34429

National Library of Canada | Bibliothèque nationale du Canada

CANADIAN THESES ON MICROFICHE | THÈSES CANADIENNES SUR MICROFICHE

NAME OF AUTHOR *NOM DE L'AUTEUR* [illegible]

TITLE OF THESIS *TITRE DE LA THÈSE* [illegible]

UNIVERSITY *UNIVERSITÉ* [illegible]

DEGREE FOR WHICH THESIS WAS PRESENTED *GRADE POUR LEQUEL CETTE THÈSE FUT PRÉSENTÉE* [illegible]

YEAR THIS DEGREE CONFERRED *ANNÉE D'OBTENTION DE CE GRADE* [illegible]

NAME OF SUPERVISOR *NOM DU DIRECTEUR DE THÈSE* [illegible]

Permission is hereby granted to the NATIONAL LIBRARY OF CANADA to microfilm this thesis and to lend or sell copies of the film.

The author reserves other publication rights, and neither the thesis nor extensive extracts from it may be printed or otherwise reproduced without the author's written permission.

L'autorisation est, par la présente, accordée à la BIBLIOTHÈQUE NATIONALE DU CANADA de microfilmer cette thèse et de prêter ou de vendre des exemplaires du film.

L'auteur se réserve les autres droits de publication, ni la thèse ni de longs extraits de celle-ci ne doivent être imprimés ou autrement reproduits sans l'autorisation écrite de l'auteur.

DATED *DATÉ* [illegible] SIGNED *SIGNÉ* [illegible]

PERMANENT ADDRESS *RÉSIDENCE FIXE* [illegible]

NL-91 (3-74)

NOTICE

The quality of this microfiche is heavily dependent upon the quality of the original thesis submitted for microfilming. Every effort has been made to ensure the highest quality of reproduction possible.

If pages are missing, contact the university which granted the degree.

Some pages may have indistinct print especially if the original pages were typed with a poor typewriter ribbon or if the university sent us a poor photocopy.

Previously copyrighted materials (journal articles, published tests, etc.) are not filmed.

Reproduction in full or in part of this film is governed by the Canadian Copyright Act, R.S.C. 1970, c. C-30. Please read the authorization forms which accompany this thesis.

THIS DISSERTATION
HAS BEEN MICROFILMED
EXACTLY AS RECEIVED

AVIS

La qualité de cette microfiche dépend grandement de la qualité de la thèse soumise au microfilmage. Nous avons tout fait pour assurer une qualité supérieure de reproduction.

S'il manque des pages, veuillez communiquer avec l'université qui a conféré le grade.

La qualité d'impression de certaines pages peut laisser à désirer, surtout si les pages originales ont été dactylographiées à l'aide d'un ruban usé ou si l'université nous a fait parvenir une photocopie de mauvaise qualité.

Les documents qui font déjà l'objet d'un droit d'auteur (articles de revue, examens publiés, etc.) ne sont pas microfilmés.

La reproduction, même partielle, de ce microfilm est soumise à la Loi canadienne sur le droit d'auteur, SRC 1970, c. C-30. Veuillez prendre connaissance des formules d'autorisation qui accompagnent cette thèse.

LA THÈSE A ÉTÉ
MICROFILMÉE TELLE QUE
NOUS L'AVONS REÇUE

THE UNIVERSITY OF ALBERTA

A STRATEGY FOR TEACHING MATHEMATICS TO ADULTS IN ACADEMIC UPGRADING PROGRAMS

by

© GORDON GEORGE BURDETT MALLETT

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF EDUCATION

DEPARTMENT OF SECONDARY EDUCATION

EDMONTON, ALBERTA

FALL, 1977

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "A Strategy for Teaching Mathematics to Adults in Academic Upgrading Programs" submitted by Gordon George Burdett Mallett in partial fulfilment of the requirements for the degree of Master of Education.

.....
Supervisor, Dr. S. E. Sigurdson
Department of Secondary Education

.....

.....

.....

DATE ..Sept. 8..... 1977

ABSTRACT

The purpose of this study was to formulate a "multi-approach rationale" for adult academic upgrading programs, to develop a mathematics teaching strategy and instructional materials appropriate to the rationale and to evaluate the extent to which using such a curriculum meets specific student characteristics and needs. The multi-approach rationale was basically an eclectic position which incorporated process and mastery learning in a module format. The subjects were the students enrolled in level I technical mathematics during the 1976 spring semester at Alberta Vocational Centre, Edmonton. They were randomly assigned to three experimental groups, one of which constituted the control.

All groups received an initial three week review. The control group then proceeded through the course in a somewhat traditional manner. The two treatment groups employed a curriculum formulated on the basis of the multi-approach rationale which was developed. Students were encouraged to do independent work on the course and to meet regularly in small groups to do remedial work.

It was hypothesized that: (1) with respect to the mid-term and final examination results, the population means of the three groups would be equal, (2) the performance on the final examination by students within each group would be independent of their attendance records, (3) the proportions of students within the three groups answering positively to various features of the treatment would be the same.

A one-way analysis of variance model was used to test the significance of differences between groups for hypothesis (1) above. Multiple comparisons were made by using the method developed by Scheffé. All other analyses were undertaken by applying a Chi Square test of independence or test of significance of the difference between proportions. A .05 level of significance was used throughout.

Results indicated that the treatment groups both scored significantly higher than the control group on the mid-term examination. For the final examination the treatment group marks were still considerably higher than for the control group, but the differences were short of being statistically significant. No statistically significant association was found between the final examination score and attendance record for students within each of the three groups. The data did indicate though, that for the control group, good marks were much more dependent upon good attendance than was the case for either of the treatment groups. Student responses to various features of the questionnaire showed remarkable similarity for the two treatment groups. Overall, the responses by students in the control group tended to be more negative than for either of the treatment groups.

It was concluded that the use of the multi-approach rationale in offering mathematics instruction to adults is an effective way to facilitate their learning as well as to meet some of the unique characteristics of these adult learners.

ACKNOWLEDGEMENTS

I wish to express my sincerest appreciation to the following persons for their assistance in the preparation of this thesis:

Dr. S. E. Sigurdson, my advisor, for his consistent encouragement, thoughtful criticism and generosity with his time during the two year period over which the research extended.

Dr. T. Kieren, for his helpful comments and encouragement during the initial stages of the research.

I am also indebted to Mrs. E. Hilgartner and Mr. T. Sadlowski, my colleagues, who taught two of the groups involved in the study and to Mrs. D. Henschel for providing expeditious typing services.

In addition, I wish to acknowledge the encouragement and support provided by the administration at Alberta Vocational Centre and the Department of Advanced Education and Manpower. Without their combined financial support the project would not have been possible.

Finally, thanks to my wife, Sandy, for her continuous support and to my children for their understanding of my lack of free time during this period.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1

INTRODUCTION AND NEED FOR THE STUDY

INTRODUCTION

A recurrent theme in education today is that the learning process must be oriented to the learner in such a way that it meets individual needs and is directed towards the attainment of individual goals. Bergevin, a specialist in adult education, shares this point of view in making the following statement about the adult learner:

> He must be offered an opportunity to attack a problem in a way suited to his nature as a learner, at a level he can handle, in a manner (process) that helps him to know more about working with others and himself as well as about a particular subject. (Bergevin, 1967, p. 26)

He is implying, then, that the learner must be the central focus of the whole educative process.

In attempting to devise an effective mathematics program for use by adult learners, one that takes Bergevin's position as a guiding principle, many factors must be taken into consideration. One of the most important factors is the formulation of a general philosophy for adult education, a philosophy which will serve to provide parameters within which decisions can be made. Before any such formulation is feasible, it seems desirable to consider the viewpoints of leading adult educators, curriculum specialists, mathematics educators, and learning theorists. As well, very definite consideration must be

given to the development of effective means for choosing of appropriate subject matter for inclusion in the program. In addition, decisions must be made pertaining to instructional methodology and evaluation techniques.

Education has come a long way from the time when the curriculum consisted of slate, rod and teacher. Today, the number of variables to consider in the process of developing and subsequent implementation of new curricula is staggering. In relation to academic upgrading programs for adult learners (for definitions of terms see section IV), though, the number of such variables to consider is somewhat reduced. This is due to several factors among which one of the most important is that adult students demonstrate a relatively high degree of maturity. This frees the curriculum developer from having to consider such things as the discipline ramifications accompanying proposed changes of instructional methodology. Further, matters related to subject matter content and mode of instruction of specific courses are not generally decided in the public arena as is the case with curricula for use in the public school system. Thus, the adult curriculum developer has a certain amount of freedom to exercise in making his decisions.

SETTING AND GENERAL PURPOSE OF THE STUDY

The setting for the study is the Alberta Vocational Centre situated in Edmonton. This institution is administered by the Department of Advanced Education and Manpower and offers unique educational opportunities to adults, who, because of limited educational and occupational

skills, find themselves at a disadvantage in obtaining and holding suitable employment.

> The modern facilities of the Centre can accommodate more than 1000 students in programs of general education and occupational skill development. Students are given the opportunity to earn the credentials necessary for direct employment or for entry to technical institutes, colleges, universities and programs of apprenticeship.
> (Alberta Vocational Centre Calendar, 1976)

Because of the fact that the Centre emphasizes placement of students at their "functioning" level, prospective students are required to complete placement tests before admission can be considered. On the basis of these tests, and other information such as vocational goal, an attempt is made to plan a program of studies which meets the needs of each individual.

The general purpose of this study is threefold:

(1) to formulate a viable rationale for academic upgrading programs and subsequently to use this to provide guidance in the development and implementation of mathematics curricula to adults.

(2) to produce instructional strategies and materials appropriate to the rationale.

(3) to use these instructional materials for one full semester and to evaluate their effectiveness in an adult upgrading setting.

In carrying out the study the focus will be on the technical mathematics program offered by the Academic Upgrading Department. This program at present is roughly the equivalent of the mathematics 13, 23

and 33 programs offered in the regular school system. At Alberta Vocational Centre instruction is provided during three semesters: two five-month semesters (August to January; February to June) and one summer session of nine weeks (July and August).

NEED FOR THE STUDY

This study can be considered as a follow-up to a 1969 study by David Schoenfield entitled A Baseline Study of Adult Training and Retraining in Alberta. One of his major considerations is that research is required into problems related to methods of training adults of different ages. He also suggests that attention be given to various variables influencing drop-out rates. His main plea is that "the major orientation of research should be towards action" (Schoenfield, 1969, p. 75). In making this statement Schoenfield is implying that the purpose of research in this field should be directed towards improving education programs as opposed to merely making "status quo" reports.

It has long been apparent that, in many respects, the mathematics programs in Alberta's academic upgrading institutions have been inadequate. Presently there is general willingness, on the part of teaching and administrative personnel alike, to consider possible changes. Oliver (1965) states that the scope of proposed curriculum improvement must be based on two primary considerations: the school's readiness for change and the nature and extent of the inadequacy of the present educational program. It would thus seem desirable that considerable energy be devoted to revision of th

present mathematics program.

Historically, the institutions involved have "borrowed" from the regular school system the course of studies and textbooks for high school mathematics and have presented the material to the students in much the same manner as is done in the more traditional public school classroom. Considering the characteristics of adults as learners which differentiate them from younger students and also the particular needs and goals of these more mature and pragmatic individuals, this is a questionable practice. The whole problem has been compounded by the questionable appropriateness and readability level of many of the prescribed textbooks. This can be exemplified by reading the opening statements in the Introductions to Principles of Mathematics, Books 1 and 2 (Dean et. al., 1970, 1971), the textbooks which are currently being used in the technical mathematics programs at Alberta Vocational Centre. In Book 1 Dean begins, "You are a very lucky person! You are young and are living in one of the most exciting periods of history." In Book 2 his opening statement is "To be a teenager in the Space Age is both a privilege and a responsibility." Bergevin (1967), a specialist in adult education, reports that his research has shown that adults are sensitive about their roles as learners and thus do not want to be exposed to learning resources which smack of childhood learning. Accordingly, Dean's statements are inappropriate for adults.

Irving Lorge, Howard McClusky, Cyril Houle and Edward Thorndike are among those who have published the results of their research relating to

the characteristics of adult learners. More recently, Bergevin (1967) and Cass (1971) have published works in which are identified several crucial issues in adult education. They have attempted to answer questions such as: How do adults learn? How can teachers of adults be used most effectively? What are the major problems which adults face upon returning to school? Cass (1971), upon analyzing the fundamental data provided by Thorndike, Lorge and others, identifies several key factors which make the teaching of adults quite different from the teaching of children. She concludes that the typical adult is ready to learn if the material presented bears upon his needs and deals with concrete practical problems. The adult feels an urgency to learn and thus tends to be an impatient learner. Further, due to the wide variation in age, experience, and past education of adults, the role played by individual differences must be accentuated. A more lengthy investigation into the psychology of the adult, as learner, is included in the Review of the Literature.

In considering the direction of this study, several further points must be made. First, there is a real need today, as expressed by both Provincial and Federal sponsors of adult students, for programs in which the students can work at a more individual rate. As is the case in many of the public schools, there is a general lack of special attention given to those students who either are very capable or are experiencing great difficulty. In addition, there are many students who express the wish to be able to work at an accelerated rate in an attempt to gain faster

entrance to some other post-secondary institution or training program. There are those, of course, who require a more extended period of time in which to master the content necessary to gain credit in a particular course. It thus seems very desirable that work be done in developing programs which allow for the individual preferences of the types mentioned.

Secondly, in adopting a more individualized approach to mathematics instruction it becomes necessary to place increased emphasis on the importance of reading ability in the learning process. For a variety of reasons, reading has not been emphasized as a vital learning tool for the adult to use in solving mathematical problems. The main reason perhaps is that many adults who return to school are, in fact, relatively poor readers and as a result tend to read only when they absolutely have to. Recognizing this characteristic of their students, instructors of mathematics have in the past based their presentations on the traditional lecture and note-taking method. This practice has had the effect of reinforcing the students' reluctance to read and has given them the impression that reading and individual "research" are relatively unimportant. In many adult classrooms the instructor has dominated the whole educative process and as a result he, rather than the student, has become the focal point. Consequently there has been relatively little time devoted to individual work or student-student interaction.

Finally, in considering the consequences of the above statements, it is necessary that a well-structured program be prepared. The

individual units of work must be organized in a logical and sequential manner to facilitate smooth progress, on the part of the students, through the program. To be effective, the materials must be complete, concise, and in a language appropriate to adult learners. Again, the emphasis must be on readability. In this study these materials will be termed modules. A module will consist of a collection of materials for use by students in a structured classroom setting or on an individual basis - including textbook(s) or teacher-prepared textual material, diagnostic (formative) tests, and remediation aids. There are many advantages to having such a program fully developed and available to adult students. Among them are the following:

(1) Those students who miss class time through illness or other circumstances (such as family break-up or babysitting problems) will be better able to "catch up" by referring to the relevant sections of a learning package, rather than by copying someone else's notes. Experience has shown that many adult students, though ill and at home will do some work while still at home in an attempt to stay abreast of their course work. Again, with a well organized learning package in their possession, such students should find it easier and much more productive to do such work.

The importance of the above is highlighted by the results of three independent drop-out studies (September 1971 - June 1972, September 1972 - January 1973, and September 1973 - January 1974) designed to ascertain the reasons for student terminations from

the upgrading program at Alberta Vocational Centre. In each survey, illness was stated as the major reason for termination. It is significant that in many cases it was illness of a family member other than the adult student himself that interfered with attendance at classes. It is quite probable that in such a case the adult can do a great deal of school work at home if, again, he has a learning package which makes it relatively easy for him to do this. The chore for the curriculum developer, then, is to prepare such a program which can be used by students without being reinforced by a great deal of lecture-giving and note-taking.

(2) Individual units of work (modules) pertaining to specific topics such as scientific notation or significant figures, can be "lifted" from the program and used by students in chemistry or physics who require extra work on a particular mathematical topic. This has in fact been a repeated request by such students and their instructors.

In summary, the above suggests that an approach to adult upgrading in mathematics be developed which incorporates materials presented in a module format. These materials should be appropriate to adult learners and should facilitate those who wish to progress through the course at an individual rate of speed.

DEFINITION OF TERMS

Most of the terminology in this study should be understandable in the context in which it is used. However, several terms must be clarified:

adult education: those systematic, sustained and supervised learning activities in which adults are engaged on a full-time basis, while attending institutions similar to Alberta Vocational Centre.

adult student: any student, regardless of age, who is attending an adult educational institution.

academic upgrading: that educational process in which students, who do not possess an adequate level of general education, are enabled to earn the credentials necessary for direct employment or for entry to technical institutes, colleges, universities, and programs of apprenticeship.

module: a collection of materials for use by students in a structured classroom setting or on an individual basis; primarily teacher-prepared textual material, diagnostic (formative) tests, and remediation aids.

mastery learning: an educational strategy defined in terms of attainment, by individuals, of a pre-defined achievement level for a specific objective or set of objectives.

process learning: an educational strategy the goal of which is to help the student to cope effectively and automonously with novel situations by being able to apply highly generalizable skills and operations.

CHAPTER II

REVIEW OF THE LITERATURE

In drawing from the contributions of leading educators it was mandatory, for the purposes of this study, to focus on possible applications to the sphere of the adult learner. This presented some problems in that the major portion of the literature was found to be directed towards a more youthful population. However, in such situations it was assumed that many of the basic concepts and generalizations could be directly applied to the adult learner, although perhaps in a modified form.

Information was required primarily in the areas of adult education, mathematics education and learning theory. In that few people could be considered authorities in all these areas, leaders in each individual field were reviewed. Their viewpoints helped provide direction to the goal of formulating a viable rationale fo. academic upgrading programs.

ADULT EDUCATION

> Time and energy are wasted by the adult educators who plan and conduct programs of adult learning without considering the nature of the learner and therefore, make little effort to fit a program to that nature. (Bergevin, 1967, p. 66)

Bergevin philosophy for adult education is based on the premise

that every attempt must be made to provide an education which is "personalized". He states that every adult can learn and that every adult can be helped to make better use of his intellectual capacities. It is further suggested that an understanding of freedom, discipline and responsibility promotes the discovery and productive use of our talents and that these three concepts can be comprehended only through a variety of inspired learning experiences. Bergevin thus concludes that traditional teaching procedures and learning facilities are very often inadequate in providing for adults' educational needs. It is argued that too much emphasis is placed on the speed of learning, and further that this "philosophy of speed" does not result in the production of quality human beings - human beings who have improved in their ability to perceive situations clearly and to learn thoroughly. This viewpoint is shared by Bloom and other proponents of the mastery learning approach to learning.

Any attempt to bring the learner into a meaningful relationship with what is to be learned, in both the cognitive and affective domains, must be done in such a manner that the adult has a dynamic relationship with the processes of learning. In making this statement, Bergevin (1967) contends that the adult must participate fully with the learning process and must be given the opportunity to exercise his judgement in learning situations. This emphasis on the processes of learning is parallel to the position taken by Biggs (1968). He (Biggs) states that the intent of process learning is to change the

learner in such a manner that he is capable of reacting effectively and autonomously when confronted with novel situations.

Bergevin cautions that one of the major problems related to implementing new approaches in education is resistance to change. The adult educator gets the student who has been schooled in the traditional system - as he himself was. The author concludes that this results in the adult student expecting what he always got from school, namely, a certain amount of information doled out in a certain amount of time, mostly by the so-called lecture method. The adult is a product of a school system characterized by a fairly rigid atmosphere, a relative lack of active learner participation, a very definite time constraint, and a teaching procedure that sets teacher and learner apart. Accordingly, the educator must be aware of the mental "set" which the student brings with him upon first entering an adult educational institution.

Bergevin states that although there are a few adults in every educational program who are concerned simply with increasing their general knowledge, the majority of participants are motivated by a much more pragmatic reason. Thus the conclusion is reached that the practicality and applicability of the material in a particular program must be foremost in the mind of the educator. He further states that "the average adult learner functions in the realm of reality more than in that of abstraction, and a problem-centered or situation-centered program is real to him" (Bergevin, 1967, p. 149). This is as opposed

to a "narrow" subject-centered approach in which it is assumed that particular subjects per se are of great interest to adult learners.

Finally, in A Philosophy for Adult Education, the following observations are made by Bergevin (1967). Each would seem to have relevancy to the adult educator.

(1) Many adults bring negative feelings with them to the classroom because they resent authority.

(2) Adults are sensitive about their role as learners and as such do not want to be exposed to resources which smack of childhood learning.

(3) Inadequacy and possible failure are more likely to be in the forefront of the adult's mind than in the mind of the average school-age child.

(4) Most adults must rather quickly see more relevance and immediacy of application of what is learned than is the case with children.

(5) Adults become frustrated and discouraged when education programs do not start at an intellectual level consistent with their previous schooling.

One is struck by the juxtaposition of observations (2) and (5) in the foregoing. In evaluating the learning packages this will

have to be taken into account. That is to what extent is it possible to start mathematics instruction at a level consistent with previous schooling and at the same time not have that portion of the program smack of childhood learning. Further, it would appear desirable to ascertain the extent to which Alberta Vocational Centre students demonstrate the many characteristics to which Bergevin refers.

MATHEMATICS EDUCATION

> Chalking a mathematical statement on the board, the professor said: 'This of course, is obvious.' He looked at it again and added: 'At least, I think it is obvious. Then he retired from the lecture-room with a pencil and paper. Twenty minutes later he returned beaming and announced: 'Yes, gentlemen, it is obvious.'

The above mentioned anecdote is used by the editor of Skemp's book, The Psychology of Learning Mathematics, to highlight Skemp's contention that mathematics can degenerate into a presentation of rules and procedures devoid of any emphasis on the underlying reasoning involved. In the book named, Skemp (1971) questions the approach used by many teachers in which mathematics is presented as being obvious. To him, a thorough understanding of what one is doing must be a major theme in the learning process. It is stated that unless we understand basic concepts in mathematics such as those

of systems of numeration, equivalence and mathematical models, then we cannot fully understand the processes stemming from them. This would seem to have implications for the application of the process learning approach as advanced by J. B. Biggs (1968). The implication for curriculum developers is that an attempt must be made to identify those sorts of learning situations which lend themselves to concept attainment.

Skemp's position is that learning must take place in an atmosphere of interaction between intelligences. He states that "in mathematics, perhaps more than any other subject, the learning process depends on agreement, and this agreement rests on pure reason" (Skemp, 1971, p. 116). It is argued that there must be a "meeting of minds" in the sense that the methods used must include the student as an active learner. This position is similar to that taken by Bergevin (1967) who states that the adult must be an active learner, that is, one who has the opportunity to exercise his judgement in various learning situations. Skemp concludes that if what the student encounters is not intelligible material (to him), then concept attainment is doubtful. He argues that presenting material as a series of seemingly simple rules (for example: to solve an equation take all of the x's to one side and all the 'numbers' to the other) is in fact harmful unless the rule is founded on a base of real understanding.

In providing a rationale for these statements, Skemp continues:

> Trying to understand something involves the accommodation of one's schemas. To the extent that what is being communicated is not intelligible, the receiver is trying to accommodate his schemas to assimilate meaninglessness. To do this would be the equivalent to destruction of these schemas: the mental equivalent of bodily injury. (Skemp, 1971, p. 117)

To clarify the above quote, a schema may be thought of as a mental structure which functions in such a way as to integrate existing knowledge and also to provide a means for the acquisition of new knowledge. Skemp thus sees the student's mind boggling at the unorganized collection of rules given to him. He states that the student is aware that he cannot find meaning in what is presented to him but more importantly is not aware that the fault does not lie with himself. The point is conceded that if all that is wanted is a quick rule for solving a particular type of problem, then an algorithmic approach is acceptable. He emphasizes, though, that to be able to adapt one's knowledge to new situations requires the understanding of firm concepts.

Skemp's contention that the emphasis must be upon the "meeting of minds" between instructor and students and upon concept attainment has implications for the curriculum and instruction goals formulated in this study. Were a completely individualized approach employed, it is doubtful that these goals could be realized. Support for this point of view is found in the Report on the Newstart Demonstration

Project which was conducted at Alberta Vocational Centre from November 1971 to March 1972. The materials for the Project were developed to facilitate individualized instruction as opposed to a group approach. Accordingly, one of the main objectives of the Project was to evaluate the individualized style of instruction which was used. The assessments reported reflected the views of all those individuals involved in the Project - students, instructors and supervisors. A major conclusion was that although there was an adequate survey of mathematics topics "considerable elaboration or topics with accompanying exercises for practice was deemed necessary if students were to acquire the command of concepts and processes required for versatility and flexibility in mathematical thinking" (Romanko, 1972, p. 12). Further, the point was made that "even with a class of only 15 students it was not possible for one instructor to provide adequate individual assistance in circumstances where students were working at up to 15 different stages" (Romanko, 1972, p. 8). It thus seems advisable that although allowances will be made in this study for students to work at a more individualized rate than has been the custom at Alberta Vocational Centre, a completely individualized approach will not be used.

In considering the problem of negative feelings towards the teacher (an authority figure) the point is made by Skemp that student-teacher clashes can be extreme in mathematics in that the learning processes in mathematics must be based firmly on reason and agreement.

If what the teacher is presenting seems unreasonable, then this deepens the feelings of resentment towards the teacher. The importance of this cannot be overemphasized in the case of the adult learner in that (as reported by Bergevin) adults often bring negative feelings with them into the classroom because they resent authority. Skemp states that the problem of reaction against authority is minimized when the students' schemas have been developed in such a way that the material seems reasonable. Under these latter conditions the instructor can be accepted as a reasonable "character" in that he has superior knowledge in mathematics - a subject which is itself reasonable.

Skemp identifies student anxiety as one very important variable which must be considered in assessing the effectiveness of any teaching method. His basic premise is that anxiety may increase, subjectively, the difficulty in understanding and mastering new material. He states:

> The more anxious the student becomes, the harder he tries, but the worse he is able to understand; and so, the more anxious he becomes. Thus a viscious circle may be set in operation. . . . Given several experiences of this kind, the situation itself, of a mathematics lesson or lecture, becomes a learnt stimulus for anxiety; so the student begins each lesson already partially defeated. That this is not an exaggerated picture will be vouched for by many, from their personal experience. (Skemp, 1971, p. 125)

In stating that many adult students enter educational institutions with extreme feelings of inadequacy and failure, Bergevin (1967) would surely favor learning situations which minimize the anxiety to which Skemp refers. Accordingly, special attention will be paid to this

variable in assessing the effectiveness of the teaching strategy formulated in this study.

LEARNING THEORY

In Information and Human Learning, Biggs (1968) identifies two general aims of education which have been traditionally distinguished: the child(learner)-centered aims and the subject-centered aims. He states that according to the former, the central focus is upon the development of the potentialities of the individual. The subject-centered approach emphasizes the importance of the transmission and enlargement of a body of knowledge. This latter approach is characterized as taking one of two rather distinct forms:

(1) the rather academic view that learning involves mastery, to a particular standard, of a body of knowledge. "The criterion of such learning is therefore the extent to which the learner is capable to give evidence for his learning" (Biggs, 1968, p. 3).

(2) the more utilitarian view that education involves the mastering of the facts and skills required by the average citizen.

In deciding upon the relative emphasis which each of the above approaches should be given in any educational setting, Biggs states that none of them are likely to provide an individual with the wherewithal to cope with future demands made upon him. He suggests that the most desirable approach is to produce an amalgam of them all.

> Such an amalgam would involve the learner as one who (a) has mastered a body of knowledge, and (b) has become, through the educational process, a better thinker and problem-solver, so that (c) he is useful to society, despite the fact that changes in society prevent us from prescribing in advance what his specific uses will be. (Biggs, 1968, p. 5)

The means by which this ideal is to be realized is termed, by Biggs, the process learning approach.

Process Learning

Biggs' process learning is characterized by teaching at a higher level of generality, in order that the learner himself may construct "codes". These codes function to allow the link-up of seemingly disparate events and also to relate these events to some more universal concept. It would seem that Skemp (1971) is suggesting a similar approach in emphasizing the need for the attainment of schemas, by the learner.

In considering the process learning approach as a possible strategy for use at the Alberta Vocational Centre, the Report on the Newstart Demonstration Project contains a key statement. In assessing the effectiveness of the instructional approach used, the instructors agreed that "the absence of variety in methodology created crises of low morale and boredom from time to time" (Romanko, 1972, p. 8). That these are undesirable effects of any teaching method need hardly be emphasized. It thus seems desirable that a "multi-approach" strategy similar to what Biggs is suggesting be used in this study in

order to minimize these undesirable reactions.

In Learning: Past and Future, Biggs (1973) further distinguishes between content and process learning. He states that while process-learning must always involve content to some degree, the emphasis must be upon the possible transfer of knowledge to novel situations. The learner must be taught to cope effectively and autonomously. Biggs conceded that when content really must be mastered then Bloom's (1968) learning for mastery strategy is indeed desirable. He claims, though, that "the processes involved here are limited in extent, and thus it is necessary--if the student's potential is to be realized--to expose him to a wider range of situations" (Biggs, 1973, p. 7).

A summary of Biggs' approach to process learning follows:

(1) In that process learning cannot "occur in a vacuum", a certain amount of basic content must first be mastered.

(2) The student must be able to (or be taught to) apply highly generalizable skills and operations such as writing and reading skills. This would imply that in applying the process to mathematics, a modicum of computational skills must be present.

(3) Basic problem-solving strategies must be learned in order to have an effective tool at hand to give focus to the skills learned in (2) above.

(4) The student must be involved in setting his own objectives. Such objectives are termed expressive (a term coined by Elliott Eisner), and "they arise in the course of the learning episode and are

recognized and formulated (if at all) by the learner, not by an outside agent. Whereas instructional objectives are appropriate where the "truth" is already known in advance, expressive objectives apply where the "truth" is relative, emergent, and for the learner to decide" (Biggs, 1973, p. 8). Further, it is emphasized that there is merit in letting the student know what it feels like to have to make his own decisions and to have to "live with" the consequences.

(5) The student should take an active part in his own efforts. For this to be an effective process, the evaluation should be criterion-referenced and formative in nature as opposed to being norm-referenced.

(6) There should be a gradual movement towards intrinsic motivation - where the task itself is of sufficient interest to the student to provide the impetus for learning. "Being intrinsically motivated is a signal that--for the time being and in that particular task--the learner is self-sufficient. And being self-sufficient is what process learning is all about" (Biggs, 1973, p. 10). Statements made in the Newstart Project report have relevance here:

> Most of the trainees possessed weak study habits and skills with the result that they were under a sever handicap in situations that required them to be self-directed and self-motivated. Several weeks of adjustment were required before trainees began to use their time efficiently. (Romanko, 1972, p. 8)

> Well motivated students developed a high degree of self-responsibility for their own learning. Regrettably, a significant number preferred to rely on the instructor to take responsibility for their learning. (Romanko, 1972, p. 9)

The first statement above reinforces Biggs' contention that to be able to cope effectively and autonomously in learning situations, the students must first have mastered some basic skills and operations and some basic content. Only when this is accomplished, then, can students be expected to take a more active role in directing their own work. In addition, it would appear from the second statement that self-responsibility of students involved in the Project w y heavily dependent upon their motivation. It would thus appea ible to consider motivation as a key variable for consideration the present study.

In assessing the progress of students in a process learning program, Biggs suggests that there are two aspects of such change to be considered. First, there are those internal changes such as flexibility and originality of thought, and ability to organize and classify data. Secondly, there are those external manifestations of such change having to do with what the learner can do. It is upon these external and more easily observable aspects that the teacher should concentrate. Thus Biggs states that "it is in fact easy to set up a checklist of behaviors, specific to situations in which the student will be exposed, and determine the extent to which he behaves effectively and autonomously" (Biggs, 1973, p. 11). In forming such

a checklist of specific behaviors, the list of suggestions for the formulation of a process strategy provides a good framework.

In summary, the point of view is presented that it is very desirable that education become a matter of process mastery as opposed to content mastery. The rationale given by Biggs is that the "knowledge explosion" has resulted in a need for the development of methods for the processing and organizing of large blocks of information. This approach is as opposed to the seemingly hopeless task of "learning it all" in the traditional sense. The emphasis in education, then, should be on learning how to learn.

Mastery Learning

Much attention has been paid over the past five to ten years to B.S. Bloom's mastery learning strategy. Biggs (see above) concedes that when content must really be mastered, then Bloom's (1968) learning for mastery strategy is indeed desirable. Accordingly, a summary of the key facets of mastery learning is included herein and possible applications to the field of adult education considered.

In Mastery Learning Theory and Practice, Block (1971) focuses on both the theory behind the concept of mastery learning and also the advantages of this approach. He describes the strategy of learning for mastery as one directed towards reversing the conviction held by many educators that only a few of the very bright students can learn

the major portion of what we have to teach. He claims that "our schools have not moved very far toward the goal of increased learning for all students" (Block, 1971, p. 2). He concludes that the result is that only about one-third of the learners have successful and rewarding learning experiences. Further, it is suggested that these unsuccessful learning experiences limit an individual's chances for economic survival and security in the field of work.

The importance of the above statements is very pronounced in relation to adult students attending institutions similar to Alberta Vocational Centre. The initial motivation for the majority of such students to "return to school" is being unable to attain adequate security for themselves (and their families); that is, they are either unemployed or underemployed. For them, an upgraded education is perhaps their only real hope of eventually attaining a decent standard of living. That these same adults represent the one-time "rejects" of the regular school system tends to lend support to Block's contention. For Block, the mastery learning strategy offers the possibility that almost all students can learn what we have to teach them - if only we use the proper techniques to attain this goal.

Upon analysis of two early attempts at the idea of mastery of learning (the Winnetka Plan of Washburne and associates and Morisson's University of Chicago Laboratory School), Block (1971) found that they shared six basic operational features:

(1) Mastery was defined in terms of achievement, by individuals, of

specific educational objectives.

(2) Instruction was structured into self-defined learning units.

(3) Complete mastery was required of each unit before preceding to the next unit.

(4) Diagnostic-progress tests were used to provide feedback to both student and teacher.

(5) Original instruction was supplemented with appropriate learning correctives if the results of the diagnostic tests indicated that such action was necessary.

(6) In that complete mastery was required by each student, the time required was let vary from student to student.

In giving a more up-to-date perspective of the idea of mastery learning, Block presents Carroll's conceptual model and then shows how Bloom extends this to give an actual working model. Carroll's model is presented in functional notation as:

$$\text{Degree of learning} = f\left[\frac{\text{time actually spent}}{\text{time needed for mastery}}\right]$$

This notation emphasizes a key feature of mastery learning, namely, that the degree of learning is dependent upon the extent to which the time actually spent in learning approaches the time needs for thorough learning (ie: for complete mastery). It is further noted that these two time variables are themselves functions of certain institutional and individual factors. Specifically, the time needed

for mastery is seen as dependent upon the student's aptitude, the quality of instruction, and the student's ability to understand this instruction. The time actually spent is seen as varying in relation to the time allowed for student work and also the student's perseverence. In considering the interrelationships between these factors it is important to note that the aptitude is probably a constant. However, the other factors are definitely variables and are capable of manipulation.

In thinking of possible applications of Carroll's model (as to adult learning for example) a study of Bloom's (1968) working model of mastery learning provides some interesting insights. Block (1971) states that the operational strategy proposed by Bloom is very similar to that of the two early mastery models. It is claimed though that Bloom's more recent strategy is a great improvement in two major respects.

> First, the feedback instruments were much improved. Their improvement was attributable in part to the greater precision with which the structure of the learning units could be described. ...These structural descriptions provided an excellent blue print from which the diagnostic instruments could be built. The feedback instruments' improvement was also attributable to a major evaluation breakthrough called formative evaluation. ...Secondly, this strategy employed a greater variety of instructional correctives than previous approaches.
>
> ...The sole function of the correctives was to provide each student with the instructional cues and/or the active participation and practice and/or the amount and type of reinforcements he required to complete his unit learning. For these purposes, the following correctives were used: small-group

> study sessions, individualized tutoring, alternative learning materials (additional textbooks, workbooks, programmed instruction, audio-visual methods, and academic games), and reteaching. (Block, 1971, p. 8)

In Learning for Mastery Bloom (1968) states that a majority of students can master what we have to teach them and thus that the educator's task is "to search for the methods and materials which will enable the largest proportion of our students to attain mastery" (Bloom, 1968, p. 1). Bloom is implying here that there is no one method which will work equally well for all students. He emphasizes the fact that instruction must be adapted to the needs of the individual learner as much as possible, as opposed to the "blanket" treatment often used. Further, it is argued that the presence of a variety of teaching procedures and instructional materials helps both teacher and student to defeat feelings of passivity about the educative process. This contention is supported in the Report on the Newstart Demonstration Project which was conducted at Alberta Vocational Centre and reported earlier in the study. A major conclusion of that Project was that the absence of variety of teaching method resulted in low morale and boredom on the part of the students. Again, an approach which incorporates a wide variety of materials and strategies suggests itself.

In describing a mastery of learning strategy (being used by a group of researchers at the University of Chicago in 1968) Bloom (1968) provides some insight into the general operating procedures and into the techniques relating to formative evaluation. It is important to note that the University of Chicago study involved university students

as subjects. In that the majority of Alberta Vocational Centre students fall into a similar age category, the results of the above study take on special significance. In other words, it should be possible to generalize, to some extent, the results of the University of Chicago study to other adult educational institutions.

Bloom establishes that a precondition of formative evaluation is that the course be broken into relatively small units of learning. These units may correspond to any well-defined content portion of the course. In the University of Chicago study the ideas presented by Gagne in Conditions of Learning and Bloom in Taxonomy of Educational Objectives provided the framework within which decisions were made relative to the content organization. An attempt was made to categorize the elements within each unit into a hierarchy ranging to complex processes such as application, analysis, and synthesis.

In describing formative evaluation Bloom states:

> We have then attempted to construct brief diagnostic-progress tests which can be used to determine whether or not the student has mastered the unit and what, if anything, the student must do to master it. We have borrowed the term Formative Evaluation from Scriven (1967) to refer to these diagnostic-progress tests. (Bloom, 1968, p. 9)

Many advantages to these formative tests are suggested, amongst which are the following:

(1) The tests pace the learning of the students and motivate them to put forth extra effort to eliminate deficiencies immediately upon

their identification.

(2) The students who have achieved mastery are assured that their present approach to learning is effective and are thus rein ed to continue their efforts.

(3) Since students may attempt the same or parallel diagnostic tests several times in an attempt to demonstrate their mastery, there should be a reduction in the anxiety associated with the testing process.

(4) The formative tests reveal points of difficulty and thus aid in the selection of instructional materials and processes required for remedial action.

That the above type of testing can in fact be overdone is suggested in the Report on the Newstart Demonstration Project. The instructional style involved in the project was "in keeping with the current view that, in planning for teaching and learning, mastery of content should be the constant while time required for mastery should be the variable" (Romanko, 1972, p. 8). In addition, a formative-type testing procedure was used. The instructors involved with the project agreed that many students came to regard the passing of tests as an end in itself. "There was a disturbing preoccupation with test-taking rather than learning for mastery" (Romanko, 1972, p. 8). This will have to be guarded against in applying the mastery strategy in the present study.

Bloom identifies various means for helping the students to work

on their difficulties. He states that the most effective method (in relation to the University of Chicago study) has been to use small groups of students who meet regularly "to review the results of their formative evaluation tests and to help each other overcome the difficulties identified on these tests" (Bloom, 1968, p. 10). In addition it is suggested that tutorial help should be available to students experiencing problems. The use of a variety of audio-visual methods is also presented as a technique especially useful in helping particular types of students.

Airasian (1971) recommends that, in an attempt to accommodate individual differences, every attempt must be made to provide for an on-going system of specific feedback to provide direction for further work. He states that in mastery learning this is especially important in that the strategy itself is based on the premise that there is a constant flow of information relating to the attainment of specific objectives.

The foregoing represents the views of several leading educators from the areas of adult education, mathematics education and learning theory. Their viewpoints will be considered while formulating a rationale for academic upgrading programs.

CHAPTER III

PROGRAM DEVELOPMENT

RATIONALE FOR PROGRAM DEVELOPMENT

In formulating a general philosophy or rationale for adult education, attention should be paid to the advice of Miel (1964). She states, in giving a historical perspective to curriculum trends, that many educators in the past fell into the error of believing that it was necessary to be against one particular approach (regarding content selection, teaching method or evaluation) to be in favor of another. It is hoped that the stance taken in this study cannot be so characterized. In analyzing the needs of adult students and also the views of leading educators, one is led to the conclusion that what is needed is a "multi-approach" rationale. The desirability of such a rationale is emphasized by Biggs (1973). He contends that although it is worthy to strive for mastery of a body of knowledge, emphasis must also be given to high level processes relating to problem solving and critical evaluation. This approach appears to be consistent with one of the recommendations in the report of the Commission of Education Planning, entitled A Choice of Futures. In emphasizing the advantages of stressing the acquisition of general problem-solving skills, the report makes the point that "the processes of schooling cannot be divorced from the process of living" (Worth, 1972, p. 153). Again, this latter recommendation does not play down the importance of the approach proposed by Bloom, in

which objectives are made explicit, beforehand, and the teaching process directed towards providing each student with the wherewithal to achieve mastery of these objectives. In fact, Worth (1972) states a bonus of such a strategy:

> The definition of behavioral objectives brings the needed clarity to program designs and enables the staff to apply their professional knowledge of the conditions of learning. (p. 153)

He further states that if the total program is pre-planned prior to the actual teaching encounter, then teachers can be expected to have more time to do those tasks they should be able to do best; namely, to develop strategies for motivating students, to select those condtions which maximize individual learning and to assess student performance.

It thus seems desirable, for the purposes of adult education, to effect a marriage between the process learning and mastery learning strategies. It will be assumed that the major portion of the mathematics content can be prescribed beforehand for the adult in an upgrading program. For this content to be "goal-directed" would require that considerable work be done in ascertaining exactly what skills, concepts and abilities are important for the student to possess as a prerequisite for entry into his chosen trade or technology. A mastery model would seem to be effective in providing for a major portion of this learning. In addition, in providing education towards the goal of self-sufficiency and the ability to be an effective problem-solver, a process learning strategy appears attractive.

Table 1 should help to put several of the variables in perspective. It shows the relationship between specific student characteristics and their consequences in the areas of selection of content, teaching method and evaluation techniques.

SELECTION OF COURSE CONTENT APPROPRIATE TO THE RATIONALE

The technical mathematics program at Alberta Vocational Centre consists of three levels (levels I, II and III), roughly the equivalent of the Mathematics 13, 23 and 33 courses offered in the regular school system. The main focus of the present study was level I of this program.

As stated earlier, one of the requirements of the study was to produce instructional materials appropriate to the rationale. To this end the total program was pre-planned prior to any instruction having taken place. Care was taken to ensure that the content selected for inclusion was compatible with the needs of students as outlined in Table 1. In addition, it was mandatory that the level I content provide adequate background for those students proceeding into the level II course.

Three other sources provided guidance in deciding upon appropriate content: the program of studies for Alberta senior high schools, recommendations from the Alberta Apprenticeship Board, and recommendations from the Mathematics Department at the Northern

TABLE 1

CONSEQUENCES OF ADULT STUDENT CHARACTERISTICS

Characteristics of Adult Students	Consequences for selection of content, teaching method and evaluation techniques
-students have forgotten many of the basic mathematical concepts and operations.	-the necessity for a thorough preliminary review. -the availability of a sequential package of learning materials which are expressed in simple language. -a good starting point for the emphasis on the importance of reading, writing, and computational skills.
-students are practical people and must see the relevancy of the material included in the program.	-the inclusion of an abundance of material relating to real-life situations as opposed to the inclusion of cold, academic data. -emphasis on the accommodation of material to the students' schemas. -necessity that the written materials are in language appropriate to adults (as opposed to the Dick and Jane syndrome).
-students have feelings of inadequacy and possible failure.	-the use of criterion-referenced formative testing procedures to help students to pin-point their difficulties. -the provision for enough time for each student to attain mastery.
-students show resentment towards the instructor (an authority figure) and have negative feelings towards learning in general.	-gradual replacement of the instructor as the one directing classroom activities to a more self-directed approach to learning. -provision of alternative learning materials and environments for those not making reasonable progress towards achieving mastery.
-students wish to be able to work at an individual rate of speed.	-the existence of a fully developed package of materials (instructional package), complete with formative tests for diagnosis of difficulties. -emphasis placed on textual material which is attractive and easily read by students. -the necessity that students demonstrate their ability to read, write and compute sufficiently well to progress on their own.

Alberta Institute of Technology. The advisability of having input from these latter two sources is evidenced by the fact that many AVC graduates enter either apprenticeship programs or NAIT technologies. Further, an attempt was made to include content related to general problem-solving skills. This content was deemed useful and advantageous to the success of those students who re-enter the work force directly upon leaving AVC, as well as to those students who continue their formal education.

Finally, on the basis of the foregoing, the level I content was organized into eight units. Each unit was further subdivided into chapters or modules, there being twenty-four modules in total. The unit headings were as follows:

Unit I	Basic Operations with Whole Numbers (Review)
Unit II	Operations involving Fractions
Unit III	Measurement of Distance, Area and Volume in SI
Unit IV	Basic Algebra Concepts
Unit V	Exponent Operations and Scientific Notation
Unit VI	Algebraic Expressions
Unit VII	First Degree Graphs and Systems of Two Linear Equations
Unit VIII	Fundamentals of Trigonometry

PREPARATION OF THE MODULES

Of the twenty-four modules or chpaters making up the course, the first sixteen were teacher-prepared. For the final eight chapters of the course the standard level I textbook, Principles of Mathematics, Book I, was used. Henceforth, the term module will be used only when referring to one of these sixteen teacher-prepared units of work. Several pages of one of the modules are included herein in the Appendix.

Many factors had an influence on the preparation of the modules. The goal was that the content of the modules be compatible with and directed towards the rationale for program development. Amongst these factors were the following:

(1) The need for a preliminary review of basic concepts operations. The first six modules were designed to is need. They concentrated upon operations with whole numbers. Included was work relating to the use of brackets, order of operations, bases indices and powers, factors and multiples and finally, expressions involving powers.

(2) The option available for students to work at an individual rate of speed. For this goal to be realized meant that students must gain confidence in their ability to read and learn on their own. Thus a major objective in preparing the modules was that they be easily read. Concepts were presented using simple language and explanations and related problems were made as

concrete and practical as possible. Each module contained numerous examples worked out in detail.

(3) The need for answer keys to be provided with each module. The benefits of this were many. First it freed the instructors from having to provide answers on a daily basis, thus allowing them to spend more time helping students. In addition, access to the correct answers was mandatory if students were to work more independently. A major objective of the teaching approach formulated in this study was for the person directing the day to day classroom activities to shift gradually from the instructor towards the student himself. The keys helped to facilitate this shift. Finally, it is the researcher's experience that adult students become frustrated in doing homework assignments when they do not have the correct answers available. They like to know if they are on "the right track" when working on problems.

(4) The need for the student to see the relevancy of the course material. To this end the material was presented in simple, straight forward, yet not childish language. Material of an explanatory nature and as many examples and problems as possible dealt with real-life situations. In this manner it was hoped that negative feelings towards the subject and consequently to the teacher might be kept to a minimum. Skemp (1971) suggests this as a consequence of teaching in cases where new material is presented as an extension to a student's existing schemas.

AVC students in level I mathematics tend, in the researcher's experience, to be practical and non-academic "types". It thus seems reasonable that they would react positively to the type of content suggested above.

Further, each module contained numerous exercises to be done by the students. Each set of exercises was designed to reinforce the concepts developed in that section. An attempt was made to sequence the exercises from easiest to hardest. The intent was that students would gain confidence by experiencing success in the initial section of a set of problems.

The modules were prepared over an eight month period of time extending from September, 1975 to April, 1976. To facilitate their production the researcher was assigned a reduced teaching load by the administration at AVC for this period of time. Graphic work and typing were done by the Audio Visual and Academic Upgrading departments of AVC respectively.

DEVELOPMENT OF THE METHOD OF INSTRUCTION

The main goal was that the method of instruction be consistent with the rationale for program development. To facilitate movement towards this goal the features outlined previously in this chapter were employed in the treatment. Accordingly, many factors were involved. Collectively these factors could be considered as stemming from three major sources: the process learning strategy as proposed by Biggs,

the mastery learning strategy of Bloom, and other influences related to various student needs. Features related to mastery learning were emphasized early in the semester with process learning becoming increasingly important as the semester progressed.

The main instructional features of the treatment related to mastery learning were as follows:

(1) Students and instructors used a learning package consisting of sixteen modules and related material (to fulfil the need that instruction be structured into well-defined learning units).

(2) A course outline with units subdivided into broad instructional objectives was given each student. Students' themselves were involved in identifying specific behavioral objectives within each module (for first sixteen chapters of the course) and within each textbook chapter (for the final eight chapters of the course).

(3) Students were not required to show complete mastery on each module before proceeding. However, they were encouraged to do remedial work to eliminate the deficiencies identified in the diagnostic-progress tests. Upon doing this remedial work students were allowed to write another examination on the appropriate section.

(4) Small groups of students met regularly in "workshop" to do remedial work, to do homework and to do drill related to the course content being discussed by the regular class at that point in time. The drill sessions were done with the students

at the blackboard. The workshops were of one-half hour duration or less and scheduled during blocks when most of the students had their spares. Attendance was optional. An instructor was available periodically at these sessions to give tutorial help to students experiencing problems. On other occasions a capable group member assumed a leadership role in this respect.

The instructional features related to process learning were:

(1) The first three weeks of the semester were devoted to a thorough review of basic mathematical concepts and operations. This was done in order that later concepts, skills and generalizations could be related to this solid base of understanding.

(2) Students were required from the beginning to do independent reading of the course material including both the modules and supplementary material.

(3) One module (Module 14) was devoted entirely to developing basic problem-solving approaches. Students were encouraged to apply these approaches in subsequent course work.

(4) Students were encouraged to become <u>actively</u> involved in their learning and in the setting of some of their own objectives. This encouragement took many forms. Each student was allowed to set his own mastery level with a minimum of fifty per cent being acceptable. Attendance at workshops was encouraged but remained an optional activity. Marking of homework was done by each student as an integral part of the homework assignment itself. Marking keys were provided for this purpose. The actual "lecture"

portion of the class (teacher-directed time) was kept to a [illegible] um - generally less than thirty minutes per class. This resulted in forty five minutes being available every day for [illegible]dent-student and teacher-student interaction as well as for individual work.

Finally, one further important factor had to be considered in the development of the method of instruction; namely, that students would learn at varying rates. To accommodate the instructional method to this factor, to the rationale and also to administrative restrictions within AVC, the following procedure was followed. Students who had demonstrated their ability to progress through the course with very little instructor guidance (that is could effectively apply a process learning strategy to their own learning), and at an acceptable mastery level, were encouraged to do so. It was anticipated that these students would form a somewhat cohesive sub-group within the larger class and that they would complete th· course more quickly than the others.

CHAPTER IV

EXPERIMENTAL DESIGN AND PROCEDURE

Alberta Vocational Centre, Edmonton has been involved in efforts to revise its mathematics program before, most recently the Newstart Demonstration Project undertaken in 1972. Unfortunately, the Project was not considered to be a complete success. It was concluded that this was, in part, due to the fact that the design of the project was too "loose". Further, it was concluded that, to be effective, such an undertaking must have clearly defined objectives and limitations, that a total operational framework be devised and agreed upon by all those involved and that a careful staff selection be undertaken. It was agreed that without these precautions such undertakings are extremely difficult to evaluate. The following summary statement highlights this concern.

> If projects are to provide data of any validity, a reasonably tight and sophisiticated research design which undertakes to account for all possible independent variables needs to be devised, and all research activities should focus on clearly identified testable hypotheses. In a field as subject to fads as education is, it is particularly critical that "new" instructional modes be subjected to carefully structured research analysis. (Romanko, 1972, p. 18)

Accordingly, the procedures outlined herein were followed in an attempt to provide a reasonably "tight" research design.

SELECTION AND DESCRIPTION OF SUBJECTS

The experimental subjects of this study were those students who were enrolled in the Level I technical mathematics program (roughly the equivalent of Mathematics 13) during the 1976 five-month spring semester. Of the total of 78 students in the program, 39 were male and 39 were female. Before the end of the semester 3 students had transferred to another math course and 22 students had terminated from Alberta Vocational Centre. Thus, 53 students completed the program.

In academic upgrading programs students are classified as being either new or on-going. New students are those who are in their first semester. They are placed into appropriate courses on the basis of the scores they achieve on placement examinations which are written prior to the commencement of the semester. On-going students are those who are continuing from the previous semester. Of the 78 students involved in this study, 27 were on-going and 51 were new students.

Selection Procedures

The established practice at Alberta Vocational Centre is to have academic upgrading classes contain no more than thirty students. Accordingly, the students were divided into three classes hereafter referred to as Class A, Class B and Class C. The classes contained 26, 25 and 27 students respectively. Classes A and B formed the treatment groups with Class C being the control. Various problems

attached to the procedures of scheduling the classes and subsequently of selecting the students for each.

Instruction at AVC is offered during six periods or blocks, each of a duration of seventy-five minutes. Ideally, all three classes might have been scheduled during the same block in order that the results of the study not be contaminated by factors such as fatigue effects associated with different class starting times. However, it was not possible to schedule all the classes in this manner. The researcher did, though, convince the adminstration to schedule two classes for the same block. Thus Class A was scheduled in block 3 starting at 11:10 every morning while Classes B and C were held in block 6 starting at 3:10 in the afternoon. It was deemed important that the control class be scheduled at the same time as one of the treatment classes. Otherwise it would be hard to eliminate class scheduling as a factor influencing results of the various measurements made in the study. All classes were held in large, bright classrooms on the third floor of Alberta Vocational Centre.

The selection of students for each class presented some difficulties in that most students attending AVC must enroll in three classes. It is school policy not to schedule these three classes in three adjacent blocks. This resulted in several students having to be placed in either block 1 or block 6 for their mathematics, depending upon what their other two courses were. However the majority of students were placed into the 3 classes on a random basis. The need

for randomization in studies involving sampling statistics is widely known and need not be reported here at great length. Briefly, it is needed in order to ensure that extraneous variables which are concomitant with the dependent variable(s) will not introduce systematic bias in the experimental results.

To validate that the students in each class were functioning at approximately the same mathematical level prior to the treatment, the following procedure was followed. The same test was given to each student at the end of the three week review period. The test covered the content being reviewed during that period of time. A one-way analysis of variance was then used to compare these marks. The analysis resulted in a non-significant F-ratio of 0.44. This result confirmed the equality of the classes with respect to mathematical functioning level at the start of the semester.

SELECTION OF STAFF

Three teachers were required to provide instruction for the classes involved in the study. At the time of the selection there were eight instructors working in the Mathematics Department at AVC. Accordingly, towards the goal of protecting internal validity of the study, a careful selection was made.

Several criteria were involved in making this selection. Each instructor was to have several years experience in teaching mathematics to adults in academic upgrading programs. A good proportion of this

experience was to have been at a level comparable to grade 10 of the regular school system. This was to ensure that the instructors be familiar with the general content of the level I program. Further, each instructor was to have a proven record of competence as a mathematics instructor at AVC. Finally, it was deemed desirable that the three instructors have more or less similar teaching "styles". To objectively choose the three instructors on the basis of the above criteria required that the senior instructor of the department be involved. His knowledge of the capabilities of each instructor, obtained by working closely with them as their immediate supervisor, proved helpful.

On the basis of the foregoing criteria the choice of instructors was made. In addition to the researcher, two other experienced instructors were chosen. The researcher was assigned to one of the two treatment groups. It is conceded that it is not possible to control the varying instructor-treatment interactions resulting from having three different instructors involved in the study. However, the procedures followed for staff selection were carried out in order that any resulting biases be kept to a minimum.

PROCEDURES FOLLOWED

Various procedures were followed to ensure that the instructors involved in the project were prepared adequately before the classes commenced. In addition, an ongoing dialogue occurred between instructors as the semester progressed.

Prior to the actual instruction it was mandatory to differentiate clearly between the different treatments. Accordingly, the following distinctions were identified and agreed upon by the three instructors. Class A, the class taught by the researcher, was to employ the complete treatment as outlined previously (see pages 42 to 45). Class B, the other treatment group, was to apply this same treatment with one minor exception. Students were not allowed to write "make-up" examinations on sections of the course in an attempt to raise their marks. Further, both groups A and B returned to the regular textbook used in level I Mathematics for coverage of the final eight chapters of the course.

The method employed for the control group, Class C, differed from the above in many respects. In general terms it could be described as the "typical" approach used for mathematics classes within AVC and in all likelihood, within the majority of public school mathematics classrooms in Alberta. As a result, most of the operational features outined previously for the treatment groups were missing. There was one exception; the first three weeks of the semester were devoted to a thorough review of basic mathematics concepts and operations. As in the case for the treatment classes, this was done in order that later concepts introduced in the course could be related to this solid base of understanding. The basic course content was the same for all three classes.

Preparation of Examinations and the Questionnaire

The three groups of students wrote common mid-term and final examinations. Marks on these examinations were to be used in testing the significance of any differences in achievement amongst the groups. Care was exercised in preparation of the tests in an attempt to maximize their reliability and validity.

At mid-term the control group was not as far along in the course as were the treatment groups. The content of the mid-term therefore included only that portion of the program which had been covered by all three classes. The examination consisted of both multiple choice and written-answer questions. All three instructors prepared sample questions of both types for inclusion on the mid-term. From amongst this collection of submitted items a decision was made by the instructors as to which items should be included. A common marking key was prepared and carefully followed. Multiple choice questions were assigned a weighting of two marks each. No penalty was assessed for incorrect choices. The written-answer questions varied in weighting from two to six marks, depending upon their difficulty and length. Partial marks were assigned objectively on the basis of the requirements identified on the marking key.

For the final examination the same procedures as outlined for the mid-term were followed. The control group, unlike the treatment groups, finished only the first seven units of the course. Accordingly, the final examination did not contain questions based on unit eight.

The emphasis on the final examination was on the course material covered after the mid-term. There were, though, questions based on the content of each of the first seven units.

A questionnaire was designed and administered to all the students remaining in the three classes at semester end. A copy of it is included as Appendix B. The intent was to solicit student reaction to the course. The student responses were used to analyze the extent to which various student needs were met and the overall effectiveness of the instructional method. In addition, students from the treatment groups were required to respond to six further questions pertaining to the use of the modules.

Students were told that their responses and answers on the questionnaire would be used by the instructional staff to help improve the course in subsequent semesters and to evaluate the course just finished. They were also informed that the information gathered would not in any way influence their final grade in the course. This information was also printed in the instruction section on page 1 of the questionnaire. Further, the students were directed to not sign their names.

All questions were of the multiple choice type with four alternative answers for each. Students were requested to circle the letter in front of the statement that best represented their view about what had happened during the semester. They were told that there were no right or wrong answers and that their honest opinions were requested. For three of the questions the students were asked to state why they

answered as they did. This was done to facilitate the analysis of the student responses on these three questions. Finally a space was provided in which students were encouraged to make any further comments.

STATISTICAL ANALYSES

The research design used in the study is outlined in this section. Of major concern was a determination of the extent to which performance on the mid-term and final examinations (dependent variables) were dependent upon the overall treatment (independent variable). To this end an analysis of variance involving one-way classification was employed. In addition χ^2 was used to test the significance of the difference between the proportions of students within the groups providing positive (as opposed to negative) answers on the questionnaire items. χ^2 was also used to test the extent to which performance on the final examinations by the students within each group was independent of their class attendance record.

The overall experimental design used was of the posttest - only control group type. This is identified by Campbell and Stanley (1973) in Experimental and Quasi-Experimental Designs for Research as a "true" experimental design strong in preserving internal validity. This strength results from the random assignment of subjects to the treatment groups. Campbell and Stanley identify randomization as the most adequate all-purpose assurance of a lack of initial biases between groups. Further, it is stated that "within the limits of confidence stated by the tests of significance, randomization can

suffice without the pretest" (Campbell and Stanley, 1973, p. 25). Symbolically, then, the design used in the study can be represented as follows:

R	X_A	O_A
R	X_B	O_B
R		O_C

R, above, refers to random assignment of students to the groups. X_A and X_B represent the application of the treatment to Groups A and B respectively. O_A, O_B and O_C represent various observations and measurements related to the students within groups A, B and C respectively.

The Application of Analysis of Variance

As stated previously, a single factor analysis of variance was used to test the significance of the differences between marks obtained by the groups on the mid-term and final examinations. It was also employed to verify that there were no significant differences between groups with respect to mathematics functioning level at semester start. Attached to this method of analysis are several assumptions which must be met if the drawing of invalid inferences is to be avoided. These are widely known (Ferguson, 1971) and therefore are not repeated here. Tests were conducted to assure that all data submitted to analysis met, within reasonable limits, these assumptions.

In testing the hypotheses related to the above, the decision rule was to reject the null hypotheses if the F-statistic was

significant at a probability level of $\alpha \leq .05$.

Following a significant F-ratio, comparisons between the pairs were made using the multiple comparison of means method developed by Scheffé. Ferguson (1971) states that this method is more rigorous than other multiple comparison methods with respect to Type I error; this method will also lead to fewer significant differences. "Because this is so, the investigator may choose to employ a less rigorous [illegible]ce level in using the Scheffé procedure; that is, the .10 l[illegible] be used instead of the .05 level" (Ferguson, 1971, p. 271). Understanding these comments a .05 level of significance was retained for the multiple comparisons.

HYPOTHESIS I: It was hypothesized that the population means on the first criterion e[illegible]mination (the mid-term) for the three classes (Group A, Group B and Group C) were equal.

The above null hypothesis may be expressed in the following terms:

$$H_0 : \mu_A = \mu_B = \mu_C$$

HYPOTHESIS II: It was hypothesized that the population means on the second criterion examination (the final) for the three classes were equal.

Again, this may be written in the form:

$$H_0: \mu_A = \mu_B = \mu_C$$

The Data were analyzed on the IBM 360, Model 67 System at the University of Alberta. The ANOV 15 DERS (Division of Educational Research Services) computer program was used.

The Application of Chi Square

It was important to determine the extent to which student achievement, as demonstrated on the examinations, was independent of, or associated with, attendance. A χ^2 test of independence was used for this investigation. No attempt was made to establish a functional relationship between the above two variables. Rather, χ^2 was used in an attempt to establish that good attendance was not needed by students in the treatment groups, to the same extent as those in the control group, to achieve a relatively high mark.

First, an overall test of independence for the combined group was done. The data were set down in a 2 x 2 or fourfold contingency table (see Ferguson, 1971, p. 185). Attention was paid to Ferguson in regards to the establishment of the points of dichotomy. He states that this establishment should take place on a completely a priori basis. Accordingly, the points were arrived at as follows. For attendance, the mean number of classes missed per student over the course of the semester was calculated. Attendance was then judged as being good or poor - on the basis of being either below or above this average number of days missed for the combined group. For those students who started the semester late, an appropriate adjustment was made in the number of classes missed.

Final examination score was the other variable to which attendance was paired. To establish a point of dichotomy for this variable, the mean final examination score for combined groups was chosen. Students were then classified as either being in the top half or bottom half of the total group with respect to this grand mean.

A test of independence for each individual group was then done. Again, a decision had to be made with respect to appropriate points of dichotomy. Two approaches were followed:

Approach (A): The points were those calculated for the combined group.

Approach (B): The points were calculated by taking the mean number of days missed and the mean final examination score for each individual class.

As a result of applying the above procedure, two χ^2 values were determined for each class.

The χ^2 tests of independence were obtained without calculating the expected values by applying the formula

$$\chi^2 = \frac{N(|AD - BC| - N/2)^2}{(A + B)(C + D)(A + C)(B + D)}$$

This formula employs Yates' correction for continuity as is recommended by most writers in cases where any expected frequency is less than 10.

In testing each hypothesis related to the above, the decision rule was to reject the null hypothesis if the χ^2 value calculated was

equal to or greater than the critical value required for significance at the .05 level for 1 degree of freedom. This critical value was 3.84.

HYPOTHESIS III: It was hypothesized that performance by students in Group A on the final examination was not associated with their attendance records. (That is, performance was independent of attendance.)

HYPOTHESIS IV: It was hypothesized that performance by students in Group B on the final examination was not associated with their attendance records.

HYPOTHESIS V: It was hypothesized that performance by students in Group C on the final examination was not associated with their attendance records.

Finally, χ^2 was used to determine whether or not the proportions of students within the three groups providing positive (as opposed to negative) answers to the questionnaire items varied significantly. For most items, alternatives a and b were considered as positive responses while c and d were considered as negative. The data were set out in a 2 x 2 contingency table and Yates' correction for continuity was applied. Again a critical value of 3.84 was chosen as required for significance at the .05 level and 1 degree of freedom.

HYPOTHESIS VI: It was hypothesized that the proportions of students within the three groups answering positively to each

of the questionnaire items were the same.

LIMITATIONS

While every attempt was made to protect the internal validity of the study, complete control was, of course, not possible. Further, during the relatively long five month interval of time over which the treatment was applied, various factors no doubt were confounded with the effects of various treatments. Accordingly, the results are considered as limited by the extent to which:

(a) experimental mortality affected the overall results.

(b) there was lack of complete randomization of assignment to treatment groups.

(c) the personality and capability of each instructor confounded with the effect of the treatments.

(d) various other factors confounded with the effect of the treatment.

CHAPTER V

THE RESULTS OF THE STUDY

In this Chapter the results of the various aspects of the overall study are reported. First the analysis of students' performance on the mid-term and final examination is presented. The relationship between attendance and examination performance is then investigated. Next, the student questionnaire results are presented. Finally observations are made pertaining to the termination of students from each Group.

EXAMINATION PERFORMANCE

A one-way analysis of variance was used to test the significance of the differences between the means of the three groups. Following a significant F test the Scheffé method was used to compare every mean with every other mean. Even though this method is more rigorous than other commonly used procedures, a 0.05 level of significance was required for significance.

Mid-term Examination Results

A common mid-term was written by the students in each class. The students in the treatment groups had covered one chapter more than had the control group students. The examination, therefore, was designed to test only that common content covered by all three groups. 80 minutes was the time limit for this examination.

The ANOV 15 computer program yielded the following results.

(a) Mean scores for Groups A, B, and C respectively were 72.5, 76.2 and 56.2.

(b) Mean score for the combined group of students was 67.4.

(c) The homogeneity of variance test yielded a chi square value of 0.54. The accompanying probability was 0.76.

(d) Analysis of variance:

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate
Between	3899.2	2	1946.6
Within	11189.9	48	233.1
Total	15089.1	50	F = 8.37
			P = .00076

(e) Scheffé multiple comparison of means:

Groups A and B comparison yielded P = .80

Groups A and C comparison yielded P = .01

Groups B and C comparison yielded P = .0021

The mean marks obtained by the two treatment groups varied less than 4% from one another. However, Group A and the control group varied by nearly 16% while Group B and the control group varied by nearly 20%. In each case the treatment group mark was the higher mark. These differences were tested following a significant F statistic ($p < .01$). The Scheffé multiple comparison method produced significant differences between each treatment group and the control group. For Group A

and the control group the difference between means was very nearly significant at the .01 level. For Group B and the control group the difference was significant at the .01 level. On the basis of these results the null hypothesis (Hypothesis I), stating that the population means on the mid-term examination for the three classes were equal, was rejected. The multiple comparison method indicated that sampling error could reasonably explain the difference between the means of the two treatment groups. However, sampling error could not be considered responsible for the differences between the means of the control and each of the treatment groups. These differences must then have occured as the result of the treatment applied.

Final Examination Results

A common final examination was written. Group A had finished the entire course; however, Group B did not cover the final chapter on Trigonometry while the control group, Group C, had not finished the final chapter nor the two previous chapters relating to equations in two variables. Thus, material from the final three chapters of the course was not included on the final.

The ANOV 15 program yielded the following results based on the final examination marks.

(a) Mean scores for Groups A, B and C respectively were 63.3 62.7 and 51.4.

(b) Mean score for the combined group of students was 58.4.

(c) The homogeneity of variance test yielded a chi square value of

2.77. The accompanying probability was 0.25.

(d) Analysis of variance:

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate
Between	1661.7	2	830.8
Within	13868.9	48	288.9
Total	15530.6	50	F = 2.88
			P = .15

(e) Scheffé multiple comparison of means:

Groups A and B comparison yielded P = .99

Groups A and C comparison yielded P = .12

Groups B and C comparison yielded P = .15

The mean marks obtained by the two treatment groups varied less than 1% from one another. However, the Group A mean final examination mark was nearly 12% higher than that of the control group. The Group B mark was more than 11% higher than that of the control group. The analysis of variance showed a non-significant F statistic of 2.88 with $p > .05$.

Even though a posteriori tests are generally applied only following a significant F test, Scheffé multiple comparisons were calculated and reported. The similarity of results for comparisons involving either treatment group and the control groupwas again evident. Further, had a simple a priori test been applied to the

differences between these pairs of means, the results would have shown significance at the .05 level. However, on the basis of the original decision rule, the null hypothesis (Hypothesis II), stating that the population means on the final examination were equal, was accepted.

EXAMINATION PERFORMANCE AND ATTENDANCE

A chi square test of independence was applied to determine the extent to which student achievement was independent of, or associated with, student attendance. For each student the final examination grade and attendance record for the complete semester were used.

First, this test was applied for the combined group. The mean final examination score of all the students was 58%. The average number of days missed over the course of the semester was 9.8. These were taken as the points of dichotomy in constructing the contingency table. Table 2 shows that the value of χ^2 obtained was 3.35. This was just less than the value required for significance at the .05 level. Thus, while not statistically significant (at the predetermined level of significance), the results did indicate a considerable degree of association between final examination scores and attendance for the combined group. Amongst those students obtaining marks on the examination above the mean, the ratio of good to poor attenders was 3:1. For those students obtaining marks below the mean, the ratio was very nearly 1:1.

TABLE 2

CHI SQUARE TEST OF INDEPENDENCE

OF FINAL EXAMINATION SCORE AND ATTENDANCE

FOR COMBINED GROUP

	Bottom Half of Scores	Top Half of Scores	Total
Good Attendance	13 (25%)	18 (34.6%)	31 (51.6%)
Poor Attendance	15 (28.8%)	6 (11.5%)	21 (40.3%)
Total	28 (53.8%)	24 (46.2%)	52 (100%)

Chi Square = 3.35 $P > .05$

Table 2 shows, at the .05 level of significance, that final examination score and attendance were independent of one another.

Chi square was also employed to test the degree of association between attendance and final examination performance for each of Groups A, B and C independently. Two tests were performed for each group. In the first test (referred to as Approach A) the points of dichotomy were as in the test for the combined group. The points in the second test (referred to as Approach B) were the average number of days missed and mean mark for each individual group. These latter values were: 11.1 days and 63.3% for Group A; 7.8 days and 62.7% for Group B; and 10.3 days and 51.3% for Group C, the control group.

Tables 3 and 4 present the results for Group A. They show chi square values of .071 and 0.27 respectively. Both values are much below that required to indicate significance at the .05 level. Thus for Group A students attendance and final examination performance show a marked degree of independence of one another.

Tables 5 and 6 present the results for Group B. The chi square values of 0.014 and 0.63 indicate that, at the .05 level of significance, the two variables are again independent of one another.

Tables 7 and 8 present the results for Group C. They show chi square values of 1.32 and 1.38 respectively. While not high enough to indicate significance at the .05 level, these values are somewhat higher than those obtained for Groups A and B.

On the basis of these results null Hypotheses III, IV and V were accepted. That is, at the .05 significance level, performance was seen to be independent of attendance.

TABLE 3

CHI SQUARE TEST OF INDEPENDENCE

OF FINAL EXAMINATION SCORE AND ATTENDANCE

FOR GROUP A *

	Bottom Half of Scores	Top Half of Scores	Total
Good Attendance	3 (18.8%)	7 (43.6%)	10 (62.4%)
Poor Attendance	3 (18.8%)	3 (18.8%)	6 (37.6%)
Total	6 (37.6%)	10 (62.4%)	16 (100%)

Chi Square = 0.071 $P > 0.70$

Table 3 shows, at the .05 level of significance, that final examination score and attendance were independent of one another.

* Approach A points of dichotomy taken.

TABLE 4

CHI SQUARE TEST OF INDEPENDENCE

OF FINAL EXAMINATION SCORE AND ATTENDANCE

FOR GROUP A *

	Bottom Half of Scores	Top Half of Scores	Total
Good Attendance	4 (25%)	6 (37.5%)	10 (62.5%)
Poor Attendance	4 (25%)	2 (12.5%)	6 (37.5%)
Total	8 (50%)	8 (50%)	16 (100%)

Chi Square = 0.27 $P > 0.50$

Table 4 shows, at the .05 level of significance, that final examination score and attendance were independent of one another.

* Approach B points of dichotomy taken.

TABLE 5

CHI SQUARE TEST OF INDEPENDENCE

OF FINAL EXAMINATION SCORE AND ATTENDANCE

FOR GROUP B *

	Bottom Half of Scores	Top Half of Scores	Total
Good Attendance	4 (26.7%)	7 (46.7%)	11 (63.4%)
Poor Attendance	2 (13.3%)	2 (13.3%)	4 (26.6%)
Total	6 (40%)	9 (60%)	15 (100%)

Chi Square = 0.014 $P > 0.90$

Table 5 shows, at the .05 level of significance, that final examination score and attendance were independent of one another.

* Approach A points of dichotomy taken.

TABLE 6

CHI SQUARE TEST OF INDEPENDENCE

OF FINAL EXAMINATION SCORE AND ATTENDANCE

FOR GROUP B *

	Bottom Half of Scores	Top Half of Scores	Total
Good Attendance	2 (13.3%)	5 (33.3%)	7 (46.6%)
Poor Attendance	5 (33.3%)	3 (20.1%)	8 (53.4%)
Total	7 (46.6%)	8 (53.4%)	15 (100%)

Chi Square = 0.63 $P > 0.30$

Table 6 shows, at the .05 level of significance, that final examination score and attendance were independent of one another.

* Approach B points of dichotomy taken.

TABLE 7

CHI SQUARE TEST OF INDEPENDENCE

OF FINAL EXAMINATION SCORE AND ATTENDANCE

FOR GROUP C *

	Bottom Half of Scores	Top Half of Scores	Total
Good Attendance	6 (28.6%)	4 (19.0%)	10 (47.6%)
Poor Attendance	10 (47.6%)	1 (4.8%)	11 (52.4%)
Total	16 (76.2%)	5 (23.8%)	21 (100%)

Chi Square = 1.32 $P < 0.30$

Table 7 shows, at the .05 level of significance, that final examination score and attendance were independent of one another.

* Approach A points of dichotomy taken.

TABLE 8

CHI SQUARE TEST OF INDEPENDENCE

OF FINAL EXAMINATION SCORE AND ATTENDANCE

FOR GROUP C *

	Bottom Half of Scores	Top Half of Scores	Total
Good Attendance	5 (23.8%)	6 (28.6%)	11 (52.4%)
Poor Attendance	8 (38.1%)	2 (9.5%)	10 (47.6%)
Total	13 (61.9%)	8 (38.1%)	21 (100%)

Chi Square = 1.38 $P < 0.30$

Table 8 shows, at the .05 level of significance, that final examination score and attendance were independent of one another.

* Approach B points of dichotomy taken.

To gain further insight into the relationship between attendance and examination performance, the following procedure was followed. By averaging the values within each cell of two contingency tables for each group, representative proportions were obtained. The values stated in each category below are for students within Groups A, B and C respectively.

Proportion of students with good attendance having marks below average: 22%, 20%, 26%

Porportion of students with good attendance having marks above average: 40%, 40%, 24%

Proportion of students with poor attendance having marks below average: 22%, 24%, 43%

Proportion of students with poor attendance having marks above average: 16%, 16%, 7%

RESPONSES ON THE STUDENT QUESTIONNAIRE

The responses to the questionnaire items are shown in Table 9. Proportions of students within each group responding positively or negatively to each item were calculated. Chi square was then applied to test the significance of the difference between these proportions with a critical value of 3:84 required for significance. For all but items 1, 2 and 8, alternatives a and b were taken as positive responses with c and d constituting the negative responses.

Three chi square tests were employed in analyzing the responses to each item. Comparisons were made between groups A and B, between

TABLE 9

LEVEL I MATHEMATICS QUESTIONNAIRE RESPONSES

TO ITEMS 1 THROUGH 10 BY STUDENTS IN THE THREE GROUPS

Questionnaire Item	Group A Responses				Group B Responses				Group C Responses			
	A	B	C	D	A	B	C	D	A	B	C	D
1	12	3	1	0	13	1	1	0	9	9	3	0
2	1	1	3	11	0	0	5	10	1	2	10	6
3	3	11	1	1	4	10	1	0	4	14	3	0
4	3	8	2	3	1	5	5	4	1	11	6	3
5	0	15	1	0	0	13	2	0	0	16	5	0
6	4	11	1	0	5	8	0	0	7	12	1	0
7	4	9	2	1	0	11	3	1	2	17	2	0
8	13	2	0	1	9	1	3	2	15	1	5	0
9	9	7	0	0	5	8	1	0	11	7	3	0
10	2	10	2	1	6	7	2	0	4	13	4	0

groups A and C, and finally between B and C. The results of these comparisons are reported in Table 10. In each case a chi square and corresponding probability are given.

ITEM 1: How much do you like mathematics as a subject?

For this question alternative a was considered as the only positive response. The choice of alternative b, "about as much as my other courses", was grouped along with c and d as being negative.

The responses by the students in the two treatment groups were very similar (chi square = [illegible], $p > .50$). 81% of these students indicated, by chosing alternative a, that they liked mathematics "a great deal". Only 43% of Group C students made this choice. The difference between proportions responding positively for groups B and C was statistically significant at the .05 level. For groups A and C, chi square was very nearly significant at the .10 level. 47 students qualified their responses to item 1 by making comments in the space provided. The information provided by Groups A and B tended to be more positive than for group C. Example comments from these former students were "I'm finally getting somewhere in mathematics"; "The subject is interesting and challenging"; and "Because it was easy to learn". Three group C students stated that they found the course to be uninteresting. No similar comment was made by a student in either of the other two groups.

ITEM 2: How would you compare your present like for mathematics with your like for the subject prior to taking this course?

TABLE 10

RESULTS OF CHI SQUARE TESTS OF THE SIGNIFICANCE OF DIFFERENCE BETWEEN PROPORTIONS OF STUDENTS ANSWERING POSITIVELY ON QUESTIONNAIRE ITEMS

Questionnaire Item	Group A and B Comparison	Group A and C Comparison	Group B and C Comparison
1	.22 ($p > .50$)	2.65 ($p < .20$)	4.25 ($p < .05$)
2	.068 ($p > .70$)	3.43 ($p < .10$)	2.85 ($p < .10$)
3	.0035 ($p > .95$)	.11 ($p > .70$)	.032 ($p > .80$)
4	1.55 ($p > .20$)	.14 ($p > .70$)	.46 ($p = .50$)
5	———	———	———
6	.01 ($p > .90$)	.32 ($p > .50$)	.44 ($p > .50$)
7	.005 ($p > .90$)	.11 ($p > .70$)	.007 ($p > .90$)
8	.82 ($p > .30$)	.09 ($p > .70$)	.13 ($p > .70$)
9	.005 ($p > .90$)	.94 ($p > .30$)	.01 ($p > .90$)
10	0 ($p = 1$)	.11 ($p > .70$)	0 ($p = 1$)

In each case, a chi square and corresponding probability are reported.

For this question alternative d was considered as the only positive response. This was done as a result of the words "much more now" which set it apart from the other alternatives.

As in item 1, the treatment groups responded very similarly to question (chi square = 0.068, $p > .70$). 68% of these students chose the positive response while for the control group 46% made this choice. The two treatment-control group comparisons produced chi square values which were significant at the .10 level. They were, though, short of the required .05 level established for these comparisons.

Reasons given for the positive answers by students in the treatment groups were varied. The main three reasons had to do with the use of modules, help given during workshops and the option available to work at an individual rate of speed.

ITEM 3: Would you be more confident now than at the beginning of the semester in attempting to learn new mathematics topics without the help of a teacher?

No statistically significant differences were found amongst the three groups. The three groups responded very similarly to this item. The probabilities resulting from the three comparisons were all greater then 0.70. The proportions of students within Groups A, B and C answering positively were 88%, 93% and 85% respectively.

ITEM 4: While taking the course, was the thought of possible failure of concern to you?

No statistically significant differences were found amongst the groups. The proportions of students within Groups A, B and C answering positively were 31%, 60% and 43% respectively. Therefore, approximately twice as many students within treatment group B as in treatment group A reacted positively.

ITEM 5: How challenging and demanding of your abilities do you feel the course was?

No students in any of the three groups chose alternatives a or d in this item. The course, therefore, was not seen by any student to be either too difficult or much too easy. All students thought the course was either of the correct difficulty or was a little too easy. 24% of the group C students thought the course was a little too easy. For groups A and B these figures were 7% and 13% respectively. A chi square analysis was not applied to this item.

ITEM 6: Do you feel your instructor spent enough class time explaining new topics when they were encountered in the course?

No statistically significant differences were found amongst the three groups. The treatment groups responded very similarly (chi square = 0.01, $p > .90$). All but one student in each of groups A and C responded positively to this question. 35% of Group C students thought more than enough time was spent. For Groups A and B these proportions were 25% and 38% respectively.

ITEM 7: Were you given enough class time to do work assigned by your instructor?

No statistically significant differences were found amongst the three groups. The three groups responded very similarly to this item. The probabilities resulting from the three comparisons were all greater than .70. For groups A, B and C the proportions of students giving positive answers were 81%, 69% and 90% respectively. Students reacting positively felt that either enough or more than enough class time was alloted to them.

ITEM 8: Were you allowed to work through the course at the speed you wanted?

No statistically significant differences were found amongst the three groups. A positive response indicated that the speed was about right. Proportions of students within groups A, B and C responding positively were 81%, 60% and 71% respectively.

ITEM 9: Do you feel that the course material will be useful to you, so far as to be helpful in preparation for your vocational goal?

No statistically significant differences were found amongst the three groups. A positive response to this item indicated that the students thought the material would be either very or somewhat useful to them. The positive response by groups A, B and C was 100%, 93% and 86% respectively.

ITEM 10: Do you feel that the course material will be useful to you in your everyday affairs?

No statistically significant differences were found amongst the three groups. All three groups reacted very positively to the question asked in this item.

It was seen that only one of the chi square values calculated in the foregoing analysis was significant at the .05 level. Two others were significant at the .10 level. Thus, taken all together, the results indicated that the proportions of students within the three groups answering positively to the questionnaire items were essentially the same. Accordingly, Hypothesis VI was accepted.

Various comments were made by students in the space provided following item 10. Six, seven and eight students from Groups A, B and C respectively provided this extra feedback.

Two Group A students identified the modules as being very helpful in learning mathematics. Two others indicated that their teacher was very good. One student suggested that the course could have moved more quickly. The remaining comments indicated a general liking for the course.

One Group B student identified the modules as being very helpful. Another reacted positively to the option available of working at an individual rate of speed. Two students suggested that they could have moved through the course more quickly. Two others asked that more review time be given.

Two Group C students expressed an appreciation for their good teacher. Two others said they found the course interesting. One student expressed some apprehension over the final examination. Another indicated that "the only reason I stayed was because once I start something I like to finish it." Two other comments were "Workshops would be very helpful" and "I would much rather have done this course by the unipak method."

Reaction by Students in the Two Treatment Groups

Students in Groups A and B provided extra feedback by answering questions relating to the use of modules. These were in the form of multiple choice questions. In addition students were asked to make a final summary statement if they so desired.

ITEM 1: What is your general attitude towards using modules of the kind used this semester in helping to learn mathematics?

100% of the Group A students indicated that they were very helpful. For Group B, this proportion was 77%. 23% of these students indicated that the modules were somewhat helpful. No students in either group indicated that the modules were only marginally helpful or of no help.

ITEM 2: If given the choice of using a textbook or modules in a new math course you were enrolled in, which would you prefer?

For group A, 67% of the students indicated that they would prefer using modules only. 33% indicated that they would prefer a combination of modules and textbook. These proportions for Group B were 69% and 31% respectively. No students in either group indicated that they would prefer using the textbook only or that they would be happy using either.

ITEM 3: How clearly written was the material in the modules in comparison to that in the textbook you used?

The results were identical for each group. 87% of the students indicated that the material in the modules was much easier to understand. The remaining 13% thought that both modules and textbook were well written and easy to understand. No one suggested that the textbook was easier to understand.

ITEM 4: Did you find it easier to organize your daily mathematics work when following the modules or when using the textbook?

67% within Group A thought it was much easier when using the modules. 23% thought it was a little easier by this method. For Group B, these proportions were 63% and 31% respectively. One student from Group B thought organization was easier when using the textbook.

ITEM 5: Would you have preferred to have had the last few units in the course presented in modules rather than from the textbook?

71% and 75% of the students within Groups A and B respectively indicated that they very definitely would have preferred the modules. Only one student indicated that he was happy within the textbook for these units. The remaining students indicated either no preference one way or the other or that they would have preferred some method other than modules or textbooks.

ITEM 6: How would you judge the amount of time per class that your instructor spent taking up homework or introducing new concepts?

100% of the Group B students indicated that about the right amount of time was spent. For Group A this proportion was 87% with the remaining 13% indicating that more time should have been spent. No students from either group indicated that less time should have been spent.

Within Group A, seven students provided extra feedback in a section headed "In the space that follows add any comments which you would like to make." Their comments were as follows:

(a) I was unhappy to find out we were not using modules anymore.

(b) I have appreciated the encouragement and lack of pressure in this class.

(c) I prefer the modules as they are easier to understand. Also you can work ahead more easily in modules.

(d) I hope the modules will be used next semester instead of textbooks.

(e) The workshops were of great help and should be encouraged, and continued.

(f) I think the course should be made up of strictly modules as the textbook is much harder to understand.

(g) The class time was about right, you didn't get bored. If you had problems you could get them straightened out then go do your work. I think it was great.

Six Group B students provided comments as follows:

(a) I think the modules are good and for extra work the textbook.

(b) The modules are presented in such a manner that those with incentive would find it easier to work ahead.

(c) I think there should be fewer people in each class if possible...

(d) I have learned a lot from this course and enjoyed math more than I did before.

(e) Some concepts were harder to understand than others and therefore should have more time in explanation spent on them.

(f) The modules are a great help with good illustrations, good explanations, made mathematics a practical subject that was understandable.

TERMINATION OF STUDENTS

The termination rate from academic upgrading programs has Historically been relatively high. In several dropout studies done

at AVC from 1970 to 1976, the percentage of students not completing the semester ranged from 30 to 40 percent. A rule of thumb has been that for every three students registered at the beginning of the semester, only two will stay for the complete duration.

In the present study, of the 78 students in the three groups, 22 students terminated before the end of the semester. This represented a termination rate of 28%. 9 of these terminations were from Group A, 7 were from group B and 6 from group C.

To test the significance of the difference between the proportions of students who terminated from the groups, a χ^2 test of independence was applied. When results for the two treatment groups were pooled, a χ^2 of .82 resulted. This was far below the value of 3.84 required to show significance at the .05 level. Thus it would appear that the rate of termination by students occured independently of treatment.

Previous studies undertaken at AVC in 1972, 1973 and 1974 lend support to the above. They showed that the major factors contributing to termination were personal illness, family illness, inadequate training allowances and increasing debts. Problems related directly to teaching - learning process were rated as less important. Again this would indicate that of the 22 students who terminated the majority did so for reasons other than those related to classroom interactions.

Campbell and Stanley (1973) state experimental mortality, or

differential loss of subjects from the comparison groups, as one of the main factors which threatens the internal validity of experiments. In order words, experimental mortality might produce effects which will confound with the effects of the treatment. In that the termination rate of students in the present study was nearly one third, this becomes an important point to consider.

One factor suggests, however, that the loss of students from each group happened in a more or less random way. Marks on the review test were compared. The students from group A who terminated had previously attained an average of 65% on the review test. For groups B and C, the averages were 67% and 65% respectively. Thus, the groups were seen to be very comparable in this respect. No group appeared to have lost students whose performance on the review test varied markedly from that of the other two. This would suggest that the effects of experimental mortality in this present study would be minimal.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The purpose of this study was threefold. First, a viable rationale for adult academic upgrading programs was formulated. This rationale was then used to provide guidance in outlining strategies for use in the development and teaching of mathematics curricula. Finally, instructional materials were prepared and were used for one full semester at Alberta Vocational Centre. An evaluation was then undertaken to determine the extent to which this curriculum was effective in meeting the individual needs of students. Students were randomly assigned to the three experimental groups: two treatment groups and one control group. All of the students involved in the study were enrolled in the level I technical mathematics program at Alberta Vocational Centre, Edmonton, during the five-month long 1976 spring semester.

All students were involved in a three week review of the basics. The control group students then proceeded through the rest of the course in a somewhat traditional manner. The two treatment groups proceeded through the course by applying the curriculum which was developed to account for various student characteristics. It was hypothesized that: (1) the population means on both the mid-term and final examinations would be equal for the three groups, (2) performance on the final examination by students within each group would be independent of their attendance records, and (3) the proportions of students within

the three groups answering positively to various features of the treatment would be the same.

Taken all together the data indicated that the use of the multi-approach rationale in offering mathematics instruction to adults (i.e.: application of the treatment) was an effective way to facilitate their learning. The results showed that on the mid-term examination the treatment groups attained scores which were significantly higher than those of the control group. On the final examination these differences were not statistically significant. However, on this examination, the mean score for each treatment group was more than 10% higher than that of the control group.

No significant association was found between the final examination score and attendance record for students within each group. The data did indicate, though, that good marks were much more dependent upon good attendance for students within the control group than was the case for those in the two treatment groups. In general, the results of the student questionnaire indicated that students from the control group tended to be less positive in their responses than did the treatment students.

CURRICULUM CHARACTERISTICS

A major advantage in using the curriculum developed for this study was that student performance was somewhat enhanced. Evidence supporting

this contention is seen in the results for both the mid-term and final examinations. On both examinations the marks attained by each treatment group were seen to be superior. Thus, these students had achieved a higher degree of mastery of the course content than had the control students. The advisability of using a curriculum which results in these gains is evident and need not be dwelt upon.

Further, the similarity of the mean examination marks of the two treatment groups is noteworthy. On each examination these marks were very close to one another. They varied by less than 4% and 1% respectively on the mid-term and final. Considering the fact that the personalities and capabilities of teachers tend to confound with the effects of any treatment, these results suggest that the curriculum used by the treatment groups was relatively teacher-proof, with respect to student performance on examinations.

Upon reviewing the design of the curriculum this characteristic is not surprising. In fact, a major component of the design was that the student himself, as opposed to the instructor, was to be the focal point of the learning process. Teacher-directed class time was kept to a minimum with more time being devoted to individual work and student-student interaction.

An additional strength of the curriculum was that it allowed students to work at a more individual rate of speed. This was mainly due to the use of the modules. Once a student had developed the

necessary process skills he was able to proceed through the modular materials relatively independently of the instructor. Six students, three from each treatment group, demonstrated this ability to a high degree. In this independent manner, they covered not only the content in the modules but also that in the final textbook chapters of the course. These students finished the course almost one month before the end of the semester. Had level II of the technical math program been organized in a manner similar to that for level I, these students would have been able to proceed with this content. As it was, they had to wait for the start of the next semester before commencing with level II.

Another advantage of the curriculum was that, upon returning to class after one or more days absence, students were better able to "catch up" on material they had missed than were those in the control group. The tests designed to gain insight into the relationship between attendance and examination performance suggested this result. They showed that on a proportional basis, nearly twice as many students in the control group, than in each treatment group, demonstrated a combination of poor marks and poor attendance. Conversely, more than twice as many students in each treatment group, as in the control group, demonstrated a combination of good marks and poor attendance. In other words, poor attendance did not seem to jeopardize the effectiveness of the curriculum developed in this study to the same extent as in the case of the more traditional curriculum. Considering

the fact that adult upgrading students tend to miss a great deal of class time to tend to personal and family matters, this result takes on added significance. Again, the similarity of the results for the two treatment groups is noteworthy. The representative proportions within each cell (see page 73) were nearly identical for these groups.

Various other results relating to student feedback on the questionnaire are noteworthy. First, on a proportional basis, twice as many treatment students as control students indicated a liking for mathematics. This difference was found to be statistically significant for the Group B and C comparison, but slightly short of significance for the Group A and C comparison. Students were also asked to compare their present like for mathematics with their like for the subject prior to taking the course. The treatment-control group comparisons produced chi square values which were significant at the .10 level. Had the totals for the treatment groups been combined and then compared to those of the control group, a statistically significant result, at the .05 level, would have occured. Further comments by students in the two treatment groups supporting their like for mathematics were very positive. The main reasons given for the positive answers had to do with the use of the modules, help given during workshops and option available for doing individual work. Assuming, then, that the positive reaction by treatment students was a result of the treatment itself, this result

is very important. Any curriculum which results in students increasing their liking for a particular course would seem to be highly desirable.

Twice as many Group A as Group B treatment students indicated that the thought of possible failure was of concern to them. This was the only area on the questionnaire in which the two treatment groups varied markedly in their responses. Chi square showed, at the .05 level, that the above difference in response was not statistically significant. However, it is the researcher's opinion that not all of this variation can be attributed to sampling considerations. The two treatments did differ in one main respect; Group A students were encouraged to write "make-up" examinations on sections of the course in an attempt to raise their marks to a particular mastery level. It is possible that this increased emphasis on demonstrating mastery was responsible, in part, for the difference in student response noted above. However, considering the similarity of responses and performance by the two groups in all other areas under investigation in this study, this does not appear to have confounded with any of the other variables involved.

The responses to the other items on the questionnaire were very similar for all three groups. No further statistically significant differences were found. However, the comments made by the treatment students indicated a more positive reaction to the curriculum than was the case for the control students. The former students overwhelmingly endorsed the use of the modules as an instructional aide.

Not one student in either of these groups indicated that the modules were of questionable usefulness. 87% of the students indicated that the material in the modules was much easier to understand than the textbook. In addition, 73% indicated that they would have preferred to have used modules for the last few units rather than the textbook. These proportions highlight the students' acceptance of the modules. The scheduling of workshops was also reacted to positively by the treatment students. Student comments indicated that they were of great help and should be continued. Several students also stated their appreciation of being able to work at their own speed.

A final advantage of the treatment curriculum was that students were able to cover an increased amount of material. The control class covered only the first seven units of the course, whereas the treatment classes finished unit eight also. This last unit included a section on descriptive geometry and an introduction to right angle trigonometry.

In conclusion: it would appear that the combination of instructional features, related to both mastery and process learning, which were employed in this study was effective in meeting many individual student needs and in helping students toward mastery of the course.

IMPLICATIONS FOR THE CURRICULUM

On the basis of the findings of the present study, including

student responses and comments on the questionnaire, the following suggestions are made.

(1) An approach similar to that developed in this study be used in offering instruction to all level I mathematics students at Alberta Vocational Centre.

(2) Modules be prepared to cover the content in the last eight chapters of the Level I mathematics course.

(3) The main intructional features of the treatment related to process learning continue to be employed:

   (a) The first three weeks of the semester be devoted to a thorough review of basic oncepts and operations.

   (b) Emphasis be given to the development and application by students of basic problem-solving approaches.

   (c) Students be required, from the beginning of the semester, to do independent reading of course material.

   (d) Students be encouraged to become involved in setting many of their own learning patterns such as deciding the rate at which they wish to work through the course and choosing their own mastery level.

(4) The following instructional features of the treatment related to mastery learning continue to be employed:

   (a) Modules to be used as the primary reference to fulfill the need that instruction be structured into well-defined learning units.

(b) Students meet regularly in small group workshops to do remedial work, homework, and drill related to the course content.

(c) Students themselves be involved in identifying specific behavioral objectives within each module.

(5) Students not be required to show complete mastery on each module before proceeding. Encouragement should be given, though, for them to do remedial work to eliminate deficiencies.

(6) Students not be encouraged to write "make-up" examinations in an attempt to raise their marks.

IMPLICATIONS FOR FURTHER STUDY

(1) Further studies be undertaken in an attempt to ascertain the interaction effects of the various contributing aspects of the overall treatment as developed in this study. For example, a study could be made to determine to what extent student attendance at workshops results in improved performance in the course.

(2) Modular materials be developed for Levels II and III of the technical mathematics program in order that students can progress through the entire sequence of courses in the same manner was was done in the present study. Analyses could subsequently be undertaken to determine the extent to which this more advanced program was effective in helping students progress smoothly in their mathematics education.

BIBLIOGRAPHY

BIBLIOGRAPHY

Airasian, P. W. "The Role of Evaluation in Mastery Learning" Mastery Learning Theory and Practice. Holt, Rinehart and Winston, Inc. 1971.

Bergevin, P. A. A Philosophy of Adult Education. The Seabury Press, 1971.

Biggs, J. B. Information and Human Learning. Cassell, Australia Ltd., 1968.

Biggs, J. B. "Learning: Past and Future." Perspectives on Curriculum. Volume 2. Faculty of Education, The University of Alberta, 1973.

Block, J. H. "Introduction to Mastery Learning: Theory and Practice." Mastery Learning Theory and Practice. Holt, Rinehart and Winston, Inc., 1971.

Bloom, B. S. "Learning for Mastery." U.C.L.A. Evaluation Comment. Los Angeles: Centre for the Study and Evaluation of Instructional Programs, 1968.

Bloom, B. S. "Mastery Learning." Mastery Learning Theory and Practice. Holt, Rinehart and Winston, Inc., 1971.

Brown, A. E., Bridge, D. E., Morrison, W. J. Mathematics in Practice. The MacMillan Company of Canada, Limited, 1964.

Campbell, D. T. & Stanley, J. C. Experimental and Quasi-Experimental Designs for Research. Rand McNally College Publishing Company, 1973.

Cass, A. W. Basic Education for Adults. Association Press, New York, 1971.

Dean, J. E., Graham, W. R., Moore, G. E. Principles of Mathematics Book I. Holt Rinehart and Winston of Canada, Ltd., 1970.

Ferguson, G. A. Statistical Analysis in Psychology and Education. McGraw-Hill Book Company, 1971.

Miel, A. "Reassessment of the Curriculum - Why?" A Reassessment of the Curriculum. New York: Teachers College Press, 1964.

Oliver, A. I. "What is the Meaning of Curriculum?" Contemporary Thought on Public School Curriculum. Wm. C. Brown Company Publishers, 1968.

Romanko, W. Report on the Newstart Demonstration Project. Alberta Vocational Centre, 1972.

Schoenfield, D. A Baseline Study of Adult Training and Retraining in Alberta. 1969.

Skemp, R. S. The Psychology of Learning Mathematics. Harmondsworth: Penguin Books Ltd., 1971.

Stake, R. E. "The Countenance of Educational Evaluation." Readings in Curriculum Evaluation. Wm. C. Brown Company Publishers, 1972.

Worth, W. H. A Choice of Futures (Report of the Commission on Educational Planning). Edmonton: Queen's Printer for the Province of Alberta, 1972.

APPENDICES

APPENDIX A

SAMPLE PAGES FROM MODULE 10

PRE-TECHNICAL MATHEMATICS

module 10

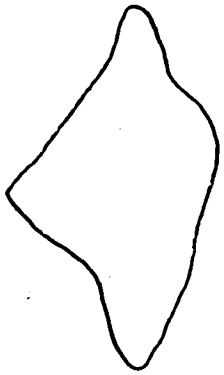
The Measurement of Area

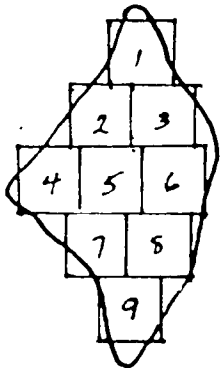
Alberta Vocational Centre

The Measurement of Area

In order to measure the size of any surface it is necessary to agree on the shape of the unit of measurement to be used. To measure distance we used the length of a line segment, and so we had linear measure. To measure surface area any shape of flat surface could be used as the unit. But for reasons of convenience the square has been chos or the unit of area, hence area is always expressed in square measure.

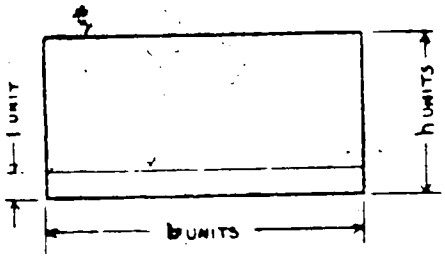
When we say that a surface measures 9 square centimeters we mean that the surface could contain 9 squares of side 1 cm if the squares were suitably arranged and divided to fit the surface.





What is the surface area of this figure?

The Area of a Rectangle



Since the sides of a square are perpendicular, the number of square units which will fit into a rectangle can easily be found if we know the length and width of the rectangle.

Let us call the horizontal side of a rectangle its base.

We shall call the vertical side of the rectangle its height.

The height of a polygon is always PERPENDICULAR to its base.

In one row along the base of a rectangle b units by h units there are b unit squares (squares of side 1 unit).

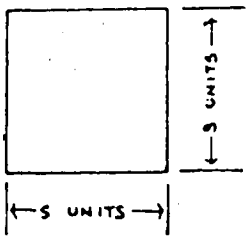
There are h rows of squares from bottom to top of the rectangle.

Consequently, altogether there are b x h unit squares in the rectangle. The area of the rectangle is bh square units. Denoting this area measured in square units by A we have, for any rectangle:

$$A = bh$$

Note: An alternate form for the rectangle formula is $A = lw$ where l represents length and w represents height.

The Area of Any Square



The formula for the area of a rectangle is $A = bh$

Since a square is a special type of rectangle in which b and h are equal, we can replace both b and h by s, and we have

$$A = s \times s$$

We write this, $A = s^2$

The Relationship between different square units

Before proceeding to find the areas of different geometrical forms let us consider the units used for area measure in SI.

Square inches, square feet, square yards and square miles are replaced by square centimeters, square metres and square kilometers. Since area is two dimensional, SI symbols for area units show the "two" as an exponent. For

example, square centimeter will be written cm^2. The acre is replaced by the hectare (rhymes with "air").

These units are abbreviated as follows:

1 square centimeter	=	1 cm^2
1 square metre	=	1 m^2
1 square kilometer	=	1 km^2
1 hectare	=	1 hm^2

The relationships between the common units are:

1 km^2	=	100 ha
1 ha	=	10,000 m^2
1 m^2	=	10,000 cm^2

To get a "feeling" for these SI units consider the following statements:

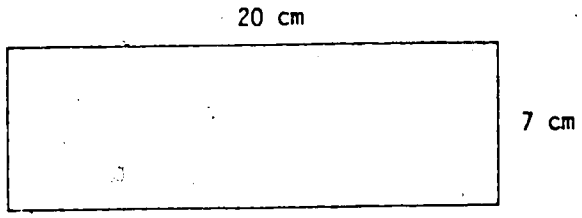
(a) The square metre (m^2) is the primary unit of area. This will play an important role in many applications, one being the sale of carpeting by the square metre.

(b) The square kilometer (km^2) is a large unit of area, generally used to measure the areas of surface regions of the earth.

(c) Intermediate between the above two units is the hectare (ha). In any track meet the 100 m dash is a standard race. The hectare can be visualized as the area of a square with sides 100 m in length. Most importantly, the hectare replaces the acre. A 100 acre farm is very nearly, equivalent to a 40 ha farm. Now forget acres; think hectares!

EXAMPLES

1. Calculate the area of the rectangle shown below:

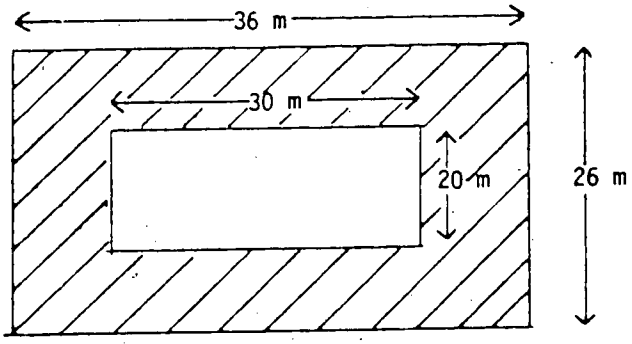


Solution $A = bh$

$= 20 \text{ cm} \times 7 \text{ cm}$

$= 140 \text{ cm}^2$

2. How many m^2 are contained in the area represented by the shaded portion of the diagram below?



Solution 1: Area of large rectangle.

$A = bh$

$= 36 \text{ m} \times 26 \text{ m}$

$= 936 \text{ m}^2$

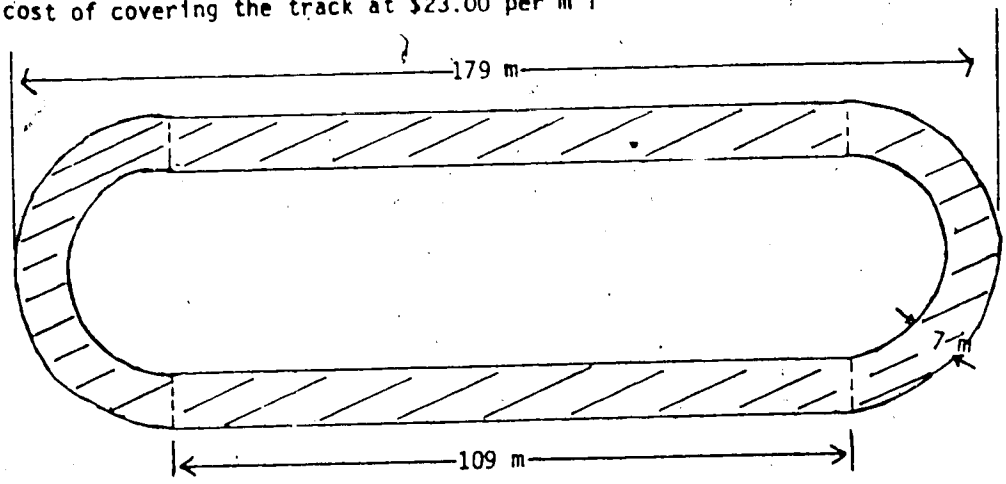
Area of small rectangle.

$A = bh$

$= 30 \text{ m} \times 20 \text{ m}$

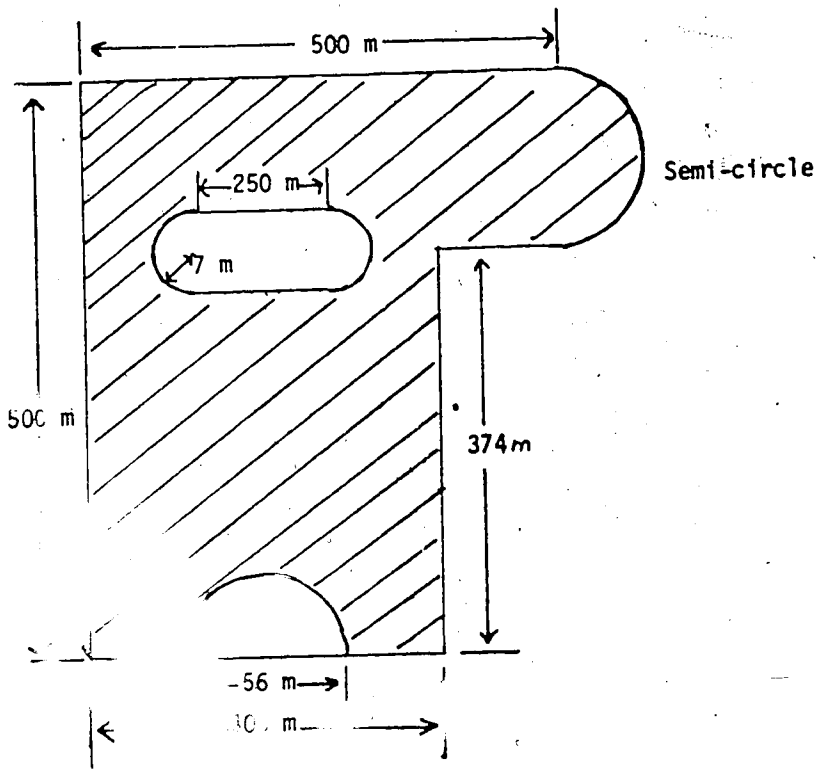
$= 600 \text{ m}^2$

3. The shaded portion of the diagram below represents an indoor race track, which is to be covered with a new synthetic material. What would be the cost of covering the track at \$23.00 per m^2?



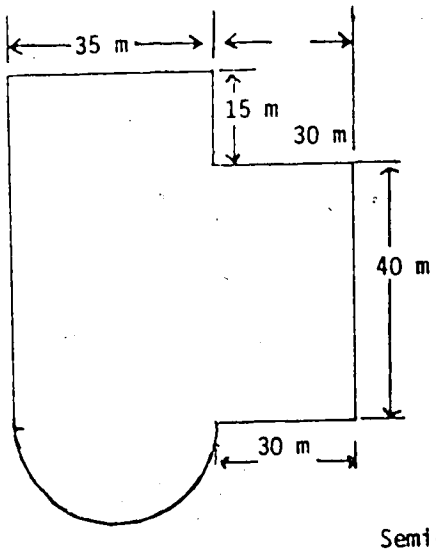
Semi-circle

4. The shaded portion of the diagram below represents a parking lot, which is to be covered with black top. If the cost of covering with black top is \$1.50 per m^2, what would the cost of covering the parking lot be?



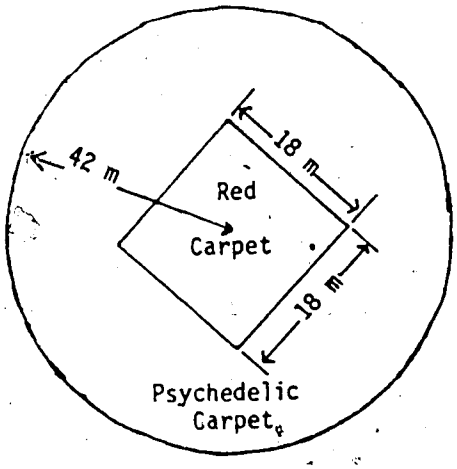
Exercise 6.

1. What would be the cost of carpeting the floor of a house with the dimensions as shown below, if the cost of carpeting is \$14.00 per m^2?



Semi-circle.

2. A symposium hall is to be covered with carpet as shown below. If the cost of installing the red carpet is \$16.00 per m^2, and the cost of the psychedelic is \$20.00 per m^2 calculate the total cost.



APPENDIX B

STUDENT QUESTIONNAIRE

QUESTIONNAIRE: LEVEL I PRE-TECHNICAL MATHEMATICS

Following are some questions about what happened in your mathematics class this semester. Your responses and answers to the following questions would be much appreciated as they will help us to improve the course. The results of this questionnaire will not in any way influence your final grade in the course.

Circle the letter in front of the statement that best tells how you feel about what happened. There are no right or wrong answers - instead we wish for you to state your honest opinion.

For certain questions you are asked to state why you answered as you did. Try to provide clear and concise answers for these.

1. How much do you like mathematics as a subject?

   a. A great deal.
   b. About as much as my other courses.
   c. Less than my other courses.
   d. Not at all.

   Please state why you answered as you did. _____

   _____

   _____

2. How would you compare your present like for mathematics with your like for the subject prior to taking this course?

   a. I liked mathematics more before taking this course.
   b. I like mathematics a little less now than before.
   c. I like mathematics a little more now.
   d. I like mathematics much more now than before.

   Can you state a reason why you answered as you did. _____

   _____

   _____

3. Would you be more confident now than at the beginning of the semester in attempting to learn new mathematics topics without the help of a teacher?

   a. Yes, I would definitely feel more confident now.
   b. Yes, I would feel a little more confident now.
   c. No, I would feel a little less confident now.
   d. No, I would feel much less confident now.

4. While taking the course, was the thought of possible failure of concern to you?

   a. Yes, I thought about it all the time.
   b. Yes, I thought about it occasionally.
   c. No, I thought about it very seldom.
   d. No, I never thought about it.

5. How challenging and demanding of your abilities do you feel the course was?

   a. The course was too difficult for me.
   b. The course was of about the correct difficulty for me.
   c. The course was a little too easy.
   d. The course was actually much too easy for me.

6. Do you feel your instructor spent enough class time explaining new topics when they were encountered in the course?

   a. Yes, more than enough time was spent.
   b. About the right amount of time was spent.
   c. No, a little more time should have been spent.
   d. No, much more time should have been spent.

7. Were you given enough class time to do work assigned by your instructor?

   a. More than enough time was given.
   b. About the right amount of time was given.
   c. A little more class time should have been given.
   d. A lot more class time should have been given.

8. Were you allowed to work through the course at the speed you wanted?

   a. Yes, the speed was about right.
   b. No, we moved through the course too quickly.
   c. No, I could have moved through the course a little more quickly.
   d. No, I could have moved through the course much more quickly.

9. Do you feel that the course material will be useful to you, so far as to helpful in preparation for your vocational goal?

   a. Yes, the material should be very useful.
   b. Yes, the material should be somewhat useful.
   c. No, the material will be of marginal usefulness.
   d. No, the material will be of no use.

10. Do you feel that the course material will be useful to you in your everyday affairs?

   a. Yes, the material should be very useful.
   b. Yes, the material should be somewhat useful.
   c. No, the material will be of marginal usefulness.
   d. No, the material will be of no use.

In the space that follows, add any comments which you would like to make. _____

_____

_____

The following questions are to be answered by those students who were in a class which used modules to cover the first portion of the course. Again, circle the letter in front of the statement that best tells how you feel about what happened.

1. What is your general attitude towards using modules of the kind used this semester in helping to learning mathematics?

   a. I think they are very helpful.
   b. I think they are somewhat helpful.
   c. I think that t' are only marginally helpful.
   d. I think that they are of no help.

   What is the main reason you answered as you did? _____

   _____

2. If given the choice of using a textbook or modules in a new math course you were enrolled in, which would you prefer to use?

   a. I would prefer to use the modules only.
   b. I would prefer to use the textbook only.
   c. I would be equally happy using either.
   d. I would prefer to use a combination of modules and textbook.

3. How clearly written was the material in the modules in comparison to that in the textbook you used?

   a. The textbook was much easier o understand.
   b. The material in the modules was much easier to understand.
   c. Both were clearly written and easy to understand.
   d. Neither was very easy to understand.

4. Did you find it easier to organize your dialy mathematics work when following the modules or when using the textbook?

   a. It was much easier when using the textbook.
   b. It was a little easier when using the textbook.
   c. It was a little easier when using the modules.
   d. It was much easier when using the modules.

5. Would you have preferred to have had the last few units in the course presented in modules rather than from your textbook?

   a. Very definitely I would have preferred the modules.
   b. No, I was happy with the textbook.
   c. I have no preference one way or the other.
   d. I would have preferred that some method other than textbook or modules might have been used.

6. How would you judge the amount of time per class that your instructor spent taking up homework and introducing new concepts?

   a. More time should have been spent.
   b. About the right amount of time was spent.
   c. A little less time should have been spent.
   d. Much less time should have been spent.

In the space that follows add any comments which you would like to make.

_____

_____

_____

_____