matter experts, 2) a Correlated Restriction (CR) based on data from subject matter experts and educational administrators, 3) an Individual Maximal Utility (IMU) for each learning environment for each student, after administrative constraints have been considered, and 4) an Average Maximal Utility (AMU) for the total student population polled, for each learning environment.

As a predictive tool at the level of programme planning, the AMU values allow decision makers to identify and prioritize learning environments and their components, for a given situation and target group.

As a prescriptive tool, the model produces values for individual students. Intermediate Utility and Individual Maximal Utility values permit the matching of particular learning environment components with individual learner traits and styles.

The systems model appears to be a useful alternative to evaluation and needs assessment approaches to educational decision making. It is especially attractive because of its capacity to simultaneously analyze multiple sources of

information from several levels of decision makers and to synthesize this array of data into meaningful aggregates for decision making.

2.2 Validity and Credibility

2.2.1 Overview

Validity and credibility of models are important measures of their success. Deductive models can be evaluated using quantitative measures since there are fundamental laws governing these systems' behaviours. These quantitative measures can then be applied to the evaluation of the model as a tool for design. For example, the design of electrical circuits rely heavily on deductive modeling and quantitative analysis of the model.

Karplus (1977) states that for inductive models, such as social, political, and economic systems, qualitative measures can be used to determine validity and credibility. In this instance, these models are ". . .frequently used to provide a general insight into system behaviour - behaviour which is often 'counterintuitive'" (Karplus, 1977:9). Because there are no known fundamental laws governing these systems' behaviours and defining the systems' parameters, hard data is almost impossible to obtain. Instead, qualitative analysis of the model is sought and is based on the insight and

intuition of the modeler and/or judges (Karplus, 1977).

Three strategies were employed to test the credibility and validity of the model presented in this study: test data was fabricated to validate the mathematical manipulations and the Fortran programme, a panel of judges was sought to determine content and face validity as suggested by Karplus (1977), and actual responses to questionnaires were analyzed. The third strategy is described in the Results section, the two other strategies are reported below.

2.2.2 Strategy I: Test Operation of the Model

For the first strategy, in order to test the Fortran programme and validate the mathematical manipulations, data describing a situation whose results were predictable, was fabricated. The data was run through the model and the results generated were compared with intuitive predictions. One such test is summarized below.

2.2.2.1 Fabricated Input Data

Importance Factor

Importance Factors were chosen to reflect learning environments with different degrees of appropriateness for the action choices selected (Table 6). All action choices were considered very important to the grouped and bounded learning environment (+5), important to the individualized

and bounded learning environment (+3), incompatible in the workplace (-3), and very incompatible in the personalized and open learning environment (-5).

TABLE 6

TABLE SHOWING TEST DATA ON THE IMPORTANCE WEIGHTINGS OF EACH ACTION CHOICE IN EACH LEARNING ENVIRONMENT AS DETERMINED BY THE SUBJECT MATTER EXPERTS

	IMPORTANCE FACTORS			
	LEARNING ENVIRONMENTS			
ACTION CHOICE	GROUPED AND BOUNDED	INDIVIDUALIZED AND BOUNDED	THE WORKPLACE	PERSONALIZED AND OPEN
Programmed Instruction...	5.0	3.0	-3.0	-5.0
Lessons in point form....	5.0	3.0	-3.0	-5.0
Study guide.....	5.0	3.0	-3.0	-5.0
Discussions.....	5.0	3.0	-3.0	-5.0
Library research.....	5.0	3.0	-3.0	-5.0

Administrative Restrictions

Administrative Restrictions were chosen to be a maximum for all five action choices selected; A major constraint to the implementation (+5), (Table 7).

TABLE 7

TABLE SHOWING TEST DATA ON CONSTRAINT WEIGHTINGS ON EACH ACTION CHOICE BY EDUCATIONAL ADMINISTRATORS

ADMINISTRATORS RESTRICTIONS

ACTION CHOICE	AVERAGE RESTRICTIONS
Programmed Instruction	5.0
Lessons in point form	5.0
Study Guide	5.0
Discussions	5.0
Library research	5.0

Student Preferences

Test data from two hypothetical students was used. Student T1, (Table 8), had a maximum preference (+5) for all action choices selected, and Student T2, (Table 9), had a minimum preference (-5) for all five action choices selected. That is, Student T1 considered all action choices highly desirable, Student T2 considered all action choices highly undesirable.

In this test, the factor, wf, weighting the relative importance of student preferences to administrative constraints was set at 1.0.

2.2.2.2 Results of Fabricated Data

The results of these tests were consistent with intuitive predictions. For example, in the case of Student T1, the Individual Maximal Utility for Grouped and Bounded learning environment was neutral (0.0) because the negative contribution by Administrative Restrictions was exactly balanced by the positive contribution of Student Preferences. Similarly, in the case of Student T2, a most negative Individual Maximal Utility was achieved due to the negative contribution by both Administrative Restrictions and Student Preferences.

TABLE 8

TABLE SHOWING TEST DATA FOR STUDENT #T1 SUMMARIZING STUDENT PREFERENCES AND ADMINISTRATIVE CONSTRAINTS AFTER CONSIDERATION OF THE OPINIONS OF SUBJECT MATTER EXPERTS

Student #T1

ACTION CHOICE	GROUPED AND BOUNDED		INDIVIDUALIZED AND BOUNDED		THE WORKPLACE		PERSONALIZED AND OPEN	
	WEIGHTED PREFERENCE	WEIGHTED RESTRICTIONS	WEIGHTED PREFERENCE	WEIGHTED RESTRICTIONS	WEIGHTED PREFERENCE	WEIGHTED RESTRICTIONS	WEIGHTED PREFERENCE	WEIGHTED RESTRICTIONS
Programmed Instruction...	25.0	25.0	15.0	15.0	-15.0	0.0	-25.0	0.0
Lessons in point form....	25.0	25.0	15.0	15.0	-15.0	0.0	-25.0	0.0
Study Guide.....	25.0	25.0	15.0	15.0	-15.0	0.0	-25.0	0.0
Discussions.....	25.0	25.0	15.0	15.0	-15.0	0.0	-25.0	0.0
Library research.....	25.0	25.0	15.0	15.0	-15.0	0.0	-25.0	0.0
Intermediate Utility	25.0		15.0		-15.0		-25.0	
Correlated Restrictions	25.0		15.0		0.0		0.0	
Maximal Utility	0.0		0.0		-15.0		-25.0	

TABLE 9

TABLE SHOWING TEST DATA FOR STUDENT #T2 SUMMARIZING STUDENT PREFERENCES AND ADMINISTRATIVE CONSTRAINTS AFTER CONSIDERATION OF THE OPINIONS OF SUBJECT-MATTER EXPERTS

Student #T2

ACTION CHOICE	GROUPED AND BOUNDED		INDIVIDUALIZED AND BOUNDED		THE WORKPLACE		PERSONALIZED AND OPEN	
	WEIGHTED PREFERENCE	WEIGHTED RESTRICTIONS	WEIGHTED PREFERENCE	WEIGHTED RESTRICTIONS	WEIGHTED PREFERENCE	WEIGHTED RESTRICTIONS	WEIGHTED PREFERENCE	WEIGHTED RESTRICTIONS
Programmed Instruction...	-25.0	25.0	-15.0	15.0	15.0	0.0	25.0	0.0
Lessons in point form....	-25.0	25.0	-15.0	15.0	15.0	0.0	25.0	0.0
Study Guide.....	-25.0	25.0	-15.0	15.0	15.0	0.0	25.0	0.0
Discussions.....	-25.0	25.0	-15.0	15.0	15.0	0.0	25.0	0.0
Library research.....	-25.0	25.0	-15.0	15.0	15.0	0.0	25.0	0.0
Intermediate Utility	-25.0		-15.0		15.0		25.0	
Correlated Restrictions	25.0		15.0		0.0		0.0	
Maximal Utility	-50.0		-30.0		15.0		25.0	

We may thus conclude that no gross computational errors exist and that the model, to a first approximation, yields valid results.

2.2.3 Strategy II: Panel of Judges

In the second strategy, the model was assessed by a panel of judges comprised of Dr. Steve Applebaum, Dean of Commerce, Concordia University, Dr. Bill Surkis, Academic Dean, John Abbott College, and Dr. James Whitelaw, Associate Vice Rector, Academic Planning, Concordia University.

Judges were visited, separately, and presented with a very brief printed synopsis of the model along with a computer printout of the information produced by the model for decision makers. After discussion of the development and nature of the information provided, judges were asked to comment on the face and content validity of the model. They were also invited to comment as educational administrators, on its potential usefulness to them, for planning. Each judge was given a set of eight questions to use as a guideline for their comments.

In each case, the panel supported a full implementation of the model. Dr. Whitelaw suggested that the model would

give decision makers information which is presently unavailable and which would be useful for planning. He sees a need for some kind of data collection on these variables. With respect to face and content validity, Dr. Whitelaw views the model as complete. His major concern revolved around a statistical issue, "the reliability of the sampling." This valid concern would be dealt with by using a full application of the model and sufficient subjects to minimize error and ensure random sampling procedures.

Dr. Applebaum's comments revolved around the self-correcting mechanism built into the model. Failure would be indicated by high dropout rates, extensive counselling requests, and high rate of absenteeism, for example. This would result in reviewing parts of the model to see where errors might have occured. Once errors had been identified, modifications to the model could be made. This comment is congruent with Morris' (1970) view of enriching and expanding models through testing, modification, and more testing. Dr. Applebaum stated that the model elicits information which would be of great use to programme and course planners. Further comments by Dr. Applebaum are reported below.

Dean Surkis was concerned about the flexibility of the components of the instructional system. According to Dr.

Surkis many, of these components, while appearing to be plastic, are not. As an example, Dean Surkis explained that while most adult learners favour the location of classrooms in a central area close to a lounge for socializing, budgetary constraints restrain implementing this component.

Mature learners represent about 10% of the student body at John Abbott College, according to Surkis. This may be reflected in budgetary priorities. However, future trends indicate an increase in the adult student enrolment. As a predictive tool, the model can serve as a computer-based data collection instrument developing a data bank on learner profiles and preferences on some selected variables to be used by decision makers for long range planning, and weighted by opinions of subject matter experts and administrative concerns.

To respond to Surkis' concern regarding the plasticity of certain components of the instructional system, a weighting factor could be introduced to accommodate those particular variables. To illustrate using the example above, if the allocation of space is particularly sensitive to operating costs, a weighting factor could be applied to the criterion variable Operating Costs reflecting this budgetary

constraint. In this way, the variables so chosen would be subjected to additional scrutiny by the model in terms of the administrative concerns impeding these activities.

Another concern of Dr. Surkis' was the quantification of the data. "What is the difference between 13 and 13.5? What does the difference mean?" For the present, the model indicates that differences do exist. What these differences mean and how significant they are, are important questions for further research and may lead to elaboration of the model.

A full implementation of this model could be carried out by putting the questionnaires on-line, placing terminals with CRT in the main lobbies of the institution, and inviting interested citizens to participate in the process. This might be a first step towards elaboration of the model.

The analysis presented above is qualitative in nature. It does not provide really hard data. It is, however, a truly logical and therefore appropriate method for analyzing intuitive models. The next step would be to obtain substantial data, on representative samples, in order to improve details of the technique.

DISCUSSION Chapter 6

This logical qualitative analysis gives rise to iterative procedures, which, according to Morris (1970:82) ". . .underscore the notion that the research need not be in the form of a single grand test of a single model but can start simply and be enriched and elaborated on through modifications." A new version of the model is produced based on modifications made by testing the model. This leads to new tests and further modifications, modifications made by testing the model. These iterative procedures result from the alternation between modifications of the model and confrontation by the data. Morris (1970:81) asserts that one need not ". . .decide whether to develop the model first or get the data first."

Ashby (1970) argues for the extension of the model's range of application as the step immediately following the development of the model as a random exploration to discover further relationships. It is within the process of these iterative procedures, the alternation between modifications, data confrontation, and further exploration and expansion of the model that relationships between subsets can be uncovered.

This flexibility permits alterations to the model as factors influencing its behaviour alters. This aspect is

particularly important for an educational system which is affected by changes in governmental policies, composition of student body, and technological changes, for example. The model can be made to be responsive to these changes through the iterative procedures.

A criterion, then, for the credibility of an inductive model would necessarily be the presence of a iterative capability. In his remarks on the value of the present model to decision makers, Dr. Steve Applebaum concluded, "The model has a built-in fail-safe mechanism. If the system fails it is an indicator that something is missing from the model; therefore review the parts and make modifications. Costs are negligible because they are self-correcting - the model controls why it fails."

As an example, Dr. Applebaum cited the case where a course for adult learners would be implemented and scheduled during the day. Few students would enrol. By reviewing the parts of the system an administrator would be able to discover that scheduling for that client group is inappropriate. Modification to the scheduling factor should increase student enrolment. While this is a simplistic example, it will serve to illustrate the iterative procedures.

Karplus argues that mathematical models have a built-in "validity-factor". This validity-factor relates to the degree of inductivity. The further away a model moves from deduction, the fewer fundamental laws it has to follow, the more qualitative in substance it becomes.

Logical qualitative analysis is not to be dismissed as being inadequate. Of paramount importance is the users' understanding of the limitations of their models and the range of validity of the predictions and prescriptions based on them.

Behavioural models, such as the one presented here, can be evaluated on face and content validity alone in the initial stages, according to Dr. Applebaum. Face validity, for Dr. Applebaum, concerns itself with the visible representation of the system as provided by the model; content validity is concerned with an evaluation of each element.

Based on face and content validity, Dr. Applebaum views the present model ". . .worthwhile implementing on a systems wide basis for planning overall programmes and courses. The information would be more reliable than 'eyeballing' since it

would be supplied by persons directly involved or potentially involved. The variables selected appear to be critical to the task of programme and course planning."

3. Flexibility and Adaptability of the Model

As a conceptual model and methodological tool the model presented here offers flexibility and adaptability for use in many learning environments. For example, at a public sector level, Manpower planners might plug in generic instructional components for their various programmes. In the private sector, industry and business might use variables which are firm-specific. Similarly, considerations for managers and administrators could be reflected in an appropriate manner by using constraint criteria critical to their own circumstances. In the banking industry, for example, federal legal considerations may play an important role in any training programme offered. This criterion could be included to accommodate this constraint.

Another area of flexibility of the model lies in its capability of dealing with selected variables. If, for example, information for decision making regarding a few selected variables such as scheduling and course content was required, only minor modifications to the Fortran programme

would be required.

In using the model as a counseling tool, individual cognitive styles could be accommodated by selective allocation of learners with given traits and preferences to specific treatments.

4. The Weighting Factors (wf)

The possibility of building sensitive weighting factors into the model illustrates one other important feature of this particular model's flexibility and adaptibility. If constraints were sufficiently well defined a weighting factor (wf) could be meaningfully implemented.

For example, wf could be assigned a value of .5, subtracting half of the value of the Correlated Restrictions from the Intermediate Utility instead of the total value (Equation 3). This would imply that Student Preferences are twice as important in the evaluation of learning environments as are Administrative Restrictions. This approach may be a minor consideration. However, situations may arise where some administrative constraints would be more important than others. In this case other values of wf could be applied.

Weighting could be assigned depending on how much

accuracy the decision makers required in the situation. In the present configuration, the weighting factor defaults to 1 unless otherwise specified by the user. In this way the user is in control over the relative importance of the information given by each level of subjects surveyed.

5. Format Alternative

Another possibility for this model is to use an interview format for data collection with the questionnaire as a guide. This would be useful where the population was small enough and detail was critical. The interview format might also prove more useful where the population was illiterate or where English was not the subjects first language.

This model has the capability of adapting to most groups, regardless of their level of education, sophistication in research, or literacy. It can accept as input, vertical and horizontal variables appropriate for the audience using it for educational decision making.

6. Flagging Counterintuitive System Behaviour

One of the benefits to be derived from inductive models is the production of counterintuitive information on the behaviour of the system under inquiry (Karplus, 1977). There are situations where known and intended practices of an

institution are sufficient to cause problems where they were intended to create solutions. That is, the behaviour of the system is counterintuitive.

One can draw on this capability of the model to flag counterintuitive behaviour and apply the concept to the model under discussion here. As an example, the construct Feedback Mode can be examined. According to Knowles (1970) adults do not enjoy being evaluated by other adults. He contends that evaluation of adult learning should be a self-diagnostic process of learning needs. Using Knowles' model of evaluation, one would intuitively expect adult learners to indicate a high preference for self-evaluation as a feedback mode. Contrary to this expected behaviour, most students in the present study, indicated a very high preference for teacher-scored tests and a very low preference for self-evaluation. By flagging this counterintuitive behaviour, modifications to existing programmes could be made to suit client concerns and learning styles.

7. Future Developments

7.1 The Predictive Model

The model presented in this study is most useful in those cases where students may be queried directly. However, in

many cases it would be more convenient if one could infer student preferences directly from census or other readily accessible information. Intuitively one would expect to obtain tolerable correlation between factors such as sex, age, level of education, and occupation, and students preferences which are relevant to suitable learning environments and their components. A brief review of the literature on adult learners bears this out (Steele, 1974; Richard, 1976; Depauw and Heft, 1980; Cross, 1983).

The Predictive Model provides another route to Equation 3 where direct access to a student population is not possible for obtaining preferences. This model provides an indirect approach using purely demographic data obtained from census tracts or personnel files. The Predictive Model allows the user to get around the real technical problems of student inaccessibility and to enter the model at the point of Equation 3.

In the Predictive Model student preferences are calculated from demographic data of the target student group (Figure 10). Correlations are then obtained by the statistical analysis of data from sample students with similar demographic and social characteristics.

The main difficulty lies in determining these correlations. As preferences for individual action choices is expected to depend upon the interplay of many demographic factors, statistical evaluation of these correlations will probably be a difficult task. However, with the judicious choice of data and sufficiently large computational facilities at the users disposal, this approach would be expected to lead to useful results.

The model, as presented, is a streamlined form of one which has potential for expansion. The purpose was to present an illustrative version and to indicate its potential for expansion, its flexibility for use, and its adaptability for a wide variety of user groups. It is recommended that additional future developments focus on sensitivity analysis of the mathematical model and the effects of different distributions of the sample.

Appendix I

TO: STUDENTS

Mature adults form a large part of the student body at most universities, CEGEPs and continuing education facilities today. Research suggests this trend will continue.

In order for these institutions to respond appropriately to adult learners, more information is needed regarding the requirements and preferences of this population.

Information from the two enclosed questionnaires will be used in research for planning programmes for mature students like you.

These questionnaires may look complicated. They are not. Please read the instructions carefully before completing each questionnaire.

Thank you for your time and co-operation.

QUESTIONNAIRE I

STUDENT FORM

INSTRUCTIONS

This is an anonymous questionnaire. We do not wish to have your name. Information from this questionnaire will be used for research on programmes for mature students.

Please complete the questionnaire by drawing a circle around the number next to the answer that applies to you. Circlé one number only.

Example:

In what programme are you presently registered?

(1.) Mature Students Programme

2. Bachelor of Arts

3. Vocational Training Programme

4. Language Training Programme

Thank you for your time and co-operation.

QUESTIONNAIRE I

STUDENT FORM

BACKGROUND INFORMATION QUESTIONNAIRE
MATURE STUDENTS STUDY

Male _____ Female _____

1. What is your most important reason for taking courses?
   1. Prepare for employment
   2. Personal enrichment unrelated to work
   3. Prepare for university
   4. Certification in a special field
   5. No particular goal
   6. Make new friends
2. Do you need to complete your courses within a certain time?
   1. No
   2. 3 - 6 Months
   3. 7 Months - 1 Year
   4. 1 Year - 2 Years
   5. 2 - 4 Years
3. How much time do you have available to study each day?
   1. Less than 1 hour
   2. 1 - 3 hours
   3. More than 3 hours
4. Given a block of time, how long can you concentrate on studying?
   1. ½ - 1 hour
   2. 1½ - 2½ hours
   3. 3 hours or more
5. Would you be interested in attending classes to improve your study skills?
   1. Yes
   2. No
6. How anxious are you before taking a test?
   1. Very anxious
   2. Moderately anxious
   3. Not anxious
7. Does the need for transportation make it difficult for you to attend classes?
   1. Yes
   2. No
8. Does the need for child care make it difficult for you to attend classes?
   1. Yes
   2. No

9. Do finances make it difficult for you to attend classes?

   1. Yes
   2. No

10. What is your first language?

   1. English
   2. French
   3. Bilingual
   4. Other

11. What is your highest level of formal schooling?

   1. Less than High School grad.
   2. High School graduate
   3. Some CEGEP or trade school
   4. Some University classes/credits
   5. University Degree

12. As a Mature Student, which formally structured courses have you taken? (Choose as many as appropriate)

   1. None
   2. Academic
   3. Leisure & Cultural
   4. Vocational
   5. Personal Development

13. How long had you been out of school before returning as a Mature Student?

   1. Does not apply
   2. 0 - 5 Years
   3. 6 - 11 Years
   4. 12 Years or More

14. What is your age bracket?

   1. 18 - 22 Years
   2. 23 - 40 Years
   3. 31 - 40 Years
   4. 41 - 50 Years
   5. 51 or over

15. What is your marital status?

   1. Single
   2. Separated or Divorced
   3. Married
   4. Widowed
   5. Common Law relationship

16. How many children do you have in the following age brackets?

	Number of Children
1. None	_____
2. Under 4 Years	_____
3. 5 - 10 Years	_____
4. 11 - 16 Years	_____
5. 17 Years or Over	_____

17. What is your primary occupation?

    1. Professional
    2. Homemaker
    3. Business Owner
    4. Manager
    5. Clerk or Salesperson
    6. Service Work

18. Do you have any physical handicap which makes it difficult for you to participate in education ? (e.g., attend classes)

    1. Yes
    2. No

    Please briefly describe _____

QUESTIONNAIRE II

STUDENT FORM

INSTRUCTIONS

Listed below is an inventory of some important components of a learning situation as determined by the experts.

In general, how Desirable to Your own learning is each of these components?

Please rate Each component according to how Desirable it is to You, in a learning situation by placing a check (✓) under one of the following:

HIGHLY DESIRABLE
DESIRABLE
NO PREFERENCE
UNDESIRABLE
HIGHLY UNDESIRABLE
I NEED MORE INFORMATION

Example:

	HIGHLY DESIRABLE	DESIRABLE	NO PREFERENCE	UNDESIRABLE	HIGHLY UNDESIRABLE	I NEED MORE INFORMATION
Summer Courses	✓					
Weekend Courses				✓		
Early Bird Courses					✓	
Evening Courses		✓				
Lunch Time Courses						✓

This would indicate: Summer Courses are highly desirable to you.
Weekend Courses are undesirable to you.
Early Bird Courses are highly undesirable to you.
Evening Courses are desirable to you.
You need more information about Lunch Time Courses.

REMEMBER: Check EACH item on the left under ONE column on the right.

QUESTIONNAIRE II STUDENT FORM

COMPONENTS OF A LEARNING SITUATION	HIGHLY DESIRABLE	DESIRABLE	NO PREFERENCE	UNDESIRABLE	HIGHLY UNDESIRABLE	I NEED MORE INFORMATION
3. SCHEDULING OF COURSES						
Once Every Week						
2-3 Times a Week						
Weekends						
An Intensive 2 Week Workshop Several Times a Year						
4. TIME OF DAY						
Mornings Only						
Afternoons Only						
Evenings Only						
Anytime						
5. SETTING						
Traditional Classroom						
Small Groups						
Study Centre with T.V. Computers, Books, Etc.						
Work on Your Own						
6. PHYSICAL ARRANGEMENT						
Courses with Regular Student Body						
Separate Courses for Mature Students Only						
An Independent Course of Study Designed for Each Mature Student						
7. PRESENTATION OF COURSE MATERIAL						
Step-by-Step Presentation of Each Lesson						
Outline of Lesson, Presented Point-by-Point						
Study Guide						
Discussion						
Library Research						
8. LEARNING PROGRESS REPORTS						
Score Your Own Tests						
Teacher-Scored Tests						
Student-Scored Tests						
Personal Discussion with Teacher						
Machine Scored Tests						

QUESTIONNAIRE II STUDENT FORM

COMPONENTS OF A LEARNING SITUATION	HIGHLY DESIRABLE	DESIRABLE	NO PREFERENCE	UNDESIRABLE	HIGHLY UNDESIRABLE	I NEED MORE INFORMATION
9. STUDY SKILLS						
Improve Reading Skills						
Improve Math Skills						
How To Take a Test						
Writing a Term Paper						
Using a Library						
10. SPECIAL COURSES FOR MATURE STUDENTS						
Career Information						
Self-Discovery						
French Language						
Leisure & Cultural						
Life Skills (Family Law, Rent Control, Etc.)						
English Language						
11. MEDIA						
Direct Teacher Contact						
T.V., Videotape Lessons						
Radio Lessons						
Cassette Lessons						
Slides with Sound						
Films						
Correspondence Lessons						
Computer Lessons						
Books, Journals, Magazines						
12. HOW YOU LEARN BEST, GENERALLY						
Group Discussion						
Listening to Lectures						
Studying on Your Own						
Presenting a Seminar						
Group Projects						
Correspondence Course						
13. LEARNING LOCATION						
On Campus with Other Students						
On Campus Independently						
At My Workplace						
Off Campus, "Y", Community Centre						
At My Home						

COMPONENTS OF A LEARNING SITUATION

14. WHICH OF THE FOLLOWING HAVE YOU PARTICIPATED IN, IN A FORMALLY STRUCTURED LEARNING SITUATION?

Listening to Lectures	Yes ____	No ____
Group Discussions	Yes ____	No ____
Studying on Your Own	Yes ____	No ____
Presenting a Seminar	Yes ____	No ____
Group Projects	Yes ____	No ____
Correspondence Course	Yes ____	No ____

15. WHICH OF THE FOLLOWING HAVE YOU WORKED WITH IN A FORMALLY STRUCTURED LEARNING SITUATION?

Direct Teacher Contact	Yes ____	No ____
T.V., Videotapes	Yes ____	No ____
Radio	Yes ____	No ____
Audio Cassettes	Yes ____	No ____
Slides with Sound	Yes ____	No ____
Films	Yes ____	No ____
Correspondence Lesson Materials	Yes ____	No ____
Computers	Yes ____	No ____
Books, Journals, Magazines	Yes ____	No ____

Appendix III

TO: EDUCATIONAL ADMINISTRATORS

Mature adults form a large semgent of the student body at most universities, CEGEPs and continuing education facilities today. Research suggests this trend will continue. In order to encourage further enrolment and respond to the requirements of this population, research in this field is indicated.

The enclosed questionnaire was derived from an analysis of learning variables. It may be useful to you as an inventory or checklist of what is available to instructional delivery systems for adult learners.

You are invited to make copies for your own purposes.

Information from this questionnaire will be used in research for planning instructional delivery systems for adult learners.

Thank you for your time and co-operation.

ADMINISTRATORS FORM

INSTRUCTIONS

The rows on the left contain Components of a learning situation.

The columns on the right contain some Constraints to the Implementation of these components.

From your own knowledge and experience with adult learners, indicate your expert opinion as an administrator on the weight/degree of each CONSTRAINT to the implementation of each COMPONENT.

Fill in EACH SPACE with a symbol of your choice from those below: see EXAMPLE

LEGEND: √√ MAJOR CONSTRAINT TO THE IMPLEMENTATION OF THIS COMPONENT
√ MINOR CONSTRAINT TO THE IMPLEMENTATION OF THIS COMPONENT
O NEUTRAL TO THE IMPLEMENTATION OF THIS COMPONENT
X FEASIBLE TO THE IMPLEMENTATION OF THIS COMPONENT
XX VERY FEASIBLE TO THE IMPLEMENTATION OF THIS COMPONENT
? NEED MORE INFORMATION ON THIS COMPONENT

EXAMPLE:

	CONSTRAINTS			
	CAPITAL COSTS	OPERATING COSTS	UNION COLLECTIVE AGREEMENT	BOUNDARIES OF MANDATE
Early Bird Courses	O	✓	√√	?
Lunchtime Courses	XX	X	✓	XX

This would indicate that to implement Early Bird Courses:

Capital Costs would be NEUTRAL (O).
Operating Costs would be a Minor constraint (✓).
Union Collective Agreement would be a Major constraint (√√).
More information is needed (?) to determine if this component comes under the respondent's mandate or authority.

To implement Lunchtime Courses:

Capital Costs would make it Very Feasible (XX).
Operating Costs would make it Feasible (X).
Union Collective Agreement would be a Minor constraint (✓).
Respondent's mandate makes the implementation of this component Very Feasible (√√).

ADMINISTRATORS FORM

INSTRUCTIONAL DELIVERY SYSTEMS FOR ADULT LEARNERS

LEGEND: √√ MAJOR CONSTRAINT TO THE IMPLEMENTATION OF THIS COMPONENT
√ MINOR CONSTRAINT TO THE IMPLEMENTATION OF THIS COMPONENT
0 NEUTRAL TO THE IMPLEMENTATION OF THIS COMPONENT
X FEASIBLE TO THE IMPLEMENTATION OF THIS COMPONENT
XX VERY FEASIBLE TO THE IMPLEMENTATION OF THIS COMPONENT
? NEED MORE INFORMATION ON THIS COMPONENT

COMPONENTS OF A LEARNING SITUATION	CONSTRAINTS: CAPITAL COSTS	OPERATING COSTS	UNION COLLECTIVE AGREEMENT	BOUNDARIES OF MANDATE
1. GOALS				
Prepare for Employment				
Personal Enrichment Unrelated to Work				
Prepare for University				
Certification in a Special Field				
No Particular Goal				
Make New Friends				
2. TIME LIMITATION FOR COMPLETION OF PROGRAM				
None				
3 - 6 Months				
1 - 2 Years				
2 - 4 Years				
3. SCHEDULING OF COURSES				
Once Every Week				
2-3 Times a Week				
Weekends				
An Intensive 2 Week Workshop Several Times a Year				
4. TIME OF DAY				
Mornings Only				
Afternoons Only				
Evenings Only				
Anytime				

ADMINISTRATORS FORM

CONSTRAINTS

COMPONENTS OF A LEARNING SITUATION	CAPITAL COSTS	OPERATING COSTS	UNION COLLECTIVE AGREEMENT	BOUNDARIES OF MANDATE
5. SETTING				
Traditional Classroom				
Small Groups				
Study Centre with T.V. Computers, Books, etc.				
Independent Study				
6. STREAMING				
Courses with Regular Student Body				
Separate Courses for Mature Students Only				
An Independent Course of Study Designed for Each Mature Student				
7. CONTENT STRUCTURE				
Step-by-Step Presentation of Each Lesson				
Outline of Lesson, Presented Point-by-Point				
Study Guide				
Discussion				
Library Research				
8. FEEDBACK MODE				
Self-Scored Tests				
Teacher-Scored Tests				
Peer-Scored Tests				
Personal Discussion with Teacher				
Machine-Scored Tests				
9. STUDY SKILLS				
Improve Reading Skills				
Improve Math Skills				
How To Take a Test				
Writing a Term Paper				
Using a Library				

ADMINISTRATORS FORM

COMPONENTS OF A LEARNING SITUATION	CONSTRAINTS: CAPITAL COSTS	OPERATING COSTS	UNION COLLECTIVE AGREEMENT	BOUNDARIES OF MANDATE
10. STUDENT SERVICES				
Career Information				
Self-Discovery				
French Language				
Leisure & Cultural				
Life Skills (Family Law, Rent Control, Etc.)				
English Language				
11. MEDIA				
Direct Teacher Contact				
Broadcast T.V. Lessons				
Radio Lessons				
Audio Cassette Lessons				
Slides with Sound				
Films				
Correspondence Lessons				
Computer Lessons				
Books, Journals, Magazines				
Video Cassette Lessons				
12. LEARNING MODE				
Group Discussion				
Listening to Lectures				
Independent Study				
Presenting a Seminar				
Group Projects				
Correspondence Course				
13. LEARNING LOCATION				
On Campus with Other Students				
On Campus Independently				
The Workplace				
Off Campus, "Y", Community Centre				
Home Based				

Appendix IV

TO: Faculty; Subject Matter Experts

Mature adults form a large segment of the student body at most universities, CEGEPs and continuing education facilities today. Research suggests this trend will continue. In order to encourage further enrolment and respond to the requirements of this population, research in this field is indicated.

The enclosed questionnaire was derived from an analysis of learning variables. It may be useful to you as an inventory or checklist of what is available to instructional delivery systems for adult learners.

You are invited to make copies for your own purposes.

Information from this questionnaire will be used in research for planning instructional delivery systems for adult learners.

Thank you for your time and co-operation.

EXPLANATION OF LEARNING ENVIRONMENTS

EXPERTS FORM

At a symposium sponsored by the United States Office of Education and the National Institute of Education in September 1973, three learning environments for higher education were defined. These are:

1. Grouped and bounded
2. Individualized and bounded
3. Personalized and open

1. Bounded environments refer to institutions in which offerings are space and time bounded, which have definite learning and entrance requirements, physical locations and space/time/resource constraints on the teaching/learning process.
   Examples are CEGEPs and Universities.

2. The difference between grouped and individualized learning environments lies in the degree to which the learner can control the pacing, scheduling, and content of the course work. Computer Assisted Instruction, PLATO and Personalized System of Instruction are examples of an individualized and bounded learning environment. Traditional lectures, classroom T.V. monitors, and seminars are representative of grouped and bounded learning environments.

3. Personalized and Open Learning environments are free from many requirements and constraints of traditional institutionalized education.
   These include home study, cultural activities and some continuing education.

4. One more learning environment is added - the Workplace - since business and industry is becoming more committed to the concept of upgrading and retraining of skills within the organization.

Please read page 1 before completing this form.

INSTRUCTIONS

The rows on the left contain components of instructional delivery systems as determined by Frank (1971), a symposium sponsored by the United States Office of Education and the National Institute of Education (1973), Gagné and Briggs (1974), and Holden (1975).

The columns on the right indicate learning environments as determined by the aforementioned symposium.

From your own knowledge and experience with adult learners, indicate your expert opinion on the degree of importance/compatibility of each component to each learning environment.

Fill in EACH SPACE with a symbol of your choice from those below: See EXAMPLE

LEGEND: ✓✓ VERY IMPORTANT TO THE LEARNING ENVIRONMENT

✓ IMPORTANT TO THE LEARNING ENVIRONMENT

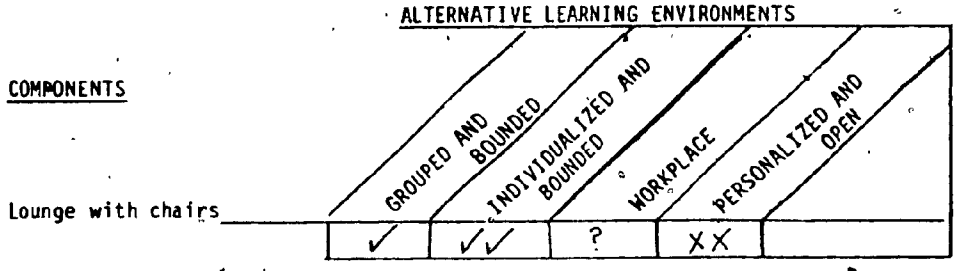
0 NEUTRAL TO THE LEARNING ENVIRONMENT

X INCOMPATIBLE WITH THE LEARNING ENVIRONMENT

XX VERY INCOMPATIBLE WITH THE LEARNING ENVIRONMENT

? NEED MORE INFORMATION ON THIS COMPONENT IN THIS ENVIRONMENT

EXAMPLE :



This would indicate that for the Respondent:

In the Grouped and Bounded Environment, Lounge with chairs is important (✓).

In The Individualized and Bounded Environment, Lounge with chairs is very important (✓✓).

In The Workplace Environment, Lounge with chairs needs further explanation (?).

In the Personalized and Open Environment, Lounge with chairs is very incompatible (XX)

EXPERTS FORM

IMPORTANCE FACTOR

LEGEND: ✓✓ VERY IMPORTANT TO THE LEARNING ENVIRONMENT
✓ IMPORTANT TO THE LEARNING ENVIRONMENT
0 NEUTRAL TO THE LEARNING ENVIRONMENT
X INCOMPATIBLE WITH THE LEARNING ENVIRONMENT
XX VERY INCOMPATIBLE WITH THE LEARNING ENVIRONMENT
? NEED MORE INFORMATION ON THIS COMPONENT IN THIS ENVIRONMENT

COMPONENTS OF INSTRUCTIONAL DELIVERY SYSTEMS	ALTERNATIVE LEARNING ENVIRONMENTS			
	GROUPED AND BOUNDED	INDIVIDUALIZED AND BOUNDED	WORKPLACE	PERSONALIZED AND OPEN
1. GOALS				
Prepare for Employment				
Personal Enrichment Unrelated to Work				
Prepare for University				
Certification in a Special Field				
No Particular Goal				
Make New Friends				
2. TIME CONSTRAINT				
None				
3 - 6 Months				
7 Months - 1 Year				
1 Year - 2 Years				
2 - 4 Years				
3. SCHEDULING				
Once Every Week				
2 - 3 Times Per Week				
2 Week Intensive Workshop Several Times a Year				
Weekends				
4. SCHEDULING				
Mornings Only				
Afternoons Only				
Evenings Only				
Anytime				

ALTERNATIVE LEARNING ENVIRONMENTS

COMPONENTS OF INSTRUCTIONAL DELIVERY SYSTEMS	GROUPED AND BOUNDED	INDIVIDUALIZED AND BOUNDED	WORKPLACE	PERSONALIZED AND OPEN
5. SETTING				
Traditional Classroom				
Small Group				
Learning Labs (Video Cassettes, Audio Cassettes, Books, Films, Computers, Human Personnel)				
Work at Home				
6. FORMAT				
Courses with Regular Student Body				
Separate Courses for Mature Students Only				
An Independent Course of Study Designed for Each Mature Student				
7. CONTENT STRUCTURE				
Programmed Instruction				
Outline of Lessons in Point Form				
Study Guide				
Discussions				
Library Research				
8. FEEDBACK MODE				
Self-Scoring Tests				
Teacher-Scored Tests				
Peer-Scored Tests				
Personal Discussion with Teacher				
Machine Scored Tests				
9. CONTENT - Study Skills				
Improve Reading Skills				
Improve Math Skills				
How to Take a Test				
Writing a Term Paper				
Using a Library				
10. CONTENT - Non-Academic				
Career Information				
Self-Discovery				
French Language				
Leisure & Cultural Activities				
Life Skills (Family Law, Rent Control, Etc.)				
English Language				

ALTERNATIVE LEARNING ENVIRONMENTS

COMPONENTS OF INSTRUCTIONAL DELIVERY SYSTEMS	GROUPED AND BOUNDED	INDIVIDUALIZED AND BOUNDED	WORKPLACE	PERSONALIZED AND OPEN
11. MEDIA				
Direct Teacher Contact				
Broadcast T.V. Lessons				
Radio Lessons				
Audio Cassette Lessons				
Slides with Sound				
Films				
Correspondence Lessons				
Computer Lessons				
Printed Materials (Books, Magazines, etc.)				
Video Cassette Lessons				
12. LEARNING MODE				
Group Discussion				
Lectures				
Indepedent Study				
Presenting a Seminar				
Group Project				
Correspondence Course				
13. LOCATION				
CEGEP/College Building				
Home				
University Building				
Learning Labs (T.V., Radio, Tapes, Printed Materials, Computer)				
Industrial Training Facility				
Local Neighbourhood Centre ("Y", Church ...)				
Management & Sales Training Facility				

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