DOCUMENT RESUME

ED 129 891 TM 005 709

AUTHOR	O'Reilly, Robert; Farland, Parnell
TITLE	Paradigm for Evaluation in the High School. Final Report.
SPONS AGENCY	Ontario Dept. of Education, Toronto.
PUB DATE	Apr 74
NOTE	120p.
EDRS PRICE	MF-$0.83 HC-$6.01 Plus Postage.
DESCRIPTORS	Academic Achievement; Academic Aptitude; Achievement Tests; Administrator Role; Aptitude Tests; Attitude Tests; Biographical Inventories; Classroom Environment; Correlation; Data Collection; Educational Administration; Educational Objectives; *Evaluation; Formative Evaluation; High Schools; High School Students; *Management; *Models; Program Evaluation; Questionnaires; *School Supervision; *Secondary Education; Secondary School Mathematics; Standardized Tests; Statistical Analysis; Student Attitudes; Student Characteristics; Summative Evaluation; *Superintendent Role; Teacher Workshops; Teaching Methods
IDENTIFIERS	Biographical Inventory; Bloom Strategy for Mastery Learning; Learning Environment Inventory; Ontario; School and College Ability Test Series II; Stanford Achievement Test High School Battery

ABSTRACT

A model for educational supervisors which attempts to link management theory to learning is demonstrated. With teachers today having greater autonomy in selecting appropriate content and methods, supervisors should focus on two tasks: they should become more involved with teachers in selecting goals and become more adept in monitoring the development of pupils. Selected characteristics of pupils and classrooms, indicators of classroom environment, and measures of achievement and attitudes of over 1,100 students in grades nine and ten mathematics classes were collected. Results indicated some areas for supervisory action. Overall achievement of students was strongly related to student characteristics, indicating that schools do little to equalize the various advantages of children or to assist individuals to achieve a high level of competence. Second, classroom environments, as measured by Walberg's Learning Environment Inventory, were also directly related to achievement. If climate, influenced both by teachers and pupils, is related to achievement, teaching method, as identified in this study, is not. Attitudes of students toward mathematics was not related to any other variable selected for the study. There was evidence to suggest that such attitudinal goals were largely ignored by teachers of mathematics. (RC)

ED129891

UNIVERSITY OF OTTAWA

PARADIGM FOR EVALUATION IN THE HIGH SCHOOL

FINAL REPORT

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Principal Investigator

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ABSTRACT

The purpose of this paper is to demonstrate a model for educational supervisors. The model attempts to link management theory to learning.

Given that teachers today have greater autonomy in selecting appropriate content and methods, it is suggested that the supervisor's role focus on two tasks. Supervisors should become more involved with teachers in setting goals; supervisors must become more adept in monitoring the development of pupils.

The paper reports on one approach to monitoring achievement. Selected characteristics of pupils and classrooms, indicators of classroom environment, and measures of achievement and attitudes of over 1100 students in grades 9 and 10 mathematics classes were collected.

The results in this example indicated some areas for supervisory action. Overall achievement of students is strongly related to student characteristics, indicating that schools do little to equalize the various advantages of children or to assist individuals to achieve a high level of competence. Second, classroom environments, as measured by Walberg's Learning Environment Inventory, are also directly related to achievement. This is related to

Likert's theory that organizational climate itself is an intervening variable which predicts later achievement in production.

If climate, influenced both by teacher and pupils, is related to achievement, teaching method, as identified in this study, is not.

Attitudes of the students toward mathematics, as measured by scales produced for the International Study of Achievement in Mathematics, was not related to any other variable selected for the study. Although there may be some reason to doubt the validity of these scales, there is evidence in this study to suggest that such attitudinal goals are largely ignored by teachers of mathematics.

ACKNOWLEDGMENTS

This project was made possible by a grant-in aid to educational research by the Ontario Ministry of Education. Considerable support was also given to the project by the Faculty of Education of the University of Ottawa.

Our gratitude is extended to our associate investigators. Patrick Babin was especially responsible for the "goals" portion of the workshops and he directed the production of the synchronized slide-cassette presentation. Harry Pullen managed much of the leg work of the project and was always a most pragmatic advisor. He also served as manager for several crucial months in the Principal Investigator's absence.

We also express our thanks to the research assistants who assisted from time to time. Marcel Bonneau, Joe Dias and Lloyd Ambler worked along with us in every phase during the first year. Lloyd was responsible for our biographical inventory questionnaires. Lewis Fu and Mark Rosen saw to the computer programming and debugging operations. John Begg assisted in the collection of the data. Sashi Bali assisted in the post-boc analyses.

We wish to thank those administrators, department heads, teachers and students who not only participated in this

study, but also made us welcome everywhere.

Finally, we wish to thank a group of educators who reviewed our work and advised us on it at one point or another.

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THE PROBLEM

I. INTRODUCTION

A major characteristic of modern Western societies is the sweeping change in the field of education. Public education has emerged as one of the largest items of national expenditure. Teachers are expected to be university-trained and to possess a variety of sophisticated skills. The managers and administrators of this enterprise must have the expertise to manage such a series of institutions which encompass up to one third of the total population either as employees or clients.

In spite of the importance of public education an effective system of evaluation has not yet been developed. This statement does not imply that education and educators have not been evaluated. They have been and they are today. The problem lies in the lack of systematic knowledge of the links between the various components of the technology (means) of education and its goals. Furthermore, educators, especially those closest to the pupil, have been reluctant to specify their goals with any degree of clarity and specificity.

On the other hand, educators are fond of saying that education is change. This makes the educator an agent of change. If the purpose of education is to bring about change in the learner (in the form of growth, development, maturity, new knowledge, attitudes or skills) then educators strive to bring about desired changes. Thus the teacher must assume that his efforts will lead to changes that are predictable, i.e. that he has definite goals which are achieved when the pupil exhibits the desired new behavior.

Extended professional training of teachers and increased levels of inservice training are oriented not so much toward instructing the teacher in what he should teach, but more in understanding the pupil, his learning processes, and how to guide these processes so that they result in the desired ends.

Clearly, today's professional teacher is expected to be able to state his expected outcomes, and to stucture his strategies to obtain them.

These statements hold true with any teaching method. The teacher may use a traditional expository method, or, in the case of the open school educator, manipulate the environment so that the child may freely learn. Both have some ends in view.

II. STATEMENT OF THE PROBLEM

This project was based on the model of action research. It was aimed at applying theoretical models to real life problems in functioning educational organizations.

The problem of the project was concerned with the changing role of educational supervisors from that of inspectors of standardized educational programs to that of monitors and evaluators of flexible curricula. It was designed to provide administrators who are in charge of instructional programs with a generalized model of supervision and evaluation which focused on the development of educational programs. In other words, it was designed to utilize a model of educational programs which demonstrated the location and impact of supervisory activity along with operational examples of data gathering techniques necessary for establishing an effective monitoring system.

Since a major activity of the instructional supervisor centers around improving the learning environment of classrooms, the study focused on a well-developed model of classroom management, the Mastery Learning Model.

III. THEORETICAL FRAMEWORK

Management of Education

In general terms, the task of management is to integrate human effort, resources and facilities toward common goals. The responsibility of management with respect to goals is related to the statement of goals, the coordination of effort toward these goals, the monitoring of effort (supervision) to see that activity is actually leading to the accomplishment of goals, and the assessment of the results in the light of the stated goals.

The above functions must be carried out in every effective organization. However, the ways in which they are carried out will vary from one organization to another. For instance, the manager does not necessarily define the goals, but he has the responsibility to see that such goals do exist.

Another important fact is that goals are never fixed. Organizations can alter them at any time. In fact, it is often as a result of the monitoring process that the need to change the goals is discovered.

It was long ago discovered that a bureaucratic-industrial model of management was not effective for schools. Thus, specific objectives and prescribed curricula mandated by a Department of Education, followed by inspectoral visits of classroom activity culminating in departmental examinations were gradually abolished in Canada during the 1960's. The standard curriculum did not allow sufficient flexibility to meet local needs and the needs of individual learners in specific classroom contexts; departmental examinations were not adequate measures of the goals which local schools, in the task of coping with local conditions, were attempting to achieve.

The recent past has seen the educational community striving to build a new and effective programme of educational management. Major units such as the Ministry of Education and regional school boards have devised general goals which are amenable to interpretation by schools and teachers. Within these general policies, the teacher may select a number of specific objectives to meet local needs.

At the present time, teachers in many jurisdictions are struggling with the task of developing specific objectives that will be suitable for the pupils under their care and at the same time conform to the policy and philosophy of superordinate units. This is a difficult task and progress is slow. Few schools today have an adequate set of suitable and useful objectives. Teachers attending workshops dealing with objectives often report that the task is difficult, challenging, and frustrating.

As teachers define their objectives, they can analyze their teaching methods to see if they are appropriate, and study the achievement of pupils to see if the objectives are obtained. This can be followed by a period of adjustment of goals and of teaching strategies until aims, programs and results are in harmony. Only then will meaningful managerial evaluation of programs be possible, and the allocation of resources be rational.

A problem faced by many educational supervisors is the lack of a suitable monitoring system. No manager can succeed in a field as complex as the field as education without one. By monitoring system we mean a system of inspection, review and information relative to the starting point of pupils, the programs, the progress toward goals, the achievement of goals, and the needs of the community. More specifically, with reference to the instructional program, the educational manager (or managerial team which could be composed of teachers organized in a collegial relationship) must have access to current and reliable information concerning antecedents of learning (ability, attitudes, background of the pupil); processes (learning experiences, pupil-teacher interaction, curricula, social climate, leadership); and outcomes (results of the learning process, achievements, new attitudes, abilities and understandings, as well as "side effects"). This calls for an efficient information system. It is safe to say that no complete, generalizable information system for an educational system has yet been devised. A highly developed system of evaluation for the purposes of educational management is required.

In order to implement an efficient information system, educational managers need a conceptual model for understanding educational programs. Such a model should organize variables into a logical system, guide data-gathering activities, and provide educational managers with information relative to areas of supervisory activities which would be expected to have an impact on learning.

Model of Educational Programs

One common conceptualization of educational programs is the input-process - output model (Stake, 1967; Astin and Panos, 1971). The research reported in this paper utilized Walberg's Model (1970) which is an attempt to use the input-output formulation for research and evaluation on instruction. Walberg's model is based on the following equation:

$$L = f\ (I, A, E)$$

where
L = learning
I = instruction
A = aptitudes
E = environment

Aptitudes refer to talents, skills, aspirations, and potentials for growth and learning that the student brings into the educational program. These input characteristics of students may affect output directly since performance tends to be stable over time, or student input characteristics may affect outputs indirectly by influencing and/or interacting with educational transactions or operations.

The most general academic aptitude, measured intelligence, typically accounts for about 50 percent of the variance in school achievement. Measures of the home environment usually account for about 65 percent of the variance in standardized tests and about 60 percent of the variance in intelligence (Wolf, 1964; Dave, 1963).

Two elements of Walberg's model, instruction and environment, occur at the process level in educational programs. These process variables include all the contextual variables that characterize an educational program. The various educational process variables have direct effects on output. Recent research has demonstrated that environments of secondary school physics classes account for from 10 to 37 percent after various aptitudes are partialled out (Walberg, 1969).

Thus, there appears to be little variance in learning left to be accounted for by instructional variables after considering the effects of aptitudes and classroom environment during instruction. This provides a possible explanation for the general finding that different instructional strategies do not differ from one another in their effects on students (Stephens, 1968).

The third component of the model, outcomes or learning in Walberg's Model, refers to the objectives or ends of instructional programs: students' achievements, knowledge, skills, aptitude for future learning, values, and other behaviors that are influenced by an educational program. Implicit in the model, is the idea that any analysis of educational programs should include not only the goals of the program, but also an evaluation of its "side effects". A program may have strong positive effects on some areas of learning and negative effects on other areas.

The conceptualization of educational programs in terms of inputs, processes, and outputs, and the results of research relative to this formulation have important implications for educational supervision and evaluation. Since the educational decision-maker can do little to change input characteristics of students which affect output variables, the educator is primarily interested in the relationship between processes and outputs. The problem is to select educational processes which maximize student performance on outcomes. Knowledge regarding the process variables which have a significant influence on output variables is necessary if supervisors are to focus their efforts on areas which have a substantial influence on student learning. Thus, research which is directed at determining the relative effect of different process variables (environmental and instructional) is required in order to provide direction for educational decision-makers and supervisors.

In this project, the Mastery Learning Model (Bloom, 1968) was used to operationalize instruction and the Learning Environment Inventory was used as an operationalization of environmental variables.

The next sections discuss classroom environments and the instructional model.

Classroom Environments

It has long been recognized that the effectiveness of groups is influenced by the psychological climate which permeates. This is the "tone" or "feel" one can sense after meeting with a group or visiting an institution. The performance of groups was related to the group climate in the early set of studies at the University of Ohio (Hemphill and Westie, 1950), and more recently by Likert (1967).

The field of educational research has also been concerned with this dimension. Some studies have attempted to link the organizational climate of schools (Halpin, 1966) to a variety of administration and teaching variables. More directly, a variety of environmental concepts have been developed which appear to influence learning. From the early work of H. H. Anderson (1946) and associates to the more recent research of Pace and Stern (1958), Walberg and Anderson (1968) and Anderson (1969) it has been shown that the psychological climate of the classroom is related to student learning.

The measure selected for this study was the Learning Environment Inventory (LEI) developed by Walberg and Anderson for the evaluation of the Harvard Project Physics (Welch, 1969). The LEI was patterned by Walberg on Hemphill's (1956) Group Dimensions Description Questionnaire, an instrument which tapped 14 group characteristics. This instrument was one of the early tools of the Ohio leadership study group which conducted one of the most extensive factor analytic studies of small adult groups. The scales of the LEI were subjected to a number of content, item and factor analysis tests and were subsequently revised. (Anderson, 1970; Walberg, 1971). The final version was prepared by Anderson (1971) who added a fifteenth scale. The scale is fully described in Chapter II.

The early versions of the LEI were found to be related to student learning in the Harvard Project Physics evaluation studies, as mentioned above. What is of greater interest, is the fact that the scales also discriminated between teaching methods. That method does influence climate has long been reported in the research literature (H. H. Anderson, and Brewer, 1946). With respect to the LEI, Anderson, Walberg and Welch (1969) found that the overall climate of classes using the Harvard Project Physics materials was different from that of the classes using other instructional materials. It should be noted that the teachers using the experimental materials had received special summer training. As the investigators had predicted, there were differences between the two groups on the two scales specifically designed to evaluate the experimental program; students in the experimental classes rated their classes as significantly lower in Difficulty and higher on the Diversity scale.

The study of learning environments is important not only because such environments are related to learning. Researchers have long ago learned once a change has been introduced and long before there are specific outcomes stated as ends, there are changes in the perceptions of the organizational members. This has been demonstrated in a variety of organizational settings by Likert (1967). He indicated that changing managerial patterns are first reflected in the attitudes of employees, and that such evidence is an important indicator to the manager. Moreover, these changes in attitudes will have a definite pay-off within a predictable period of time in terms of higher profits, less waste and lower turn-over. Similarly, such data in schools should be examined to judge the progress of a program, for changes in the perceptions of the environment will show up later in terms of student learning and student attitudes.

Objectives and Learning

Learning is a process of growth and development. The purpose of education is to direct such development toward desired goals. It follows then that clearly defined goals should be an important segment of the instructional process. Curriculum specialists since Tyler (1949) have made goals the primary element of their curriculum models. More recently there has been considerable emphasis in the educational literature on behavioral objectives (Mager, 1962). Whereas most educators seem to agree with this point of view, there have been some who have questioned the value of behavioral objectives. Eisner (1967) points out that whatever the logical arguments in favor of behavioral objectives, there has been little or no research of their value in learning. This study did not limit itself to a study of behavioral objectives, but is concerned with any objective which is clearly stated and understood by those concerned.

The term objectives have been given many meanings. For the moment let us define them generally as "those things we want students to know, to perform and to appreciate". Whereas all teachers do have some goals for their teaching, they are often the informal, unstated, intuitive, unexamined goals. As such they often have little impact on the academic achievement of students. In other words, the goals, not being formally studied, are not always logically related to classroom procedures, student activities and evaluation. Two research examples demonstrate the problem.

Popham (1971) compared the learning of two groups of high school classes. One group was taught by their regular, certified, experienced teachers. The others were taught by a group of university students who had never taught before and who had received no instruction in methods of teaching. Each group was instructed to give a series of classes to a number of matched social studies high school classes. At the end of the experiment, it was found that the experienced teachers did not appear to be more efficacious than the university students. The experimenter, a noted authority in the field of educational evaluation, concluded that the teachers did not show superior teaching results because they were not accustomed to using "criterion-referenced" teaching techniques, i.e. basing teaching on established objectives.

A study recently completed at the University of Ottawa by Connelly (1972) is also enlightening. A sample of grade twelve teachers from secondary schools in Ottawa indicated that although there was wide agreement by teachers on a large number of possible and suitable objectives for their courses, the teachers reported that they evaluated only a small number of these, and most of these were at relatively low cognitive levels. His study is all the more striking, since he asked teachers to report not only those objectives evaluated in formal testing situations, but also those objectives evaluated in informal, casual ways.

Bloom (1971) recommends that, in addition to establishing a set of over-all goals or intents, each teacher specify a set of outcomes for each unit of his course. Such a unit would be covered in a period of two or three weeks. These objectives would be made known to the students; possibly these objectives could be discussed with students and consequently modified.

The research on this method of providing objectives to students is mixed. Duchastel and Merrill (1973), in reviewing a series of studies on the topic, concluded that providing objectives to the student does aid learning in some cases and does not cause any harm.

Carroll hypotheses. Objectives are important to the processes of education, teaching and learning. However, identifying them does not automatically lead to improved performance in our current academic institutions. Some scholars would link that process with three other elements in the teaching and learning processes: (1) expectations (2) the nature of scholastic aptitude and (3) student control over learning. Each of these in turn is linked to the Carroll hypotheses (Carroll, 1963).

John Carroll, a noted Harvard psychologist, rejects the notion that scholastic aptitude is an innate, predetermined ability to learn. Such a concept consigns half our population to "below average" levels of achievement automatically. He defines aptitude as a function of the amount of time required by the learner to attain mastery of a learning task under ideal learning conditions. The acceptance of this definition means we must revise our expectation that a given proportion of each class must fail. They will fail if, and only if, they are constrained to one rigid time-table. Under present conditions the correlation between aptitude scores and achievement scores are usually about +.70. This correlation can be reduced to almost zero if varying learning methods and variable amounts of time were available so that up to 95% of all secondary students could achieve mastery. The review of empirical studies by Duchastel and Merrill (1973, p.62) indicates that when students can control the amount of time they spend learning in addition to knowing the objectives, learning is greatly enhanced. Paradoxically, learner control also greatly reduces the learner time required.

Formative evaluation. Evaluation should be linked to goals. Traditional evaluation in school has emphasized the competitive nature of our social system in that students are ranked, compared to "national" norms, or located at some

TABLE I

FORMATIVE AND SUMMATIVE EVALUATION

SUMMATIVE EVALUATION	FORMATIVE EVALUATION
Formal evaluation techniques.	Informal evaluation techniques.
Aimed at student assessment at the end of a course or topic when no subsequent changes in treatment for that learning will be made.	Aimed at evaluation of student's learning during a course when changes can be made in the strategy of subsequent instruction on the basis of current attainment.
Samples a relatively large block of content.	Samples a relatively small block of content.
Concern of the administrator.	Concern of the teacher.
Provide information to the administrator regarding the success of students.	Provide information to teachers and learners regarding the success of the instructional program.
Focus on the group.	Focus on the individual.
Norm-referenced (interpreted in terms of a reference group; concerned with the competency level of the individual relative to a <u>group</u> of students with similar characteristics).	Criterion-referenced (interpreted in terms of absolute criterion scores; concerned with the competency level of the individual relative to some <u>standard</u>).
Description of the distribution of test scores on the total test.	Analysis of accuracy of item responses.
Descriptive (results used to describe and evaluate students, usually for administrative purposes).	Prescriptive (results used to diagnose weaknesses and strengths of individual students).
Used as part of the grading process.	Used as part of the teaching-learning process.

percentile rank on a normal curve. Thus in education we casually place students in a massive zero-sum game where only one or a select few can win.

Formative evaluation is Stake's (1967) term to designate that form of evaluation which indicates if desired goals are achieved. It is criterion-referenced rather than norm-referenced. The standards indicate accomplishment of goals rather than surpassing others. Thus, teachers can share with students the identification of evidence which indicates mastery.

Carried to its logical conclusion, Bloom (1971) states that formative tests should not be assigned a grade. Students should not be "graded" as they learn: they need to know when they have indeed mastered an objective.

Consequently, effective instruction should include frequent testing to guage progress toward a goal and to indicate changes in the learning process.

The experience of the University of Chicago group with Bloom (1971, ch. 3) indicate that class performance is little affected by formative evaluation alone. After each test, there must be follow-up or remedial work. In one small study, a group of students received a great deal of such direction and they were assisted by non-specialists, often their parents. This group achieved well and the correlation between their aptitude and their achievement was greatly reduced while that of a comparison group was .95 (Bloom, 1971).

Summative evaluation. Educators must evaluate to make administrative decisions which are distinct from the decisions teachers make in the student-learning process. Superintendents must conduct system-wide analyses; counsellors must guide students; boards must grant diplomas. Such formal evaluation does not imply any immediate change in the pupil's programme. These are end-of-year or end-of-program assessments. The evaluator rather than the teacher usually is responsible for this assessment.

There are 5 purposes of goals in the learning process: (1) goals provide direction; (2) goals provide organisation to the subject matter; (3) goals serve as a management guide in the proper use of student time; (4) accomplishment of intermediate goals serve as rewards, and reinforce motivation; (5) results of testing intermediate goals indicate re-structuring of the learning process to favor achievement of goals.

Learning theory and management theory. Likert's (1967) theory of management is similar to that of the teaching model suggested above. He insists that goals be high goals; that they be shared; that employees be free to determined the best way to achieve goals; that employees be given freedom to organize their time; and that wages be tied to the accom shment of objectives.

Mastery Learning Model

The elements of the Mastery Learning Model (MLM) have been suggested above. The model was introduced by Bloom (1968). It consists of the following parts:

1. Organisation of the course into manageable blocks which require two to three weeks of teaching time, e.g. a chapter of a text.

2. Establish suitable criterion-referenced goals for the unit. They often will be communicated to the students.

3. Provide frequent formative tests. Do not use these test results to calculate grades. These tests should be a means of frequent feedback.

4. Provide remedial work, supplementary materials, tutorial assistance, or other alternative learning modes for those students whose tests results do not indicate mastery.

IV. CONCLUSION

The superintendent's role is that of the educational manager. As such he requires a set of goals, an information system which monitors not only the achievement of those goals but also of key variables which influence the accomplishment of these goals. These variables include a set of variables which he cannot control but which are important, e.g. the parents' educational background and aspirations, the pupils' aptitudes. There are also variables over which educators either control or partially influence, e.g. selection of instructional goals, instructional strategies and classroom climates.

The mastery learning model is only an example of an instructional strategy but its elements should be found in all the definitions of valid educational technologies.

The teacher working with students similarly requires a set of instructional goals and a monitoring system. As is the case with all efficient monitoring systems, the information should be used to alter the teaching and learning strategies to lead to effective accomplishment of goals.

The teacher does not work in a sterile climate. He influences and is influenced by the psychological climate of the classroom, which in turn is strongly related to student outcomes of cognitive learning and of attitudes.

This climate is influenced by social values, norms, and the personalities of the individuals involved; it is also influenced by teaching method (H. H. Anderson; Logan).

The following chapters detail some attempts to verify the arguments posited in this chapter and also demonstrate a method and process for evaluation of secondary school programs.

CHAPTER II

PROCEDURES AND DESIGN

I. INTRODUCTION

The purpose of this chapter is to outline the procedures used in our attempts to verify the linkages among the variables defined in the first chapter.

The second part describes the research scales and instruments used in this study to operationalize our concepts.

The third part reviews the procedures we used to select the sample, collect the data and to describe the workshops. These were designed to review with teachers the role and nature of objectives in teaching and to acquaint them with the Mastery Learning Model. In this section the sample is described.

Limitations of the Study

Two limits of the study should be noted at this point. The first is that there is some difficulty in determining the instructional strategy of teachers in a study such as this. There was no extensive training for teachers; no observational techniques were attempted. Thus any attempt to compare instructional strategies will be difficult as there will be little evidence that the two groups are indeed different.

The second limitation is also serious. When this study was begun, the intention was to use as an outcome variable a test specifically designed to measure the achievement of mathematics of students in Ontario secondary schools. Although such a test was in the development stage, it was not available for use at the time of this study. Consequently, the Stanford Achievement Test (SAT) was used. A description of the SAT is given below..

II. RESEARCH INSTRUMENTS

The plan for gathering data was developed from the input-process-output model of educational programs. Input characteristics of students were measured by means of the School and College Ability Test (SCAT) Series II, a measure of academic aptitude, and a Biographical Inventory which measured family educational background, dislike for schooling, and career plans. The process variables were indexed by means of the Learning Environment Inventory, a measure of the social environment of school classes, and the Mathematics Class Inventory, a question-naire which was designed to obtain students' perception regarding use of the Mastery Learning Model in their mathematics classes. The output variables were measured by means of the Stanford Achievement Test, Mathematics-Part A, a measure of cognitive achievement in Mathematics, and the School Mathematics Inventory, a questionnaire used in the International Study of Achievement in Mathematics (Husén, 1967) to measure attitudes toward mathematics. A detailed description of each of the above is presented in what follows.

School and College Ability Test (SCAT) Series II.

The SCAT Series II is designed to measure verbal and mathematical ability. The test yields three scores: a Verbal score, a Mathematical score, and a Total score based on a combination of the Verbal and Mathematical scores. The Kuder-Richardson Formula 20, used to estimate the reliability coeficients for Form 2A and Form 3A, range from .87 to .94. For purposes of analysis, each of the three saw scores were changed to converted scores and the latter were used in all statistical analyses.

The validity of the SCAT Series II for predicting academic performance has been demonstrated in a number of studies. The SCAT Series II scores were correlated with the Verbal and Mathematical scores on the Scholastic Aptitude Test of the College Entrance Examination Board; the resulting correlations based on 244 individuals, between the Verbal and Mathematical scores for the two tests were .83 and .86 respectively.

Biographical Inventory (BI)

Following the work of Walberg (1970), the project team developed a fourteen item inventory to collect the following data: sex, age, parents' education, the student's attitude toward school in general and to mathematics in particular, the student's willingness to discuss future career plans with the guidance counsellor or other adults, previous achievements and future plans.

Data from the BI were factor analyzed and three factors were extracted. The first factor dealt with home background and consisted of items dealing with the education of the father and mother. The second factor was identified as dislike for schooling. This factor consisted of items measuring the time spent on homework, the time spent with peer groups, liking for school and liking for mathematics. A high score on this factor indicates a dislike for school, little time spent on homework and a great deal of time spent with peer groups. The third factor is labeled future planning. This indicates that the student has discussed various career possibilities with adults. The factor structure is shown in Table II.

Although there are no reliability or validity data for these items, they are simple direct questions which have been used successfully in many studies. The factor

TABLE II

FACTOR LOADINGS FOR THE BIOGRAPHICAL INVENTORY BASED ON A QUARTIMAX ROTATION

Items	Factor I	Factor II	Factor III	h^2
113. Father's education	.88	-.09	-.05	.78
114. Mother's education	.88	-.06	.01	.77
119. Time spent with gang	.08	.55	.11	.32
120. Time spent on homework	.15	-.55	.16	.35
124. Like mathematics class	.03	.71	-.13	.52
121. Like School	.05	.59	.11	.36
122. Discuss career plans ...with counsellor	-.04	.12	.81	.67
123. ...with other adults	-.00	.14	.83	.71
Eigenvalues	1.57	1.49	1.41	

N = 560

structure is based on a large enough population to warrant confidence in its use.

Learning Environment Inventory (LEI)

This instrument was designed to measure the psychological climate of a class as perceived by the pupils within it. The final version contains 105 statements describing typical school classes. Each student expresses his agreement or disagreement with each statement on a four point scale.

Most of the items were based on the Group Dimensions Description Questionnaire of Hemphill, (Hemphill and Westie, 1950). The original authors added two scales to evaluate the Harvard Project Physics (HPP) courses: Difficulty and Diversity. The fifteen scales of the LEI are defined on Table III.

The instrument has proved to be useful to the HPP team and in subsequent studies in a wide variety of subject areas with diverse populations of students. Several reliability scores are available. For individual respondents, the Alpha scores for each scale range from .53 to .82. (Anderson and Walberg, 1972). Test re-test correlations for each scale range from .43 to .73 (ibid.). For classes, the intraclass correlations range from .31 to .92.

TABLE III

LEARNING ENVIRONMENT INVENTORY SCALES

1. Cohesiveness: The feeling of intimacy that has developed as a result of several individuals interacting over a period of time.

2. Diversity: The extent to which the class provides for a diversity of pupil interests and activities.

3. Formality: The extent to which behavior within the class is guided by formal rules.

4. Speed: The rate of progress of the class.

5. Environment: The physical environment, including the amount of space available and the type of recreational equipment.

6. Friction: The extent to which conflict may affect the behavior of the class.

7. Goal Direction: The recognition of goals and their subsequent acceptance by the group.

8. Favouritism: The extent to which pupils possess a low academic self-concept.

9. Cliqueness: Aims at revealing the extent to which cliqueness exists in a classroom and its influences on social interaction.

10. Satisfaction: The extent to which students like or dislike their class.

11. Disorganization: The extent to which students consider their class to be disorganized.

12. Difficulty: The relative perceived difficulty levels of various courses.

13. Apathy: Complements the cohesiveness scale, but also indicates if individuals within the class feel any affinity with class activities.

14. Democratic: Indicates the extent to which a "democratic" atmosphere exists within a classroom.

15. Competitiveness: The degree of competitiveness existing within the class.

The main comparative study of HPP (Anderson and Walberg, 1972b) contrasted randomly assigned groups for a true experiment and the results of the LEI scores were as predicted, in that the HPP classes are perceived as less difficult and the activities more diverse. Other analyses of the data revealed that the HPP was seen as providing a more stimulating environment, less cliquishness and friction among class members, more democratic and cohesive behavior than other classes. (Anderson, Walberg and Welch, 1969).

In other studies with the LEI, it was found that the LEI is sensitive to a variety of classroom climates which are associated with a variety of environmental, social and organizational factors, (Anderson and Walberg, 1972) as well as being linked to classroom learning (Anderson and Walberg, 1968). In their study, the IQ of students accounted for 16% of the variance in learning when the effects of pretest scores had been removed. The sum of all the LEI scales accounted for between 13% to 46% of the variance in learning, that is, considerably more than IQ alone.

Overall, the LEI can be considered as a reliable instrument for this study, and it has been demonstrated that it adequately accounts for social, environmental and climate factors in the classroom, and for student learning.

Mathematics Class Inventory.

The Mathematics Class Inventory was developed by the research team. It consisted of six questions which were concerned with the major variables of the Mastery Learning Model. It was designed for administration to students to provide the researchers with feedback data relative to the use of mastery learning techniques in both the experimental and control classes. It was felt that this information was necessary because many teachers use aspects of mastery learning in their teaching even though they do not have specific knowledge regarding the Model and these teachers could be working in the control classes. Also, it was necessary to have information regarding the impact of the use of the Mastery Learning Model in experimental classes from the point of view of students.

The inventory with the pupil responses in terms of percentages is given on pages 88-89 of this report.

STANFORD ACHIEVEMENT TEST (SAT): HIGH SCHOOL MATHEMATICS TEST FORM W - 1965

The need to select a general standardized achievement test was described in the INTRODUCTION to this chapter.

This test was developed in the early 60's during the "New Math" era and it does represent a measure of broad mathematical development.

The test is divided into Part A and Part B with 40 and 34 questions respectively. Part A is general in nature, and pertains mainly to Grades 8, 9 and 10, while Part B covers mainly the latter years of High School.

The breakdown in areas covered is as follows:

	No. of Items	%
Algebra......................	42	58.3
Geometry....................	15	20.6
Probability and Statistics...	4	5.5
Trigonometry................	2	2.75
Matrices and Determinants....	2	2.75
Vectors.....................	2	2.75
Arithmetic..................	2	2.75
Graphs......................	2	2.75

From this breakdown, the lack of sufficient examples in specific areas becomes apparent, and its validity then becomes a matter of sufficient content in specific areas.

The test is reviewed by Broswell and Wilson in Buros, Mental Measurements Yearbook, (Buros, 1972). Both authors claim that it is useful, but that its validity for specific mathematics programmes is doubtful. Wilson, states that it is more valid than most other available mathematics achievement tests.

Since the sample of students in this study was limited to first and second year students, Part A of the test was used. Raw scores were used for the statistical analyses.

SCHOOL MATHEMATICS INVENTORY

The School Mathematics Inventory measures the attitudes of students concerning the nature of Mathematics. This instrument was developed for the International Study of Achievement in Mathematics (Husén, 1967).

Each of the seven scales in the questionnaire was developed by postulating a continuum for each environmental and attitude variable. In the case of the scale concerned with mathematics teaching and learning, the continuum ranged from a teaching-learning situation which was directed at stimulating students by means of an inquiry approach to a mechanical, formalistic mode with emphasis on rote memorization. The scale dealing with the climate of the school and school learning ranged from an inquiry-oriented approach which was aimed at engaging students in a continuing process of discovery to an authoritarian, instructor-directed mode.

In addition to the two environment scales described above, the instrument contained five attitude scales which were concerned with student attitudes toward school, mathematics, or life. The five scales were as follows:

1. Attitudes toward Mathematics as a Process.
2. Attitudes about the Difficulties of Learning Mathematics.
3. Attitudes Toward the Place of Mathematics in Society.
4. Attitudes Toward School and School Learning.
5. Attitudes Toward Man and his Environment.

An underlying continuum was postulated in the development of each scale. The underlying continuum for attitudes toward mathematics as a process ranged from "a view that mathematics is a fixed, formal system governed by rigid and unchanging rules which a student had to master to a view that mathematics was a subject that was still in a process of development..." (Husén, 1967, Vol I, p.112). In the case of the scale dealing with attitudes toward difficulties of learning mathematics, the underlying continuum ranged from "a view that mathematics is a subject which could only be learned by an elitist few to a view that anyone can master mathematics" (Husén, 1967, Vol I, p.113). The continuum underlying the scale measuring attitudes toward the place of mathematics in society ranged from "a view that mathematics is neither essential to a nation's development nor useful in meeting the problems of everyday life, but rather a subject to be indulged in by a luxury class...(to) a view that mathematical knowledge and understanding is absolutely essential to a nation's development..." (Husén, 1967, Vol I, p.113). The scale measuring attitudes toward school and school learning was based on a continuum that ranged from "total dislike for school and a strong desire to leave school as soon as possible to a total enjoyment of all aspects of school life and a desire to obtain as much schooling as possible" (Husén, 1967, Vol I, p.113). The final scale, man and his environment, contrasted the view that "man is at the mercy of his environment and could only hope to secure some measure of adjustment to forces outside of himself, to a view that man could gain complete mastery of his physical and social environment and use it for his own purposes" (Husén, 1967, Vol I, p.113).

The procedures followed in the development of each scale involved writing a series of statements for each scale, screening items to delete ambiguous or complex statements, and rating the items relative to the overall continuum for each scale. The items were than assembled and administered to a trial population. These responses were analyzed using Guttman Scale Analysis procedures. This resulted in the elimination of a number of items. The coefficients of reproducibility obtained from the Guttman Scale Analysis ranged from .77 to .92.

For the purpose of the research reported in this paper, four scales were selected as indices of output variables. The four scales were Views about Mathematics Teaching, Attitudes Toward Mathematics as a Process, Attitudes about the Difficulties of Learning Mathematics, and Attitud Toward the Place of Mathematics in Society.

Publication of the Scale.

For this study, the researchers purchased the right to use the School Mathematics Inventory from the holders of the copyright, Almqvist and Wiksell, Stockholm. Since permission was not obtained to reproduce the Scale in this report, there is no copy in the Appendix. Readers will find a complete description of the scales in volume II of Husén (1967).

III. RESEARCH PROCEDURES AND SAMPLE

The nature of the project required the selection of a sample of schools, teacher involvement in a mathematics workshop, selection of experimental and control classes, and the administration of questionnaires and standardized tests to students. A description of these procedures is given in this section.

Selection of Schools.

In drawing up the sample for this study, there were the usual problems encountered in conducting large research and development projects in education.

It was decided to restrict the sample to secondary schools in Eastern Ontario where the language of instruction was English.

The sample of schools was selected from schools in four boards of education. The number of schools included in the sample from each board was proportional to the total number of schools under the jurisdiction of the board. The Ottawa Board of Education was represented by 6 schools, the Carleton Board of Education by 2 schools, the Renfrew Board of Education by 2 schools and the Lanark Board of Education was represented by 2 schools.

The sampling techniques used included both random and judgmental sampling. The six schools from the Ottawa Board were selected randomly. The method employed involved matching schools on the basis of a school index of general scholastic aptitude. Three matched pairs were randomly selected from this Board. The six schools from the remaining three boards were selected by means of judgmental techniques in consultation with the regional consultant of mathematics. An attempt was made to select two schools from each board which were equal in every respect, except for the possibility that one of these schools would not be able to participate in a mathematics workshop.

Since it was necessary to use judgmental techniques it is possible that some of the experimental schools were more innovative than the control schools. However, we were not able, either through casual observation or formal methods, to find any consistent differences between the two groups of schools.

Inservice Teacher Education: Workshops

The content of the workshops focused on the Mastery Learning Model with emphasis on using objectives and formative evaluation techniques. In this phase, workshop sessions were held with teachers of first and second year high school mathematics to demonstrate the establishment and utilization of objectives for the teaching of high school mathematics and to demonstrate the use of a number of formal or informal methods of formative evaluation. Source material for the objectives were the Ontario Ministry of Education objectives for the teaching of mathematics and various other sources which are compatible with the program guide published by the Ministry. The workshops were directed at general techniques rather than at specific content. Thus, the workshops did not place restraints on the flexibility of mathematics programs within schools.

The workshops were based on the following plan:

1. Presentation: "An Overview of the Mastery Learning Model".

2. Presentation: "Instructional Objectives"
   a) Rationale for using Instructional Objectives.
   b) Definitions of Instructional Objectives and the problem of specificity.
   c) The components of an Instructional Objective.
   d) The utilization of Instructional Objectives in teaching.

3. Work Session
   a) Examination of examples of Instructional Objectives and evaluation of the quality of these objectives.
   b) Discussion on the use of Instructional Objectives in the classroom.
   c) Examination of lists of objectives and selection of suitable objectives for courses.

4. Presentation: "Formative Evaluation".
   a) The mastery learning model.
   b) The nature of formative evaluation.
   c) Differences between formative and summative evaluation.
   d) The use of objectives for formative evaluation.
   e) Individualization.

5. Work Session
   a) Discussion and development of techniques for formative evaluation in the classroom.
   b) Determination of resources required by teachers during the year.

6. Establishment of Information Exchange
   a) Teachers were encouraged to develop Instructional Objectives and evaluation items and forward them to the Faculty of Education.

As the year progressed, teachers received materials which enabled them to evaluate their progress and the progress of their students.

A number of regional workshops were conducted. The time required for each workshop was eight hours. Four workshops were conducted during all-day sessions; in one case, a workshop was conducted in two half-day sessions. This phase of the project was carried out between October 15 and December 15, 1972.

At the end of the workshops, participating teachers were requested to evaluate the workshop using an instrument prepared on the basis of the content of the workshop. The reactions of the teachers to these workshops are reported in Appendix B.

In addition, in early October, the workshop procedures were tested out in a trial workshop. Teachers from Vankleek Hill High School, Seaway Valley High School and a group of French-speaking teachers from Hawkesbury High School participated.

Selection of Classrooms.

After the workshops had been conducted, the researchers solicited the cooperation of the teachers in the experimental schools to agree to use the model in at least one class during the following semester. From among this groups of volunteers, we selected four classes from each school. The final sample for the experimental group was 24 classes of mathematics: 12 at the grade 9 level and 12 at the grade 10 level. These groups were further equally subdivided into advanced academically-oriented classes and general or terminal classes. Once again, classes from the control schools were selected to match those of the experimental groups.

The total sample consisted to 48 classes and 1100 students. According to the estimates of knowledgeable judges and according to our data, there appeared to be no consistent differences between the two groups of classes.

Data Collection.

Questionnaires and tests were administered in two sittings with each of the 48 classes. One sitting involved the administration of the Stanford Achievement Test-Mathematics - Part A, and the SCAT-Series II, Form 2A in Grade 10 Classes, Form 3A in Grade 9 Classes. The Stanford was administered to 2/3 of the class while the SCAT was administered to the remaining one third. In the other sitting, the LEI and the Biographical Inventory were administered to one half of the class while the School Mathematics Inventory and the Mathematics Class Inventory were administered to the remainder of the class. Males and females were proportionally represented in each segment of data collection.

The order of administering sets of instruments in the two settings was alternated to eliminate order effects. This method of collecting data was consistent with procedures used by Anderson and was economical in terms of research effort.

IV. SUMMARY

The final sample consisted of approximately 1100 students from 48 grades 9 and 10 (or equivalent) mathematics classes selected from 12 schools. Six schools were randomly selected and the six others were selected by means of judgmental techniques in cooperation with local and regional officials who knew the respective mathematics departments well. Three of the randomly selected schools and three other schools were invited to participate in a 2-day workshop for teachers. The purpose of the workshop was to ensure that enough of the sample would consciously use goals in their teaching as well as those elements of good teaching found in the Mastery Learning Model. The classes of twenty-four teachers who indicated that they would use the model the following semester were selected as the experimental group. These were evenly divided between grades 9 and 10, and advanced and general classes. Within these strata, a control group was randomly selected from the remaining schools. The numbers of boys and girls were proportionately represented in each data collection phase.

Since we were concerned with the effects of climate on other variables, the classroom was the unit of analysis, and all comparisons of scores were based on the class average.

The data was collected from each class in two sittings during the month of May.

In one sitting, two-thirds of the students completed the Stanford Achievement Test-Part A (SAT) and the other third completed an I.Q. test School and College Ability Test, Series II (SCAT-II). In the other sitting half the class completed the Learning Environment Inventory (LEI) and the Biographical Inventory (BI) while the other half completed the School Mathematics Inventory (attitude scales) and the Mathematics Class Inventory, which was designed to elicit student perception of the use of the Mastery Learning Model by the teacher.

The class means were first intercorrelated and then subjected to more complex tests of multiple correlation, regression analysis and canonical analysis.

CHAPTER III

DATA ANALYSIS

In this chapter, a report of the analysis of data using the input-process-output model as the framework is presented along with interpretations and conclusions based on the analysis. Readers not familiar with the statistical methods employed will find some helpful notes in Appendix E.

I. RELATIONSHIPS IN THE MODEL

This section gives an overview of the relationships between the sets of variables in the INPUT-PROCESS-OUTPUT model.

Input and Output.

Within this model, the variables selected as input are beyond the control of the educator. They are conditions within which he must work. Two sets of input are used in this study: 1. verbal and mathematical scholastic aptitude; and 2. biographical indices (a) parent's education, (b) dislike for schooling, and (c) career planning. These are related to the output variables, namely achievement in mathematics and four selected attitudes. The attitudes, as defined earlier, are

(1) views about mathematics teaching (teachers are viewed as requiring mechanical, rote learning to encouraging inquiry methods); (2) views about mathematics as a process; (3) difficulties of learning mathematics (reverse scoring used); and (4) importance of mathematics in a modern society.

Table IV contains simple and multiple correlations between input characteristics (aptitude and biographical variables) and learning criteria. Six of the twenty-five simple correlations are significant. There are positive relationships between mathematics achievement and verbal aptitude, mathematics aptitude, parental education and a negative correlation between mathematics achievement and dislike for schooling. There are also positive relationships between attitudes toward the place of mathematics in society and verbal and mathematical aptitude. Thus, students who have strong verbal and mathematical aptitudes tend to have high mathematics achievement scores and tend to view mathematics as essential and necessary for the development of a nation.

Two multiple correlations were significant. The five input characteristics considered together produce a multiple R of .88, which indicates that 77 per cent of the variance in achievement can be accounted for by input variables. The five input variables also account for 24

TABLE IV

Correlations Between Biographical Characteristics and Scholastic Aptitude With Learning Criteria (N = 48)

	MATHEMATICS ACHIEVEMENT	MATHEMATICS ATTITUDE SCALES				
		VIEWS ABOUT MATH. TEACHING	ATTITUDES TOWARD MATH. AS A PROCESS	DIFFICULTIES OF LEARNING MATH.	PLACE OF MATH. IN SOCIETY	R
1. Verbal Aptitude	.62*	.15	.07	.17	.31*	.65*
2. Math. Aptitude	.86*	.24	.22	.19	.31*	.87*
3. Parental Education	.48*	.01	-.11	-.10	.08	.58*
4. Dislike for Schooling	-.41*	-.11	.11	-.19	-.06	.53*
5. Career Planning	-.26	-.22	-.22	-.08	-.22	.36
R	.88*	.32	.48*	.31	.38	

* $p < .05$

per cent of the variance in an attitude variable, attitudes toward mathematics as a process. Thus, the input variables are better predictors of cognitive than of non-cognitive learning criteria.

A closer examination causes us to consider the possibility of revising the classification of the attitude scales. The first scale appears to be more a perception of how the teacher conducts the class; thus it is more of a teaching style or process variable than an output variable. The remainder of the scales appear to tap attitudes which appear to be learned at school, and thus should not be related to input variables such as those selected for this study.

In addition to the simple and multiple correlations using the five input variables as predictors, Table IV contains five multiple correlations based on regressing the independent variables backwards on the dependent variables. This was designed to determine the significance of, and dependent variance accounted for by, each independent variable. Four of the five multiple correlations were significant. Once again, it is obvious that mathematics achievement is strongly related to the input variables.

Conclusion. Pundits thoughtlessly state that schools do not make a difference. Obviously children do learn a great deal at school. But the quality of their learning appears to be tied to their background. If input can account for so much of <u>the variance in learning</u>, then it indicates then schools must re-structure learning so that more children can achieve mastery and thus become somewhat more equal than when they begin school.

Secondly since input does not account for much of the variance in attitudes, it indicates that schools may be doing a more egalitarian job in this area.

<u>Learning Environment and Output</u>

The correlations between the fifteen environment variables and the five learning criteria are presented in Table V. The fifteen environment variables account for 68 per cent of the variance in mathematics achievement and for 56 percent of the variance in one attitude variable, Views About Mathematics Teaching. Thus, the environment variables are good predictors of only one of the four attitudes toward mathematics. As was indicated earlier, this particular attitude variable is more process than output. This scale may be measuring the same phenomena as the LEI.

The simple correlations between the environment scales and mathematics achievement indicate that cognitive achievement in mathematics is associated with an environment that is characterized by high scores on the Cohesiveness,

TABLE V

Correlations Between Learning Environment Inventory Scales and Learning Criteria (N=48)

ENVIRONMENT SCALES	MATHEMATICS ACHIEVEMENT	MATHEMATICS ATTITUDE SCALES				
		VIEWS ABOUT MATH. TEACHING	ATTITUDES TOWARD MATH. AS A PROCESS	ATTITUDES OF DIFFICULTIES OF LEARNING MATH.	ATTITUDE: PLACE OF MATH. IN SOCIETY	R
1. Cohesiveness	.30*	-.02	.23	.16	.15	.37
2. Diversity	-.23	.16	.14	-.02	-.18	.44
3. Formality	-.09	.15	.03	.03	.18	.28
4. Speed	.11	-.24	.16	-.19	.17	.52*
5. Environment	.32*	.24	.00	.30*	.19	.49*
6. Friction	-.59*	-.42*	-.01	-.10	-.19	.69*
7. Goal Direction	.19	.07	-.21	.12	.13	.38
8. Favoritism	-.44*	-.07	.07	-.17	-.06	.53*
9. Cliqueness	-.34*	.09	.08	-.15	-.10	.44
10. Satisfaction	.45*	.22	-.04	.26	.28	.58*
11. Disorganization	-.52*	-.23	-.01	-.21	-.28	.60*
12. Difficulty	.33*	-.10	.24	-.13	.06	.46*
13. Apathy	-.44*	-.16	.07	-.08	-.18	.50*
14. Democratic	.47*	.09	-.04	.14	.08	.60*
15. Competitiveness	.25	.12	.24	-.05	-.01	.36
R.	.82*	.75*	.60	.49	.62	

* $p < .05$

Environment, Satisfaction, Difficulty, and Democratic scales and low scores on the Friction, Favoritism, Cliqueness, Disorganization, and Apathy scales. Thus, the classroom environment that is associated with high cognitive achievement in mathematics is characterized by friendly, cooperative teacher-student interaction, an uncrowded room with adequate materials and books, students who enjoy the work of the class, a sharing of decision-making processes, an emphasis on treating everyone equally, along with well-organized classroom r dures.

The correlations obtained between the fifteen environment scales and mathematics achievement are similar to correlations reported by Walberg and Anderson (1972) based on eight class means. A comparison of the correlations obtained in the two studies indicates that the direction of the relationships is similar for all variables with the exception of Cliqueness.

This is the only study so far to report a significantly negative correlation between class means for mathematics achievement and Cliqueness. However, the theory underlying the scale as described by Anderson (1971) would suggest that our finding is plausible. In the study reported by Walberg and Anderson (1972), Cliqueness is not related to achievement in the physical sciences but is negatively related to achievement in some of the social science subjects. Further Cliqueness is significantly related (r = -.30) to total achievement, and the correlation remains significant when the effects of IQ are partialled out (r = -.26). Thus, in general, we can conclude that Cliqueness is negatively related to class achievement. Walberg and Anderson reported four significant relationships between cognitive achievement in Mathematics and the L.E.I. scales; they reported significant positive relationships between Mathematics Achievement and Environment and Competitiveness, and significant negative relationships between achievement and Friction and Apathy. These results were replicated in the present study with the exception of the relationship between achievement and Competitiveness.

Competitiveness is a new scale developed by Anderson and only recently added to the LEI. Only Walberg and Anderson (1972), report its use. The relationship between mathematics achievement and Competitiveness in the Walberg and Anderson Study is very strong (r = .72). They also report a partial correlation, controlling for IQ, between total achievement and Competitiveness which is significantly positive. This scale has good reliability. However the correlations between it and achievement shifts widely from one subject to another, even within the Walberg and Anderson report: mathematics, r = .72, physics, r = -.83; biology -.46; geography, r = -.88. Since the direction of the correlation for mathematics is the same for both studies it appears that there is a positive association between class means in mathematics achievement and this variable, although this conclusion should be considered to be very tentative.

The results of the backward regression reported in Table V indicate that nine of the fifteen multiple correlation coefficients were significant. In terms of accounting for variance, the following Learning Environment Inventory variables are strongest: Speed, Environment, Friction, Favoritism, Satisfaction, Disorganization, Difficulty, Apathy, and Democratic.

Conclusion. Since both input variables and classroom environment share large proportions of the variance in achievement, then we may safely conclude that students themselves share responsibility for the learning climate in the classroom. The interaction between teacher, teaching style, social values, pupils and facilities account for environment. Nevertheless, climate is strongly related to achievement. It may be that in education as well as in industry that climate does produce an eventual pay-off in productivity.

In a design such as this one, it is difficult to state with certainty which occurs first: achievement or climate. The theory strongly suggests the latter.

The LEI accounts for a significant proportion of the variance of only one attitude: views about mathematics teaching. As was stated earlier, this appears to measure how the pupils perceive the predominant teaching style of their teacher. Thus it is expected to be related to classroom environment.

The learning of attitudes do not appear to be related to climate whereas cognitive achievement is. A number of possible explanations could be given. The preferred interpretation at this time is that teachers do not have these as objectives for their teaching. Thus these attitudes are probably learned independently of the classroom. This suggests that mathematics teachers should be more aware of the affective domain of their subject.

Teaching Method and Output

The correlations between use of the Mastery Learning Model and the learning Criteria are presented in Table VI. For the purpose of calculating these coefficients, Mastery Learning was used as a dummy variable. In other words, classes which used the Model were placed in a group and assigned a value of 1 while classes which did not use the Model were assigned as value of 0. The resulting correlations are point-biserial. The results given in Table VI indicate that Mastery Learning was not significantly related to any of the learning criteria.

TABLE VI

CORRELATIONS BETWEEN MASTERY LEARNING MODEL AND LEARNING CRITERIA (N = 48)

	MATHEMATICS ACHIEVEMENT	MATHEMATICS ATTITUDE SCALES				
		VIEWS ABOUT MATH. TEACHING	ATTITUDES TOWARD MATH. AS A PROCESS	DIFFICULTIES OF LEARNING MATH.	PLACE OF MATH. IN SOCIETY	R
MASTERY LEARNING MODEL	-.20	.03	-.15	.18	-.02	.33

There are several possible reasons for the failure to obtain significant relationships. In the first place, student perception of the extent to which the model was used in the two groups of classes indicated that there were no substantial differences in the use of the model between the two groups of classes. The nature of the Mastery Learning Model is such that most teachers use some of the elements of the Model in their teaching. Although the workshop and related activities appeared to have an impact on teachers' knowledge and willingness to use the model (see Appendix B), these differences were not apparent to students. Another possibility for the failure to obtain significant relationships is the fact that instructional variables such as Mastery Learning Strategies generally account for only a small portion of the variance in learning criteria (Stevens, 1968). In order to have an impact, instructional variables would likely have to be changed drastically and even then considerable time would be required before the change would have an impact on output variables (Likert, 1967). In this sense, the results demonstrate the need for supervisors to consider the time variable along with the difficulties involved in changing classroom techniques.

The analysis of the Mathematics Class Inventory proved to be disappointing. It was designed to inform the researchers if the teachers were using the Mastery Learning Models. This survey showed that almost none of the teachers were using the entire model. Since goals were the primary concern of this study we examined that one question. Unfortunately there was a lack of discriminating power in this item as 80% of all students indicated that teachers did communicate goals to them. If 80% of the students did indeed receive goals, then we must assume that it is a universal practice among teachers.

In attempting to study relationships between use of the various elements of the model, or various combinations of elements, we were unable to link these to any input or output variables.

Since this is contradictory to the work reported by Bloom (1971) and Block (1971) we can only assume that our questionnaire lacked sufficient reliability and validity and that this question will have to await a more rigorously designed test to ascertain use of the Mastery Learning Model.

Input-Process-Output

The results of the backwards multiple regression reported in Tables IV and V indicated that thirteen variables were significantly related to the dependent variables considered together. To determine the relationship between these thirteen variables considered together and the five learning criteria, canonical analysis was used. The analysis resulted in one significant canonical variate ($r_c = .92$). This implies that there is one factor which links the independent and dependent variables into one construct. In other words, the canonical analysis provides a highly generalized answer relative to the links between the input, process, and output variables used in the study.

The canonical loading for the significant variate are plotted in Figure 1. In the figure all the dependent variables are shown on the right-hand side. This variate indicates that the construct is characterized by high emphasis on cognitive achievement in mathematics. The other elements qualify the construct as denoting mathematics as being rather easy but mechanical, formal and fixed.

On the predictive side are shown the elements with normalized beta weights larger than =.24. Here the elements are high mathematical aptitude, apathy and high parental education.

The nature of our data did not permit us to extract other canonical constructs. The content of the construct identified by developing this composite of predictors and dependent variables, is as follows: a group of students with high mathematical aptitude, relatively indifferent to what happens in the class, and from homes where parents

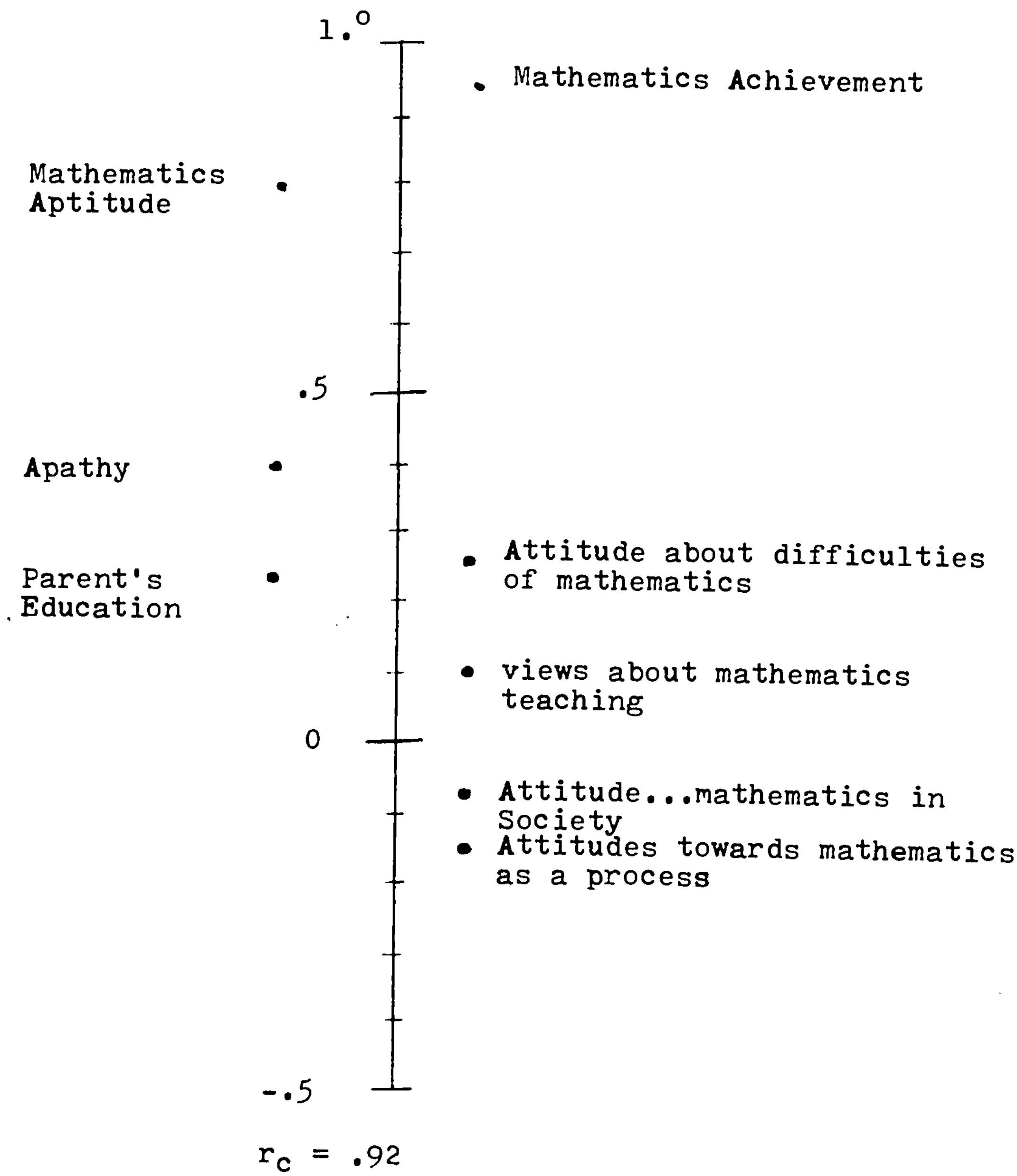

FIGURE 1. Input and Process Variables as Predictors of Learning Criteria

are well-educated, are oriented toward learning mathematics, which they find is mechanical in nature and relatively easy.

This construct identified by the canonical analysis is somewhat different from the characteristics Anderson (1971b) attributed to his sample of nine grade 10 or 11 mathematics classes in Montreal. In interpreting his data, he claimed that mathematics classes were quite different from the science, humanities and French classes. The mathematics classes were characterized by high friction, favoritism, cliqueness, difficulty, lack of formality and perceived lack of democracy and disorganization. In the U.S., Flanders also finds that mathematics teachers are highly indirect (Flanders, 1964). The Ontario pattern appears to be more formal.

On the basis of the data gathered for this report, we cannot verify all of Anderson's findings. Our data however is not inconsistent with what he has reported, but in this instance, our more conservative results are more probable. The reason for this is that the canonical variate selects best predictors, whereas Anderson compared each of his classes on the basis of one variable at a time.

II. CONCLUSIONS

The purpose of this chapter was to report the analysis of the data together with some interpretations.

Input and Output

As expected, there is a high correlation between scholastic aptitude and achievement in mathematics. The correlation ranged from .62 to .86. Aptitude also is related to the class's attitude that mathematics and mathematicians are very important in our society.

Two biographical variables are also significantly related to learning mathematics: education of parents ($r = .48$) and dislike for schooling ($r - -.41$). Although the correlation is not statistically significant, students who do not discuss their career plans achieve better; since this biographical factor is also negatively related to scholastic aptitude, perhaps the correlation with achievement is spurious. None of the biographical variables are related to learning of attitudes.

These input variables together account for 70% of the variance in cognitive achievement and 23% of the variance in the attitude that the field of mathematics is a developing one which calls for originality and understanding (mathematics as a process versus mathematics as a fixed, formal, mechanical system).

These input variables, except one, are fixed and are not subject to the influence of the school; the exception is "Dislike for schooling". Although it may in part be a social or cultural value, it probably was learned at school, possibly as a result of continuous early failure. The child who is not given an opportunity to achieve mastery at his own level of development tends to dislike school.

Since attitudes towards mathematics are not related to input variables, we would expect that the role of the school be quite important in developing those attitudes.

Process and Output

Ten of the fifteen learning environment scales are related to cognitive achievement, all of them in the expected direction. The results reflect the earlier findings of the Harvard Project Physics series of studies.

The correlation between Difficulty and output seem strange at first glance. The R is .46 ($p < .05$). Individual correlations between difficulty and mathematical aptitude and parental education were positive (.41 and .31) respectively, indicating that perhaps better students were in fact placed in more demanding mathematics classes. Another possibility is the fact that a teacher who sets high standards often achieves better results. This explanation is plausible for the correlation between goal direction and difficulty is also significant ($r = .37$).

Finally the theory of Jerome Bruner (1960) and the research by Logan (1973) demonstrate that inquiry methods of teaching, although seemingly more difficult, do lead to higher achievement. In this study, the correlation between the students' description of the teaching method as stimulating students to think about phenomena and develop principles (views about mathematics teaching) and achievement is also positive (r = .48). Each of these three reasons would explain the correlation.

It should also be noted that the correlations between the LEI scales and achievement reflect the advantages claimed for the Mastery Learning Model. It would appear that most teachers use some elements of the model. Certainly casual observation of classrooms would confirm this. However, we were not able to detect sufficient variability among teaching styles to be able to demonstrate links between its use or non-use.

The lack of correlations between the measures of classroom climate and attitudes is puzzling. No other studies have yet reported on classroom climate and learning of attitudes about a subject. In the HPP, Walberg (1969a,b) reports correlations between interest in a subject and various LEI scales, principally Friction, Cliqueness, Satisfaction and Apathy. However, the attitudes measured here do not indicate only interest, but indicate attitudes concerning the role and nature of mathematics.

Input-Process-Output

There is some speculation that teachers do not consciously pursue attitudinal objectives. Connelly (1972) in a study using a similar population of grade twelve teachers in Eastern Ontario found that mathematics teachers at that level used almost no such objectives and did not evaluate the achievement of those non-cognitive objectives that they did have. Nevertheless these students are not untypical. Their average scores for attitudes are more favorable than the average score of all the nations included in the international study by Husén (Husén, Vol 2, p.47). Once more our data shows little variability and thus correlations are difficult to obtain.

Does climate truly affect learning achievement or are both factors determined by the input variables? The theory and our experience suggest that climate is important. Some evidence for this position is supplied by Walberg and Anderson (1972). Their simple correlations between the LEI scales and achievement are similar to the ones reported here. They then calculated partial correlations, which in effect eliminated the influence of intelligence. The partial correlations between achievement and the LEI scales were somewhat reduced but remained substantially unchanged and significant.

Thus classroom climate, an amalgam of pupil background, social values, teacher background and teaching styles, significantly affect cognitive achievement.

CHAPTER IV

SUMMARY AND CONCLUSIONS

I. SUMMARY

The purpose of this study was to work toward a model of instructional supervision and to indicate to the supervisor the interconnections between various links in the educational process. This model indicates the points at which the supervisor should monitor the process and at which he can intervene in order to produce more satisfactory learning situations and outcomes.

The educational model indicates that today, with present methods, social background factors of the student account for a great deal of learning. The most significant factor, of course, is intelligence. The purpose of the schools, if they are to be maximally efficient, is to produce results which indicate that each child is successful, thus reducing the impact of social background factors on achievement.

Our management model is that of Likert (1967). His model includes the collective responsibility for achieving high goals, full and open communication to all levels of the organization, mutual trust among participants and shared decision-making. Hall (1970) has already shown the link between the elements of this model and a school climate index-the organizational climate description questionnaire.

An important element of the model is the sharing of goals. Chapter I outline the appropriateness and necessity for goals in teaching. While not accepting the recent Kettering Foundation Report (Brown, 1973) entirely, we are in sympathy with its statement that:

> Every secondary school and its subordinate departments must formulate a statement of goals and develop performance criteria for students. Goals and objectives should be published... (Brown, p.13).

This statement is in keeping with the demand for a new rationality in education.

The study included approximately 1100 students, 48 teachers and twelve schools in Eastern Ontario. The sample was limited to mathematics classes at the grades 9 and 10 level.

Figure 2 shows the major relationships found in this study. Mathematics achievement is a product of student characteristics and classroom characteristics. Although student characteristics do account for climate as well, it is reasoned that climate itself has a major independent contribution to make even under current practices. The most successful classes were characterized by high cohesiveness, low friction favoritism and cliqueness, high satisfaction, low disorganization, high difficulty, low

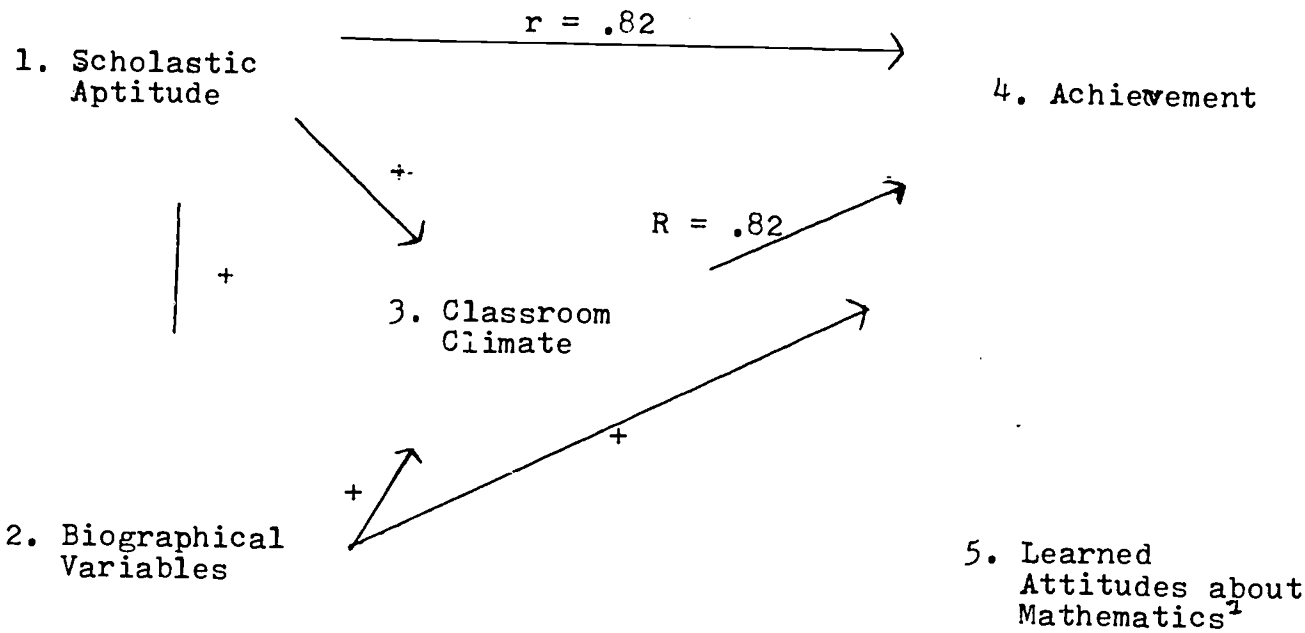

FIGURE SUMMARY OF RELATIONSHIPS

[1]Relationships between other variables and the learned attitudes about mathematics tend to be low or not significant.

apathy and highly democratic procedures. These findings are in conformity with earlier research. The finding concerning difficulty was explained in Chapter III.

The over-all picture of the mathematics classes surveyed is the construct yielded by canonical analysis, which indicates a mechanical, cognitive orientation with students who possess an aptitude for mathematics but are relatively uninterested in class activities. This is supported by other research which indicates a lack of concern on the part of teachers concerning the teaching of mathematics attitudes and their dry uniform approach to the subject as characterized by low scores on the scale "diversity".

II. SUPERVISION AND MASTERY LEARNING

Supervision and Mastery Learning.

Classrooms serve as the point of contact between school systems and individual learners; it is at the level of the classroom that the educational effort comes to life. Thus, the evidence that approximately 20 per cent of the variance in learning is accounted for by all classroom variables (Greenfield, 1963) is meaningful information. Since this is variance that excludes input characteristics of learners, it represents process variables which can be manipulated by educators and supervisors to improve the outcomes of education. In this sense, supervisors should assign priority to activities which focus on improving the learning environments of classrooms.

The study reported in this paper focused on the classroom. It provided a conceptual model of an educational program at the classroom level in terms of inputs; processes, and outputs. In particular, the project focused on two sets of process variables, environmental and instructional, in an attempt to determine the impact of these variables on cognitive and attitudinal learning in mathematics classes.

The Mastery Learning Model, an operational description of teacher behavior in typical group-based instructional situations, was used by the project team as a framework for demonstrating ways in which teaching behaviors could be changed to improve the environment of learning and, subsequently, the cognitive and attitudinal behavior of students. The Mastery Learning Model is based on humanistic assumptions about human potential. The central thesis of the Model is that up to 95 per cent of the student population can master what we have to teach them. The teaching strategies specified by the model include formulating and communicating meaningful objectives, using criterion-referenced teaching and evaluation techniques, and utilizing diagnostic and prescriptive feedback followed by remediation.

The implementation of the model in a classroom should result in a classroom learning environment that is characterized by a cohesive group of students who are involved in organized goal-directed activities. The speed and level of difficulty of classroom activities would be matched to the educational needs of learners. The class would also be characterized by a lack of tension, disagreement, antagonism and apathy. The use of the model would also provide for democratic classroom procedures which would encourage student participation in making decisions about goals and activities; the result would be increased satisfaction and an increased liking for the subject. The use of the mastery strategy would minimize the development of divisive outgroups within the class. It would also provide for a diversity of materials and environmental experiences. Environmental characteristics such as the above could be expected to have an impact on both cognitive and attitudinal learning. Also, it must be recognized that the creation of these types of environmental characteristics is a worthy activity in its own right.

The fact that the data obtained in the study did not provide any evidence relative to a direct link between the use of the Mastery Model and learning does not detract from the theoretical and practical validity of the Mastery Model as a classroom-oriented framework that provides a strategy for changing many relevant classroom variables.

The same statement can be made relative to the observation that only a small number of teachers were able to implement all elements of the model. However, these results do provide support for Likert's claim that time is an important variable in changing organizational variables (Likert, 1967) and Weiss' claim that schools have reached a level of development to the point where the marginal utility of additional change-oriented efforts becomes smaller (Weiss, 1974).

In other words, it is evident that instructional supervisors have to consider time and the marginal utility of efforts in addition to the content and characteristics of change-oriented programs. Resources are required so that supervisors are able to follow an innovation over time using every available leadership and technical skill.

While evidence of a direct relationship between the use of the Mastery Learning Model and learning was lacking, the study did provide evidence indirectly in the sense that the environmental characteristics that a mastery strategy would be expected to create were related to certain learning criteria. Environmental characteristics that were related to cognitive learning criteria included a tightly-knit social group, a variety of materials and resources, an emphasis on democratic classroom processes, a feeling of concern on the part of students for classmates, satisfaction on the part of students, and goal-directed activities which were associated with treating students equally. These are environmental characteristics which theorists associate with situations that provide for student self-actualization (Stern, 1970). In other words, the Mastery Learning Model, provides a meaningful model of classroom management which could have an impact not only on traditional learning criteria, but also on significant process variables in the classroom.

A general statement relative to the results is that cognitive learning criteria played a major role in terms of significant relationships. Most educational theorists agree that the manifest goals of schools are primarily cognitive and that there is a need to recognize affective and attitudinal outcomes of education. The fact that the highly generalized results i.e. canonical analysis, of the study indicated that mathematics classes were cognitive in orientation deserves some attention. One possibility for the failure to demonstrate relationships with non-cognitive criteria is the quality of the instrumentation used to measure attitudes toward Mathematics. The results obtained in this study were similar to the results obtained in the International Study of Achievement in Mathematics (Husén, 1967); since Husén was also unable to discriminate on the basis of the scales, the instruments should be tested further before they are used in further research.

The quality of the instrumentation relative to attitudes not withstanding, the fact remains that mathematics classes are primarily cognitive places. The generalized picture is an emphasis on product learning in the cognitive domain; the developement of attitudes toward mathematics as an exciting discipline appears to have lower priority than the acquisition of knowledge. While a portion of this orientation can be accounted for by the contribution of secondary school educators, it must be recognized that secondary school students would likely have developed a "mental set" toward mathematics as a result of experiences with mathematics during the first eight years of schooling. It seems possible that this set of student expectations could be a factor which contributes to the cognitive orientation of secondary school mathematics classes.

The implications for instructional supervision are significant. Secondary school mathematics teachers are not in a position to drastically modify student expectations. However, curriculum supervisors are in a position to develop, monitor, and influence classroom learning in their coordination roles. Only the supervisor can provide the mechanisms which will result in articulated school experiences from grade to grade and from elementary schools to secondary schools. In this sense, the results of this project indicate that an important area of future supervisory activity is to place priority on developing learning environments which have an impact on the development of attitudes.

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APPENDIX A

QUESTIONNAIRES

1. LEARNING ENVIRONMENT INVENTORY
2. BIOGRAPHICAL INVENTORY
3. MATHEMATICS CLASS INVENTORY

LEARNING ENVIRONMENT INVENTORY

University of Ottawa

DIRECTIONS

The purpose of the questions in this section of the booklet is to find out what your class is like. This is not a "test". You are asked to give your honest, frank opinions about the **class which you are now attending**.

Record your answer to each of the questions on the answer sheet provided. Please do not mark on this booklet. Answer every question.

In answering each question go through the following steps

1. Read the statement carefully.
2. Think about how well the statement describes your class (the one you are now in).
3. Find the number on the answer sheet that corresponds to the statement you are considering.
4. Blacken one space only on the answer sheet according to the following instructions:

   If you **strongly disagree** with the statement, blacken space A.

   If you **disagree** with the statement, blacken space B.

   If you **agree** with the statement, blacken space **C**.

   If you **strongly agree** with the statement, blacken space **D**.
5. You will have approximately **40** minutes to complete the questions in this booklet. Be sure the number on the answer sheet corresponds to the number of the statement being answered in the booklet.

The first 105 statements in this booklet are based on the Learning Environment Inventory developed for research purposes at Harvard University by Dr. Herbert J. Walberg and Dr. Gary J. Anderson.

		Strongly disagree	Disagree	Agree	Strongly agree
1.	Members of the class do favours for one another.	A	B	C	D
2.	The books and equipment students need or want are easily available to them in the classroom.	A	B	C	D
3.	There are long periods during which the class does nothing.	A	B	C	D
4.	The class has students with many different interests.	A	B	C	D
5.	Certain students work only with their close friends.	A	B	C	D
6.	The students enjoy their class work.	A	B	C	D
7.	Students who break the rules are penalized.	A	B	C	D
8.	There is constant bickering among class members.	A	B	C	D
9.	The better students' questions are more sympathetically answered than those of the average students.	A	B	C	D
10.	The class knows exactly what it has to get done.	A	B	C	D
11.	Interests vary greatly within the group.	A	B	C	D
12.	A good collection of books and magazines is available in the classroom for students to use.	A	B	C	D
13.	The work of the class is difficult.	A	B	C	D
14.	Every member of the class enjoys the same privileges.	A	B	C	D
15.	Most students want their work to be better than their friends' work.	A	B	C	D
16.	The class has rules to guide its activities.	A	B	C	D
17.	Personal dissatisfaction with the class is too small to be a problem.	A	B	C	D
18.	A student has the chance to get to know all other students in the class.	A	B	C	D
19.	The work of the class is frequently interrupted when some students have nothing to do.	A	B	C	D
20.	Students cooperate equally with all class members.	A	B	C	D
21.	Many students are dissatisfied with much that the class does.	A	B	C	D
22.	The better students are granted special privileges.	A	B	C	D
23.	The objectives of the class are not clearly recognized.	A	B	C	D
24.	Only the good students are given special projects.	A	B	C	D
25.	Class decisions tend to be made by all the students.	A	B	C	D

		Strongly disagree	Disagree	Agree	Strongly agree
26.	The students would be proud to show the classroom to a visitor.	A	B	C	D
27.	The pace of the class is rushed.	A	B	C	D
28.	Some students refuse to mix with the rest of the class.	A	B	C	D
29.	Decisions affecting the class tend to be made democratically.	A	B	C	D
30.	Certain students have no respect for other students.	A	B	C	D
31.	Some groups of students work together regardless of what the rest of the 'ass is doing.	A	B	C	D
32.	Members of the class are personal friends.	A	B	C	D
33.	The class is well organized.	A	B	C	D
34.	Some students are interested in completely different things than other students.	A	B	C	D
35.	Certain students have more influence on the class than others.	A	B	C	D
36.	The room is bright and comfortable.	A	B	C	D
37.	Class members tend to pursue different kinds of problems.	A	B	C	D
38.	There is considerable dissatisfaction with the work of the class.	A	B	C	D
39.	Failure of the class would mean little to individual members.	A	B	C	D
40.	The class is disorganized.	A	B	C	D
41.	Students compete to see who can do the best work.	A	B	C	D
42.	Certain students impose their wishes on the whole class.	A	B	C	D
43.	A few of the class members always try to do better than the others.	A	B	C	D
44.	There are tensions among certain groups of students that tend to interfere with class activities.	A	B	C	D
45.	The class i' well-organized and efficient.	A	B	C	D
46.	Students are constantly challenged.	A	B	C	D
47.	Students feel left out unless they compete with their classmates.	A	B	C	D
48.	Students are asked to follow strict 'ules	A	B	C	D
49.	The class is controlled by the actions of a few members who are favoured.	A	B	C	D
50	Students don't care about the ' ,ure of the class as a group.	A	B	C	D

		Strongly disagree	Disagree	Agree	Strongly agree
51.	Each member of the class has as much influence as any other member.	A	B	C	D
52.	The members look forward to coming to class meetings.	A	B	C	D
53.	The subject studied requires no particular aptitude on the part of the students.	A	B	C	D
54.	Members of the class don't care what the class does.	A	B	C	D
55.	There are displays around the room.	A	B	C	D
56.	All students know each other very well.	A	B	C	D
57.	The classroom is too crowded.	A	B	C	D
58.	Students are not in close enough contact to develop likes or dislikes for one another.	A	B	C	D
59.	The class is rather informal and few rules are imposed.	A	B	C	D
60.	Students have little idea of what the class is attempting to accomplish.	A	B	C	D
61.	There is a recognized right and wrong way of going about class activities.	A	B	C	D
62.	What the class does is determined by all the students.	A	B	C	D
63.	After the class, the students have a sense of satisfaction.	A	B	C	D
64.	Most students cooperate rather than compete with one another.	A	B	C	D
65.	The objectives of the class are specific.	A	B	C	D
66	Students in the class tend to find the work hard to do.	A	B	C	D
	Each student knows the goals of the course.	A	B	C	D
68.	All classroom procedures are well-established.	A	B	C	D
69.	Certain students in the class are responsible for petty quarrels.	A	B	C	D
70.	Many class members are confused by what goes on in class.	A	B	C	D
71.	The class is made up of individuals who do not know each other well.	A	B	C	D
72.	The class divides its efforts among several purposes.	A	B	C	D
73.	The class has plenty of time to cover the prescribed amount of work.	A	B	C	D
74.	Students who have past histories of being discipline problems are discriminated against.	A	B	C	D
75.	Students do not have to hurry to finish their work.	A	B	C	D

		Strongly disagree	Disagree	Agree	Strongly agree
76.	Certain groups of friends tend to sit together.	A	B	C	D
77.	There is much competiti in the class.	A	B	C	D
78.	The subject presentation is too elementary for many students.	A	B	C	D
79.	Students are well-satisfied with the work of the class.	A	B	C	D
80.	A few members of the class have much greater influence than the other members.	A	B	C	D
81.	There is a set of rules for the students to follow.	A	B	C	D
82.	Certain students don't like other students.	A	B	C	D
83.	The class realizes exactly how much work it has to do.	A	B	C	D
84.	Students share a common concern for the success of the class.	A	B	C	D
85.	There is little time for day-dreaming.	A	B	C	D
86.	The class is working toward many different goals.	A	B	C	D
87.	The class members feel rushed to finish their work.	A	B	C	D
88.	Certain students are considered uncooperative.	A	B	C	D
89.	Most students sincerely want the class to be a success.	A	B	C	D
90.	There is enough room for both individual and group work.	A	B	C	D
91.	Each student knows the other members of the class by their first names.	A	B	C	D
92.	Failure of the class would mean nothing to most members.	A	B	C	D
93.	The class has difficulty keeping up with its assigned work.	A	B	C	D
94.	There is a great deal of confusion during class meetings.	A	B	C	D
95.	Different students vary a great deal regarding which aspect of the class they are interested in.	A	B	C	D
96.	Each student in the class has a clear idea of the class goals.	A	B	C	D
97.	Most students cooperate equally with other class members.	A	B	C	D
98.	Certain students are favoured more than the rest.	A	B	C	D
99.	Students have a great concern for the progress of the class.	A	B	C	D
100.	Certain students stick together in small groups.	A	B	C	D

		Strongly disagree	Disagree	Agree	Strongly agree
101.	Most students consider the subject-matter easy.	A	B	C	D
102.	The course material is covered quickly.	A	B	C	D
103.	There is an undercurrent of feeling among students that tends to pull the class apart.	A	B	C	D
104.	Many students in the school would have difficulty doing the advanced work of the class.	A	B	C	D
105.	Students seldom compete with one another.	A	B	C	D

We wish to check whe re marking your responses beside the right numbers on your sheet. To assist us please mark as follows:

106. Mark A

107. Mark B

108. Marc C

109. Mark D

110. Mark E

BIOGRAPHICAL INVENTORY

University of Ottawa

DIRECTIONS

The purpose of the questions in this section of the booklet is to obtain information about you. Please answer each question sincerely and accurately.

Record your answer to each of the questions on the same answer sheet as you used for the questions in the first part of this booklet. **Please do not mark on this booklet.** Answer every question. Be sure the number on the answer sheet corresponds to the number of the statement being answered in the booklet.

Now go to number 111 and answer every question as well as you can.

* 111. State your sex.
- A. boy
- B. girl

* 112. How old are you?
- A. 12 or younger
- B. 13
- C. 14
- D. 15
- E. 16 or older

113. What is the highest level of your father's education?
- A. elementary
- B. some high school
- C. high school
- D. some university or community college
- E. university degree

114. What is the highest level of your mother's education?
- A. elementary
- B. some high school
- C. high school
- D. some university or community college
- E. university degree

* 115. Your last year's final average for all subjects was about
- A. 80 percent or higher (A+, A, A–)
- B. 65 percent to 79 percent (B+, B, B–)
- C. 50 percent to 64 percent (C+, C, C–)
- D. any grade or mark lower than the above

* 116. What is the highest level of education you expect to have actually attained fifteen years from now?
- A. not finished high school
- B. high school graduate
- C. community college graduate, registered nurse, etc.
- D. university degree, e.g., B.A., B.Ed., B.Sc.
- E. professional degree, e.g., doctor, lawyer, Ph.D.

* 117. What yearly income do you expect to actually make fifteen years from now?
- A. below $6,000
- B. $6,000 to $8,999
- C. $9,000 to $11,999
- D. $12,000 to $15,000
- E. more than $15,000

* 118. Among the things you strive for during your high school days, which of the following is most important to you?

A. pleasing your parents
B. learning as much as possible in school
C. living up to your religious ideals
D. being accepted and liked by other students
E. pleasing the teacher

119. How many evenings a week do you spend with the gang?

A. none
B. one
C. two
D. three
E. more than three

120. How much time, on the average, do you spend doing homework outside the school on a weekday?

A. none or almost none
B. less than one hour
C. one or two hours
D. two or three hours
E. more than three hours

121. In relation to all the subjects you are studying this year, mathematics is the subject which you

A. very frequently enjoy
B. often enjoy
C. sometimes enjoy
D. rarely enjoy

122. How often do you discuss career plans with guidance counsellors?

A. rarely
B. sometimes
C. often
D. very frequently

123. How often do you discuss career plans with adults other than guidance counsellors?

A. rarely
B. sometimes
C. often
D. very frequently

124. Do you like school?

A. yes
B. no

* These items were not used in our analyses.

MATHEMATICS CLASS INVENTORY

University of Ottawa

DIRECTIONS

N = 519

The following questions are concerned with your mathematics class since the beginning of the second term. Please think of your mathematics class as you answer each question.

Record your answer to each of the questions on the same answer sheet as you used for the questions in the first part of this booklet. Please do not mark on this booklet. Be sure the number on the answer sheet corresponds to the number of the statement being answered in the booklet.

Now go to number 71 and answer every question as well as you can.

71. How many short tests in mathematics have you had since the beginning of the second term?

    A. one 5.4%
    B. two 14%
    C. three 25.6%
    D. four or more 51.7%
    E. none 3.3%

72. Did the scores on these short tests count in some way towards your final mark?

    A. always 58.7%
    B. sometimes 27.5%
    C. never 1.7%
    D. do not know 12.%

73. In cases where you had mistakes in these short tests, were you given assistance or direction to help you improve your understanding?

    A. always 51.4%
    B. sometimes 38.2%
    C. never 10.4%

74. Did you find that these short tests in mathematics were helpful to you?

    A. yes 83.5%
    B. no 16.5%

75. When a new unit or chapter was introduced, were you made aware of the objectives for the unit or chapter?

    A. yes 79%
    B. no 21%

76. If your answer to 75 above was "yes", did you find that knowing the objectives of the chapter or unit was helpful to you?

    A. yes 79%
    B. no 21%

PLEASE CHECK TO SEE IF YOUR SCORING HAS BEEN NEATLY PENCILED IN.

APPENDIX B

WORKSHOP EVALUATION

QUESTIONNAIRES AND RESPONSES

WORKSHOP EVALUATION QUESTIONNAIRE AND
SUMMARY OF DATA FROM SIX SCHOOLS

Please check each of the following items. Feel free to write additional comments beside any of them.

1. The overall quality of the presentations at the workshop was:

   2 EXCELLENT   22 GOOD   16 AVERAGE   3 FAIR   __POOR   2 NO RESPONSE

2. The language level of the workshop presentations was:

   1 VERY DIFFICULT   14 DIFFICULT   30 ABOUT RIGHT   __TOO EASY

3. How good were the meeting room facilities for the workshop?

   2 VERY GOOD   30 GOOD   10 POOR   2 VERY POOR   1 NO RESPONSE

4. Was the time allowed for the workshop sufficient to learn the materials?

   33 YES   11 NO   1 NO RESPONSE

5. The pace at which the workshop was conducted was:

   3 TOO FAST   31 ABOUT RIGHT   11 TOO SLOW

6. The sequence of activities during the workshop was:

   __VERY CONFUSING   14 CONFUSING   29 EASY TO UNDERSTAND   2 NO RESPON

7. Your feeling during the workshop can best be described as:

   __VERY FRUSTRATED   12 FRUSTRATED   23 NEUTRAL   7 EAGER   3 NO RESPONS

8. Did you have prior exposure to the concepts presented on instructional objectives?

   4 QUITE A LOT   30 SOME   11 NONE AT ALL

9. Did you have prior exposure to the concepts presented on formative evaluation?

3 QUITE A LOT   28 SOME   14 NONE AT ALL

10. During the workshop, did you wish to discuss instructional problems that had arisen in your work?

24 YES   16 NO   5 NO RESPONSE

11. If answer to item 10 above was "YES", was there an opportunity to pursue this interest?

8 QUITE A LOT   16 SOME   __ NONE AT ALL

12. Did the amount of time provided for discussion during the workshop seem acceptable?

1 TOO MUCH   37 JUST RIGHT   6 TOO LITTLE   1 NO RESPONS

13. Did the amount of problem solving required during the workshop seem acceptable?

1 TOO MUCH   19 JUST RIGHT   13 TOO LITTLE 12 NO RESPONSE

14. Will you use what you have learned in the immediate future?

34 YES   1 NO   10 NOT SURE

15. Would you like to learn more about instructional objectives as defined in the workshop?

30 YES   13 NO   2 NO RESPONSE

16. Would you like to learn more about formative evaluation as defined in the workshop?

34 YES   9 NO   2 NO RESPONSE

17. Did you develop solutions to any instructional problems during the workshop?

16 YES   25 NO   4 NO RESPONSE

18. How would you describe the correspondence between what you expected to get out of the workshop and what you actually did get out of the workshop?

22 ABOUT WHAT I EXPECTED

15 MORE THAN I EXPECTED

5 LESS THAN I EXPECTED

3 NO RESPONSE

19. What would you like to see changed in the workshop and how would you change it? What would you add or delete?

Complete the table below by placing checks in each column to indicate your feeling about various tasks.

TASK	As a result of my attendance at the workshop:			
	I am able to attack this task more effectively.		I see immediate practical application of the technique.	
	YES	NO	YES	NO
a. Determining the characteristics of an instructional objective.				
b. Writing an instructional objective.				
c. Planning a program which utilizes instructional objectives.				
d. Determining the nature of formative evaluation.				
e. Determining the role of the teacher in utilizing instructional objectives.				
f. Planning a program which utilizes formative evaluation.				
g. Determining the use of instructional objectives in planning a formative evaluation program.				

APPENDIX C

LIST OF PARTICIPATING SCHOOLS

APPENDIX C

PARTICIPATING SCHOOLS

1. Arnprior District High School
   Arnprior, Ontario

2. Brookfield High School
   Ottawa, Ontario

3. Colonel By Secondary School
   Ottawa, Ontario

4. Gloucester High School
   Ottawa, Ontario

5. Fisher Park High School
   Ottawa, Ontario

6. Lisgar Collegiate Institute
   Ottawa, Ontario

7. MacKenzie High School
   Deep River, Ontario

8. Perth District High School
   Perth, Ontario

9. Rideau High School
   Ottawa, Ontario

10. Sir John A. Macdonald High School
    Ottawa, Ontario

11. Sir Wilfred Laurier High School
    Ottawa, Ontario

12. Smiths Falls District Collegiate Institute
    Smiths Falls, Ontario

APPENDIX D

DESCRIPTIVE STATISTICS

TABLE VII

Means and Standard Deviations of the Class Means for the School and College Ability Test (SCAT Series II)

N = 48

	MEAN	S.D.
Verbal	265.67	14.36
Mathematical	282.47	13.72
Total	274.58	10.83

TABLE VIII

Means and Standard Deviations of the
Class Means for the Biographical Inventory

(N = 48)

SCALE	MEAN	S.D.
Parental Education	5.96	1.05
Dislike for School	9.64	.66
Career Planning	3.63	.49

TABLE IX

Means and Standard Deviations of the Class Means for the Fifteen Scales of the Learning Environment Inventory (LEI)

(N = 48)

LEI SCALES	MEAN	S.D.
1. Cohesiveness	18.93	1.39
2. Diversity	20.36	.72
3. Formality	17.85	1.17
4. Speed	17.73	1.60
5. Environment	17.30	1.31
6. Friction	17.48	1.75
7. Goal Direction	18.64	1.31
8. Favoritism	14.34	1.50
9. Cliqueness	18.61	1.36
10. Satisfaction	17.33	1.73
11. Disorganization	15.69	2.05
12. Difficulty	18.88	.99
13. Apathy	17.11	1.75
14. Democratic	17.33	1.07
15. Competitiveness	17.86	1.24

TABLE X

Mean and Standard Deviation of the Class Means for the Stanford Achievement Test, Mathematics - Part A.

	MEAN	S.D.
Stanford Achievement Test, Mathematics Part A	23.58	4.44

TABLE XI

Means and Standard Deviations of the Class Means for the Four Scales of the School Mathematics Inventory

(N = 48.)

SCALE	MEAN	S.D.
Views About Mathematics Teaching	12.45	1.34
Attitudes About the Difficulties of Learning Mathematics	10.90	.93
Attitudes Toward the Place of Mathematics in Society	9.56	1.35
Attitudes Toward School and School Learning	11.53	1.30

APPENDIX E

TECHNICAL NOTES ON THE

STATISTICAL METHODS EMPLOYED

Some Technical Notes on Statistics

The purpose of this appendix is to provide a few additional notes on the use of statistics in this report. Part one reviews the rationale for grouping the data into class means. Part two is a review of the correlational methods employed. The advanced reader will find some of this very elementary, but it is presented for the benefit of the reader who has no background in statistics.

I. Classroom Scores

One of the first questions in research refers to the target of research: the pupil, the class, the teacher, the school, or some other unit of analysis. While the individual pupil is important in educational research, and whereas the school as a unit is often an important factor, the focus of this study is the classroom.

To base our analyses on the scores of individuals would be inappropriate. Learning is influenced greatly by classroom factors: the teacher, the presence of one or more unruly students, the time of day a class is scheduled. Further, another of the important variables, is clearly a class measure: the learning environment inventory (LEI). Although each student gives his or her perception of the climate, that student is also a part of that class. Thus the scores of individual members of any group in a climate study are not strictly independent. The class average is the best estimate of the collective perception of climate. Consequently our data is grouped into classroom units, and most of the tests conducted were based on the assumption that there were 48 individual units, as 48 classrooms participated in the study.

The appropriate test for reliability of the scales is the intraclass correlation which is based on the ratio of between-class variance to within-class variance:

> "It indicates both the extent to which pupils within the same class respond similarly and the extent to which the scale discriminates among classes."[1]

Similarly, the other measures were grouped into class means because we required characteristics of the class, and results of classes so that programs, rather than pupils, could be evaluated. Again, the appropriate unit of analysis was the classroom.

II. Statistics

Correlation: r

The most frequent statistic in this report is the correlation, which indicates the degree of relation between two sets of scores. For instance achievement in mathematics is related to aptitude for mathematics. The class with many students with a high aptitude will usually have the highest achievements. If the 48 classes in our sample were perfectly matched on these two variables, then the correlation would be perfect ($r=1.00$). If there were some discrepancies, for instance an usually good

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1 Gary Anderson, The Assessment of Learning Environments: A Manual for the Learning Environment Inventory and the My Class Inventory, Halifax, Atlantic Institute of Canada, 1971, p. 12.

teacher obtained superior results from an average class, then the correlation would decrease. If no relation existed between these two sets of scores, then the correlation would be zero ($r = .00$). If, by some perverse circumstance, classes with low aptitudes achieved the highest scores, then the correlation would be negative, e.g. $r = -.45$.

Correlations are only as accurate as the tests used to measure the variables. An instrument with less than perfect reliability will usually cause a correlation to drop and thereby underestimate the true nature of the relationship.

Although the correlation is only a measure of association, historically it has been used to predict. Thus, in this example, we can use aptitude scores to predict achievement scores. Predictions can be made on the basis of true experimental results or on theoretical grounds. In an experiment, it can be shown that adding varying amounts of chemicals to soil samples produces fruit of varying sizes. Thus the presence of these chemicals predicts the later appearance of larger fruits. In the classroom, certain teaching styles may be associated with improved learning. It may be difficult to prove that there is a causal connection between the two, but theory may strongly support such a contention.

Mathematically, correlation is a measure of shared or common variance. On occasion, researchers do not find correlations between two sets of scores, because of a lack of variance. For instance, if all students obtained the same mark on a test, this lack of variance would yield a correlation of zero. If all marks clustered narrowly about one score, this relatively small variance would make it difficult to detect a correlation.

A correlation is a measure of common variance. The proportion of shared variance is obtained by squaring the correlation coefficient: r^2. A correlation of .5 between an aptitude test and success in a task indicates that the test accounts for 25 per cent of the variance in the success scores.

When is a correlation significant? Social scientists are usually confident that there is a true association between two variables when there is a .95 chance (19 out of 20) that the relationship is real. That is, the probability is less than 5% ($p < .05$) that totally unrelated sets of scores would, by chance, obtain a correlation as large.

The level of confidence is related to the size of the sample. In this report, since we have 48 classrooms, correlations greater than .29 or less than —.29 are accepted as significant and true (df 46, p. 05 = .285, two-tail test).

Partial correlation

If two variables, height and reading achievement in children are related, $r = .8$, it may be because these two items are related to a third factor, age. Partial correlation is a technique of measuring the relationship between two factors, after subtracting the common variance they share with a third variable. Thus in this case, since both height and reading ability in children are related to age, the partial correlation between the two would probably be reduced to zero. The partial correlation is otherwise interpreted as an r.

Multiple Correlation: R

When several factors, e.g. a battery of tests, are related to a single variable, then the multiple correlation is used. This is an index of association between a set of predictors and one criterion. In this study, the fifteen LEI scales were used to predict mathematics achievement. Statistical methods are available to calculate the contribution of any of the predictor variables.[2] The R can be interpreted in a manner similar to r. R^2 is an indicator of the shared variance between the set of predictors and the criterion. The significance levels of R is usually larger than r.

Canonical Correlation Rc

This relatively new and most complex technique is used to relate a set of predictors to a set of dependent variables, e.g. 15 LEI scales to 4 attitude scales. Although the method was developed in 1935 by Hotelling, it is still infrequently used. It identifies elements of one set of variables that are most highly related to elements of the other set.[3] It takes into account the correlations of variables within each set as well as the correlations between the sets. The result is two variates, a predictor and a criterion, between which there is the greatest possible correlation.

The result is a construct which must be interpreted. This is accomplished by examining the relative weights of each element within the two variates. These weights also express the correlation between the variate and the individual variables.[4]

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2 Richard B. Darlington, "Multiple Regression in Psychological Research and Practice", Psychological Bulletin, 69, pp. 161-182, 1968.

3 Maurice Tatsuoka, Multivariate Analysis, Toronto, John Wiley, p. 183, 1971.

4 R.D. Bock and E.R. Haggard, "The Use of Multivariate Analysis of Variance in Behavioral Research," in D.K. Whitta, editor, Handbook of Measurement and Assessment in the Behavioral Sciences, Reading, Mass., Addison-Wesley, 1968.

Generally, one canonical correlation is not sufficient to explain all relationships. Two or three pairs of variates are usually identified. The reader will note that only one Rc was significant in this study, possibly leading to an incomplete description.

Computer Programs

The data was tested, for the most part, with the aid of the University of Ottawa computer program library. All the tests in this report were calculated on programs which were derived from the Biomedical Computer (BMD) Library Program of the University of California at Los Angeles.