Modular Tutorial Instruction (MTI)

Versus

Individual Tutorial Instruction (ITI)

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Thesis Equivalent

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ABSTRACT

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The purpose of this study was to determine the effectiveness of MTI versus ITI in Remedial Math. Both methods were tested using Pilot-testing and Summative Evaluation. Pilot Testing with a small sample of 8, grade 7 Remedial Math students, was significantly in favor of MTI. Summative evaluation was conducted with 22 randomly selected, grade 7 Remedial Math students using two treatment conditions with equal participants, the Modular (MC) and the Tutorial (TC). Four tests were administered to both conditions and a Questionnaire to MC. MANOVA for group differences showed significance for MC, $F(5,16) = 10.71$, $p < .0002$. Effects estimate ω^2 showed 42% difference in gain for MC. ANOVA for difference between Immediate and Delayed Tests revealed significant main effect for treatment, $F(1,20) = 95.84$, $p < .0001$, and time, $F(1,20) = 55.33$, $p < .0001$. MANOVA for completion time was not significant $F(5,16) = 2.019$, $p > .13$ MANOVA for group efficiencies revealed significance, $F(5,16) = 3.125$, $p < .03$. ω^2 for efficiency indicated a difference of .145 or 15% in favor of MC. Results of Student Questionnaire were greatly in favor of MTI.

Dedicated to Galliopi, Demitri, and Basile whose love have caused me to believe in contributing to humanity until I die.

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CHAPTER I

INTRODUCTION

The Problem

"College Tutorial" is located on Park Avenue, Montreal, and is a private school of 'tutoring'. Its purpose is to help students with difficulties in their subjects and studying habits. It offers Individual Tutorial Instruction (ITI) for all levels, from elementary school to college. College Tutorial (which from now will be called 'The College'), operates an all year round tutorial program. The groups are usually quite small (4-6 students in each group) and each student works independently at his/her own rate, pace, and time. The tutor gives individual help to each student according to his/her needs, assigns homework or classwork, corrects his/her assignment(s), administers tests and decides if a student has mastered a particular concept and if he/she is ready to move to another one. The College, with the cooperation of parents and the administration of public schools, receives students who have difficulty in their subject(s) for ITI.

Since each student who attends lessons in The College has a specific problem in his/her subject(s) which is different than that of any other student of The College, and since each student differs in his/her capacities, rate of learning background and motivation,

it becomes difficult for the administration of The College to create homogeneous groups to satisfy the needs of all students. The administration is forced to create groups consisting of students who belong to different levels and have different capacities and purposes.

The principal of The College, who is also the person conducting this study, after 12 years of experimenting on how to improve individualized instruction, has identified the following problem:

1. The fact that students who follow tutorial lessons at The College come from different school systems of Montreal, having different backgrounds, motivations and interests, makes it very difficult for The College to create homogeneous groups with students covering the same material and using similar texts. This forces the administration to create heterogeneous groups with students of different levels, needs, and capacities, making it difficult for the tutor to handle all these different students' needs and levels.
2. Since in each class there are students of different capacities, backgrounds, rates of learning and motivations, it is difficult for the tutor to distribute the class time equally, giving equal help to every student in the group. Whereas one student, for example, can do 10

exercises in 5 minutes, another can take 20 minutes, or even more, for the same exercise. The slower student is usually motivated less, his/her attention span is shorter than that of the faster student, and is less willing to ask questions. The student whose motivation is high, on the other hand, is more willing to ask questions and performs tasks more rapidly than the less motivated student. This results in the tutor spending more time with the more able student and less with the less able one, so that the tutor's time is monopolized by the faster or the more able student.

3. Since student's needs are not always satisfied to the desired level, for the reasons mentioned in the above two paragraphs, motivation and performance problems are created while the student's dependence on the tutor tends to increase. Low motivation usually means low performance. Thus, a student's mastery level is not reached unless much time and effort is put in by the tutor for each individual learner. This, in turn, causes another problem:

4. Since much effort and time is needed for each individual learner, a tutor cannot receive more than a very small number of students at a time (4-6 students). This forces the administration of The College, to either hire many tutors to

tutor a small number of students or to extend tutors' hours to cover the needs of the students. More classes are also demanded as the number of student's increases. All these mean more cost to The College, and more cost means higher tutoring fees.

The problems heretofore mentioned have caused the administration of The College to rethink the instructional organization and approach to learning that The College has traditionally used. It is obvious that a more effective approach is called for, which:

1. Treats students as individuals even though they may be working within heterogeneous groups.
2. Produces more effective use of the tutor's time.
3. Allows students to work at their own level and pace, thus improving the students' motivation and desire to achieve the needed objectives.
4. Reduces the need for extra tutors', thereby reducing the cost of instruction.

It appears that The College is in need of some form of individualized instruction. In the next section, the literature on this subject is briefly reviewed in order to determine if an individualized approach could partially address the problem of The College.

CHAPTER II

REVIEW OF LITERATURE

During the last two decades a number of approaches to Individualized Instruction have been developed. Among those approaches, the most important ones seem to have emerged between 1960-1978. After 1978, very few improvements were made to existing approaches. During these two decades, much has been said and written; libraries were filled with descriptions, prescriptions and approaches to improve this field. Yet, there is little evidence that meaningful change has or is taking place.

Among the common approaches developed between 1960-1978, are PSI, PLAN, IGE, IMS, PLATO, DPI, ATA, PSA, and IRI (Gronlund, 1974). In the past, many efforts have been made to sequentially arrange the curriculum in small components which clearly state performance objectives so that the students may proceed at their own rate of learning or self-pacing. Packages developed have been typically a self-contained set of teaching-learning materials designed to teach a single concept or idea and structured for individual and independent use in continuous progress school program (Georgiadis, 1974).

Teaching-learning materials which were developed in the past were not found all effective as self-pacing, self-instructional, or self-evaluating according to some studies which will be mentioned later in the section. In the past, one aspect of teaching or context in which

teaching occurred that had received little attention by researchers of teaching, was individualized instruction (Zahorick, 1969). Zahorick states that there was a complete paucity if not a complete absence of knowledge concerning teaching in a one-to-one-situation. He stresses the fact that individualization deals with individuality and its purpose is to recognize, enhance, and develop individuality. It helps individual children to grow in individual ways, to become what they might become, and to extend their vision and promises. The goal is to make a unique person more unique. Though many individualized systems have failed their purpose in the past and many curriculums were not built to satisfy individual needs, there are many positive elements, many advantages, in a well designed curriculum of individualized instruction .

According to Parker (1963), there are two important outcomes of individualized instruction: (1) pupils learn better and faster on their own, and (2) tutor's time is saved for guidance which seams to be one of the best guarantors of equality in an organizational framework in our schools that is built on the basis of a clear recognition of individual needs.

Sherman (1978) empirically concludes that Personalized System of Instruction (PSI) shows a reinforcement of positive attitudes toward the course, higher motivation, and increase level of performance. His conclusion seem

in accord with Parker's confirmation about the outcome, of individualized instruction.

Lewis (1977) gives a more precise outline of the advantages of individualized instruction. He states that individualized instruction seeks to make determination about each child's learning potential to the fullest extend with a variety of carefully selected instructional approaches. For him, the system of individualized instruction is an "effective grading system" and the principles of this system are: (1) the student has a knowledge of what is expected, (2) the student has an opportunity to perform at his own pace, (3) the student knows how he or she is doing, (4) the student receives assistance and support and (5) the student is rewarded on the basis of results achieved.

Helen Davis Dell (1972) states that many teachers who have experienced changeover from the traditional to the individualized classroom have noted that growth has occurred not only in their students but in themselves. She believes that each student in a classroom is a unique person with his/her own needs, interests, and abilities. Individual students should have the opportunity to work toward achieving objectives that are appropriate for them and be allowed to work at a pace that is challenging to them. They should be encouraged to work on an objective until they have reached it, or change to one that is more appropriate to their ability. Dell does not see the point for the students to move on

to a new concept until they have mastered the old one(s). Repetition of a concept should be rather encouraged; as long as, of course, the student is not forced to this repetition but it is left to his or her own volition.

Carroll (1967) states that most learning tasks in a school curriculum can be mastered by all students if every student is given the necessary time. The time needed by a student to learn a school task is viewed as a function of the complexity of the task, the aptitudes and prior learning of student, his/her ability to understand instruction, his/her preserverance in mastering the task, and the quality of the instruction which depends on how clearly the learning tasks are defined, how well the materials are sequenced and graded, and how effective tests are used to provide encouragement, praise and corrective feedback.

Champagne and Goldman (1975) believe that most students can and should be responsible for the direction, mode, and pace of learning. When a student is not prevented from assuming this responsibility, learning becomes a major factor in building a positive self-image for each learner. If this is a sound experimental evidence, then Dell is justified in stating that a change-over was experienced not only in students but in the teachers as well by letting individuals work at their own pace.

The Association for Supervision and Curriculum Development (1964) gives a still better outline of the

advantages of self-pacing instruction. According to this Association, in order that maximum potentiality can be achieved in teaching children, seven possible ways are suggested: (1) observing and listening to learners with increased care and concern, (2) achieving openess in pupil-teacher relationships to permit improved responses and interactions, (3) recognizing and accepting different ways of responding according to learner's individualized styles and needs, (4) questioning, probing, and responding in ways that lead learners to assume responsibilities, (5) standing aside judiciously to let the learner discover and exercise his own resources, (6) place learners in varying roles, (7) achieving free and constructive communication with the learners, and (8) clearing the way by whatever means for stretching learner's minds and abilities in creative, self-fulfilling endeavor.

In a study on individualized instruction at the University of Pittsburgh by Robert Glaser (Hooper 1971), who was the director of Learning Research and Development Center of the University, three important areas were emphasized: (1) the analysis and definition of continuous educational objectives, (2) the development of assessment and diagnostic procedures to monitor individual learner's progress through the individualized curriculum, (3) the design of appropriate instructional materials in various media. Among the six requirements that Glaser

provides in designing individualized systems of instruction in order to satisfy individual differences, two of these requirements seem to promise more in the success of designing such a system. The first is that the students must be provided with appropriate instructional materials so that students acquire increasing competence in self-directed learning; this requirement implies that the curriculum must be designed in a way as to help the student gain self-independence and confidence in self-studying and self-evaluation. The second important requirement in designing an individualized system of instruction is that special professional training must be provided to school personnel so that they can accomplish the evaluation diagnosis and guidance of student performance. According to Glaser, a design of individualized system without special professional training of the designer in such systems is likely to fail to achieve its objectives. A successful system of individualized instruction is one which is well designed, re-evaluated, re-implemented in a continuous feedback procedure until it is perfected or until it meets all necessary criteria of an individualized system mentioned earlier in this section.

Individualized instruction studies conducted at the secondary school level generally report no significant difference in achievement or the quality of work produced. However, one study reported that low IQ and low reading ability groups did achieve significantly

better through the self-instructional method (O'Toole, 1966).

Another important study on individualized systems of instruction in secondary schools was recently conducted by Bangert, Kulik & Kulik (1983), at the University of Michigan. This study was referred by the authors as "meta-analytic" synthesis of findings from 51 previous studies on individualized instructions conducted by Hartley in 1978. Results of this "meta-analysis" indicated that the 'use' if individualized teaching systems have only a small effect on student achievement in secondary school courses. This result was based on a variety of academic settings and research designs and it held true for both published and unpublished studies according to Bangert. In addition, it was found that individualized teaching systems did not contribute significantly to student's self-esteem, critical thinking ability, or attributes toward the subject matter being taught. Bangert states that in Hartley's 51 separate studies on individualized mathematics teaching, it was found that at elementary level individualized teaching raised performance by only .12 standard deviations while at high school level the performance increment was .44 standard deviations. Bangert also mentions another later studying in 1981 by Kulik which reported a .60 standard deviations at college level. These findings, according to Bangert were different from those of Black and Burns in 1976 who found that students taught for mastery outscored non-mastery

students on achievement tests by .80 standard deviation higher on achievement measures and that mastery approaches typically elicited more favorable affective responses from students. To summarize Bangert's findings on 51 studies, 49 reported effects of individualized systems on examination achievement of students, 14 studies reported effects on student attitudes toward school subjects, 4 reported effects on student self-concept, and 4 on critical thinking skills.

Bangert and his colleagues concluded that individualized systems of secondary school teaching have not met the great hopes they once raised and that only one-quarter of the 51 separate studies yielded significant findings; since nearly one-third favor conventional instruction, and that their own 'meta-analysis' produced similar results. They also suggest that elementary and secondary school students may need more stimulation, guidance, and support, a requirement which is not necessary at college level since students at this level may be prepared to work under conditions of individualized instructions.

The above findings by Bangert, Hartley, and others are very significant in the field of individualized instruction and raise several important questions: Should individualized system of instruction be removed from schools? Should future course designers be discouraged in designing individualized systems? Was the theory of individualized learning as giving the best results misleading and

unrealistic in application ?

Neither Bangert and his associates nor other researchers of the area of Individualized Instruction who have reported weaknesses in individualized teaching systems have come with analytic explanations of these weaknesses. That a great number of individualized instructional systems are proven to be ineffective and not as desired does not actually mean that curriculum designers should be discouraged and turn to another direction. It means that future designers and implementers should be more cautious about the effectiveness of such approach and that a thorough investigation should be conducted to determine why some systems were proven ineffective. On the other hand, existing system could be used until alternative ones are developed and tested and could replace the existing ones. Future course designers should be more careful in designed individualized system so that not only appropriate software and hardware are provided but also it is important that the designers of such systems should be well trained in accomplishing properly and effectively the evaluation, diagnosis, and guidance of student performance. Implementors of self-instructional systems should conduct formative and summative evaluation as outlined by Bloom (1956, 1971), Wakarchuk (1973), Drumheller (1971), and others.

There are self-pacing systems which have fulfilled their objectives to a maximum expectency such as the SRA

(Parker, 1969) which is proven successful and is used in many schools of North America for the last 10 or 15 years to teach English and other subjects. On the other hand, there might be other factors which are not previously mentioned that affect students in not achieving as they should through self-pacing curriculum(s).

One of these factors which seems to contribute most in the lack of effectiveness of even well designed systems, particularly in lower grades is the inability of students to be self-taught. Particularly at elementary school levels teacher are, as Davies (1971) points out, spoonfeeding students. Students are not trained to become self-independent. Glaser (Hooper, 1971) suggests that students must be taught and provided with appropriate instructional materials so that they can require (and of course acquire) repeating competence in self-directed learning. This training should, for best results, start at the very early stage of the child's development. At this early stage, children should be trained so that they can perform tasks on their own, with the constant cooperation, required aid, and observation of their school administrator permitting them to develop gradual increment in self-studying capacities, self-actualization, and in the creation of self-image. Only then individualized instruction, even the less well-designed one , will be more effective and more beneficial to children in all three domains, the

cognitive, the affective, and the psychomotor.

Among the many approaches that can be found in designing an efficient, self-pacing, self-evaluating, individualized system of instruction, Russel's (1974) approach seems to be more attractive one. Russel calls his system of individualized instruction, " Modular Instruction". For him, a 'Module' is an instructional package dealing with a single conceptual unit of subject matter. It is an attempt to individualize learning by enabling the student to master one unit of content before moving to another one. Some of the fundamental characteristics of Modular instruction are:

1. Self-contained, self-instructional package
2. Concern for individual differences
3. Statement of objectives
4. Association, structure and sequence of knowledge
5. Utilization of a variety of media
6. Active participation by the learner
7. Immediate reinforcement of responses
8. Mastery evaluation strategy

Russel states that these are the general characteristics of Modular Instruction but any given Module may not have all these characteristics.

CHAPTER III

DESIGN OF MATERIALS

Tentative Solution to the Problem

In the section of "Review of Literature" a number of approaches to individualized instruction were discussed with the intention of uncovering a method that could be used to solve the problem of The College.

The findings indicated that individualized instruction is a good method for tutoring students. Of course, individualized instruction means different things to different people. Some of the methods discussed were created to improve learning by individualizing traditional instruction in a way to meet the needs of the majority of learners. Other approaches suggested teaching by the use of a computer and still others by prepared learning packages of Modules. Among all these approaches, 'Modular' instruction (Russel,1974) was chosen as a basis of this study.

The essential characteristic of this type of instruction is the students' freedom to move through the program at their own rate and time. The students through this type of instruction work on a particular objective until they have mastered the appropriate concepts. Modular instruction gives emphasis to self-direction, self-instruction, self-evaluation and confidence on the part of the learner. The self-instructional approach of Modules, the predesigned tests and prepared step-by-step solution of exercises and problems, give continuous and quick feedback, so that the

students can decide whether or not they have mastered a particular learning objective.

Referring to the "Problem Section" of this study it is easy to see that the existing problem was created due to the diversity of the students' goals, needs, background and motivation. The administration of The College decided to Individualize Instruction to the point that the student would become independent of the tutor and of the other students of the class and that the student could choose the objectives ensuring thus efficiency and effectiveness in his/her performance.

The administration started producing self-instructional Modules, that could teach Remedial Math to grade 7 students who were following courses at an English Secondary Institution and if results were satisfactory this method would be extended to cover other grades and other courses. Then each successful course would be also translated into French so that students who would come from a French system would fit into the same curriculum and into the same class as the anglophone students. This system of self-instructional Module was based on Russell's (1974) concept of Modular Instruction.

This program if successful, would consist of Individualized Modular packages containing a number of "Self-Instructional Modules". The number of Modules a

Modular Package would contain would be between 20-30 and would cover the requirements of one year course of study in Math as outlined by the Minister of Education of the Province of Quebec.

Each Module was divided into 4 parts:

1. "A Pretest" was designed to measure the entry ability of the student and how much he/she already knew from objectives contained in the Module; this determined whether a student was necessary to study all work of the Module or only a part of it.
2. Main conceptual "Frames" covered the concepts or objectives of that Module including examples and exercises. Instructions used in the Frames were made simple for the student to follow and solutions to examples were provided for immediate feedback.
3. A "Post-test" was designed to measure student's performance after studying the Module and how much the student had gained.
4. An "appendix" had included answers to Pre/Post Tests, Solutions to Review Exercises, and a Student Score or Evaluation Sheet.

Pilot-testing

Method of Pilot-testing

A pilot-testing was conducted by the author himself at The College in the summer of 1982 between the dates of July 20 and 30.

Eight grade 7 Math students (first year high school) volunteered for the experiment. These volunteers were taken from different groups of students who were having tutorial lessons in Math, and two prepared Instructional Modules were tested. These particular Modules were:

Module 1. Adding Integers

Module 2. Multiplying Integers

The volunteers were informed on the purpose of the testing, the procedures of the evaluation, and the method they should follow in order that the result of the evaluation would be valid and would show the effectiveness of the system as self-instructional. The method employed in the Module was also explained (The function of the "Pre/Post Test" as well as the "Frames" and "Review Exercises" of the Modules).

Procedures of Pilot-testing

After the students had completed the two Modules a prepared 'questionnaire' was given to them to test the strengths and weaknesses of the system.

For testing the system, "Pre/Post Test" and "Timing" were considered. The purpose of the Pre/Post Tests was also to test the method and content of the Modules if appropriate as Self-Instructional while time was kept to see whether a Module was too long or too short.

Results of Pilot-testing

General Observation. The maximum time to complete each Module was 60 minutes and the minimum 40 minutes while the average time was 45 minutes. The time it took to complete each Pre/Post Test was approximately 40-45 minutes.

Only 4 of the 8 students asked the tutor questions in the first Module and only one in the second. Questions asked were about clarification of directions given and after each Pre or Post Test.

Analysis of Responses of the Student Questionnaire resulted in the following results in percentages:

1. Seven of the 8 (87%) students who participated in the Modular treatment agreed that Modules could be used as both Main and Review Teaching Material and only 1 of the 8 (13%) stated that Modules should be used as Main Teaching Material. Thus, all 8 students agree that Modules could be used as Teaching Material.

2. Six of the 8 students (75%) stated that tutor was not necessary.

3. One of the 8 students (13%) stated that the tutor was necessary in the beginning of the lesson in case someone would need him/her.

4. Seven of the 8 students (87%) stated that Modules were very easy to follow while 1 of the 8 (13%) said that they were relatively easy.

5. Five of the 8 students (62%) highly recommend this system to be used as 'main' teaching or learning material in their regular schools, while 3 of the 8 students answered that the system could be much used in their schools.

6. All participants of the treatment (all the 8 students) found the Modules 'normal' in length .

7. In responses to the question on whether they were lost somewhere in the Module during the study only 2 of the 8 students (25%) responded that they were lost only few times and had to ask the tutor for help.

Interpretation of Results. Results of this Pilot-testing were very encouraging. The responses of the participants of the testing were positive as to 'content', 'method', and 'system' as self-instructional. Eighty-seven percent (87%) of the participants found Modules very easy and the rest found them fairly easy (which suggests that all participants found them easy). Most of them (84%) found that the tutor was not necessary and (75%) affirmed that they were never lost during the study.

The fact that all participants recommended the system to be used in their school either as 'main' teaching Material or as an 'aid' showed their preference of this system over any other one.

Results also showed that Modules were of 'normal' length and that the maximum time to complete each Module was 60 minutes.

Conclusion. The above findings of the Pilot-testing were very encouraging and showed the administration of The College "the green light" to go ahead with the system and produce more Modules for further 'implementation' and 'testing' for efficiency and effectiveness. How much the new Modular system would help solve the problem of The College would be decided by the findings of the Summative Evaluation which followed next.

CHAPTER IV

EVALUATION

Goals of Evaluation

The goal of Summative Evaluation was to test the Effectiveness of the system. It determined the success of the author in developing an appropriate instructional strategy based on related available research that provided logical arguments in support of the following objectives:

1. The first objective of this study was to ascertain that students could gain more between Pre and Post Test in Remedial Math through Modular Tutorial Instruction than through the usual tutorial help provided to the students as outlined in the 'Introduction' section.
2. The second objective was to ascertain that students who study through the Modular Method would retain more of the knowledge they have possessed than students of Tutorial sessions, after a period would have been elapsed.
3. The third objective was to ascertain that students of Modular Instruction would not take a much longer time to perform a task than the student of Tutorial session.
4. The next objective was to ascertain if:
   a) students could follow exact instruction through the Modular Method,

b) students could be better motivated through this method,

c) tutors could be needed much less by the student than are needed by the usual tutorial lessons.

Results of this evaluation would also serve to guide revisions of this teaching system to make it more effective and efficient (as is the purpose of Formative Evaluation) and to encourage the administrator of The College to 'design' and 'implement' a whole curriculum in tutoring mathematics for high school students of all grades.

Method

Sample

The sample consisted of 22 students, 20 males and 2 females. This comprised about 20% of the total college population at the time when this sample was drawn from this population. The sample of 22 students were all grade 7 regular[1] Mathematics students who had particular difficulties in Mathematics and were attending regular tutorial lessons at The College. The conditions for selecting the subjects for the experiment were as follows:

1. Initially, only regular students with an average grade of less than 50 percent(50%) in their regular school work were considered for remediation and selection; students with an average of 50% or above were not taking tutorial lessons for remediation but for improvement only and could not be considered for this study.
2. All participants chosen were 'regular' students and no students with known learning disorders participated in this study.

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[1]Regular students in this context means that they were enrolled in normal junior high school classrooms in the public school system.

3. All[1] grade 7 remedial students (with less than 50% average grade in their school work) were randomly assigned into 6 administration sessions.

Next, the sample of 22 students were randomly assigned to two main groups: Modular Condition(MC) and Tutorial Condition(TC). Exactly half of the subjects participated in each of the conditions. From each of the two conditions 3 administration sessions were randomly formed.

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[1] All available grade 7 Remedial Mathematics students who were following Tutorial lessons in the summer of 1983 at The College, with an average of less than (50%) in their regular school work, were considered for this study.

Design

Four different tests were considered in the design of this study. These tests were as follows:

1. Pretest (O_1)
2. Posttest (O_2)
3. Immediate test (O_3)
4. Delayed test (O_4)

The Pre/Post tests (O_1 and O_2) were part of the materials and were used to help the evaluator analyse the performance of the students and their gains while moving from one lesson to another, during the administration sessions.

The Immediate and Delayed tests (O_3 and O_4) were used as main testing instruments for the analysis not only of student's performance and behavior, but also of testing the validity of the evaluation as a whole, by analysing tests O_3 and O_4 across the two treatment conditions using these tests as repeated factors. Test O_4 was also designed to determine if a particular behavior of the student during instruction would be extended past the instructional period (several weeks later). Using test O_4, the time effect could also be studied and decisions as to which of the two methods, the MC or TC, is a better one could be made.

The Posttest only Control Group Design was used for the treatment of both Conditions in this study. The Modular Condition and Tutorial Condition are shown in Table 1 which is based on Tuckman (1972), with the addition of the immediate (O_3) and the Delayed (O_4) tests.

TABLE 1

Basic Experimental Design Used in this Study

Treatment (T)		Lessons[1]
T_1 : MC	R	$O_1\ X_1\ O_2$ $O_1\ X_2\ O_2$ $O_1\ X_3\ O_2$ $O_1\ X_4\ O_2$ $O_1\ X_5\ O_2$ $O_3\ O_4$
T_2 : TC	R	$O_1\ X_1\ O_2$ $O_1\ X_2\ O_2$ $O_1\ X_3\ O_2$ $O_1\ X_4\ O_2$ $O_1\ X_5\ O_2$ $O_3\ O_4$

[1] These refer to the consective nature of the lessons within each treatment condition.

In Table 1, X_1, X_2,X_3,X_4, and X_5 indicate the five consecutive lessons that students of both conditions received during the instructional period. Tests O_1 and O_2 are the Pre and Post tests. Tests O_3 and O_4 indicate the immediate and delayed tests, while R indicates that subjects of both treatment conditions were chosen randomly.

Two groups were employed in this design. One group, the MC, received a treatment T_1 of Modular Instruction (MTI) while the second group TC, received treatment T_2 of Tutorial Instruction (ITI). Both groups were given a Pretest O_1 and a Posttest O_2, and an immediate test O_3 and a delayed test O_4. The subjects of the MC were subjected to the same experiences as that of the subjects of the TC under different treatments: T_1 (MC), and T_2 (TC).

Materials

Sample Materials. Five prepared Instructional Modules were presented to the students during the experiment. These five Modules (see Appendix A for a sample of one of these Modules) were designed to be used for grade 7 students. Each Module covered one basic concept in Math and is designed for classroom work of 75 minutes or less for a normal student. The five Modules cover the following concepts:

Basic Concepts of Sets
Order Operations
Properties of Natural Numbers
Adding Integers
Subtracting Integers
Multiplying Integers

These Modules cover approximately one fourth of the Modular package (see Appendix B) of the Remedial Math grade 7 course which consists of 20 prepared Modules. Each of these Modules was divided into the following sections:

1. A statement on 'Entry Skills' was included right before the 'Pre-test" to inform the users of the Module what knowledge they must have possessed in order to enter the particular Module.
2. A 'Pre-test' is a part which contained items designed to measure the objectives covered in

the particular Module. The scores of the Pre-test determined whether the student had sufficient knowledge of the concepts covered in the Module and would be ready to move on to another one or whether some additional study had to be done in that particular Module in order that mastery level would be attained. Answers to the questions or items of the Module (usually all tests are 10 questions or items covering all necessary concepts of the Module) were found at the end of each Module.

3. The main part of the Modules was divided into "Frames" and each Frame included the "objective" of the Frame which told the student what he/she was supposed to accomplish at the end of the Frame. Each Frame covered only a part of the main objective of the Module. Answers to the questions of the Frames were given at the end of each Frame for feedback purpose. Care was taken by the course designer that all sub-concepts of the Frames were well explained, no step was missing, and that language was as simple as possible. The student did not have but to follow all steps of the Frame and would inevitably reach the required objective of the Frame (see Appendix A, for a sample of one of the prepared Modules).

4. 'Review Frames' consisted of Frames which cover briefly all subconcepts of the previous Frames. Students who would score 50% or over in their Pre-test could study only the review Frames and then take the Post-test. The Review Frame also contained enough review exercises so that the student could master the concepts of the Module. Not only were answers provided for the review exercises but step by step solutions were given as well. Review Exercises were divided into sections each of which covered a number of exercises. Students were directed to complete and master one set of exercises before starting another one so that when they had finished all the sets, a mastery level would be inevitably attained. Review Exercises were also considered as 'embedded' or Self-Tests.
5. A 'Posttest' was found at the end of each Module to test the level of performance of the students after they would have fulfilled all required steps of the Module. If a student would score 80% or more on a test, he/she would be considered to have reached mastery level. Otherwise, the student would be directed back to the Review Frames and then again to the Posttest until mastery level

would be attained. Only then the student would be permitted to start another Module.

6. Answers to the Pre/Post tests were found at the end of each Module but the tutor could remove them to make sure student's scores of the tests would not be biased by the student.[1]

Instrumentation. Four different tests, which are explained in the 'Design' and the 'Materials' section, and a questionnaire were administered to the subjects of both conditions, the Modular and the Tutorial. Each Module contained a Pretest and a Posttest of 10 items each, while the Immediate and the Delayed tests contained 5 sections corresponding to each Module with a total of 25 questions in each of these tests.

A Student Questionnaire was administered to each subject of the MC to indicate the student's subjective opinion about the strengths and weaknessess of the Modular system. Responses to this questionnaire aided the evaluator in examining through statistical analysis the motivations of students, the appropriateness of the MTI system, etc.

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[1] The answers were removed for the purpose of this evaluation.

Procedure

Procedure for Modular Condition. Subjects for the MC were randomly chosen among students of The College as stated earlier. When the evaluation of these materials started, the tutor explained to each subject of the MC the whole procedure of the treatment (the different parts of the Module, the importance and method of Pre/Post tests, how the solution and answer section of each Module should be used, etc.).

Next, each subject started his/her pretest and worked on each particular Module following all instructions as required. A time limit of 75 minutes was suggested for each Modular Session, but students were allowed to stay a longer period if necessary, or return another day to complete the particular Module.

Upon completion of the evaluation sessions which consisted of 5 prepared self-instructional Modules, each subject was asked to take a follow-up or 'immediate' test and next to this, a prepared 'questionnaire' was administered to each subject of the MC. As a last step, two weeks later, a final or 'Delayed' test was administered to each subject of the MC.

Procedure for Tutorial Condition. The subjects for the TC were also chosen in a similar way as that of the MC as shown in Table 1. The subjects of the TC were subjected to the usual Tutorial method of The College except that the concepts covered by the subjects of TC were

the same as that of the MC. Only the treatment method was different. Pretests, Posttests, Review Exercises of the Modules, Immediate test, and Delayed test were all the same as those of MC.

Subjects were taken one at a time leaving about 15 minutes between the starting time of one subject and another and the procedures of Pre/Post Tests were clearly explained. After the Pretest was administered to the first subject, the tutor received the second subject and followed the same procedure as that one of the first subject. The tutor helped each subject individually to understand the prearranged concepts designed for the subjects of the TC and time limit was also suggested but not instisted to be 15 minutes for tutoring, and 30-45 minutes for classwork done by the subject. A student was permitted to extent finishing time as long as the lesson would require.

On the completion of the experiment, the same procedure as that one of the MC was followed to administer the Immediate and Delayed tests. No Questionnaire was administered to the subjects of the TC.

Data Analysis

Difference between the pre and the post-tests, the pre and the immediate, the pre and the delayed, the post and the immediate, the post and the delayed, and the immediate and the delayed tests, were analysed using analysis of variance.

A multivariate analysis of variance (equivalent to Hotelling's T^2) was conducted across the design of the experiment to establish the equivalence of MC and TC groups on the lesson pretests.

A multivariate analysis of variance was also conducted to determine if a reliable difference existed between the MC and the TC as a result of the different instructional treatments.

A two-way analysis of variance with repeated measures was conducted, across the two treatment conditions, on the immediate and delayed posttests to determine if the potentially facilitative effects of MC during instruction were extended past the instructional period several weeks later.

In addition, a multivariate analysis of variance was conducted on gain scores (posttest minus pretest), for tests that were part of the instructional treatments.

Next, the measured variable, Time, the student spent working on the lessons in the two treatment conditions, was estimated. Because 5 times were involved, a

multivariate analysis of variance was necessary to be used.

Then, a multivariate analysis of variance was conducted to determine the degree of efficiency of Modular Instruction against Tutorial Instruction. The efficiency for each lesson was found by dividing each Difference Score (Gain) by time (Dayton and Schwier, 1979). Effects estimate $\hat{\omega}^2$, omega squared (Keppel 1982), was used to calculate the magnitude of the effects of the difference in treatment on gain scores, and efficiency in respect to time.

Lastly, an analysis of Student Questionnaire was conducted for only the Modular Condition group to find out students' subjective opinion of the Modular Method. Data were analysed by converting the students' responses to percentages.

Results

Analysis of Pretest Scores

The first step in the analysis of these data was to establish the equivalence of the MC and TC groups on the lesson pretests. Since there were five of these lessons, representing five separate dependent variables, a multivariate analysis of variance (equivalent to Hotelling's T^2) was conducted across the design of the experiment, the means and standard deviation of the comparison between MC and TC are shown in Table 2. The multivariate test of significance showed that there was an overall lack of difference between the two groups, $F(5,16)=1.61$, $p > .20$. Only one of the univariate tests proved to be significant. Pretest four produced a significant difference, $F(1,20)=7.2$, $p < .02$. However, it can be readily ascertained from Table 6 that this difference in means occurred in favor of the TC condition.

TABLE 2

Mean Difference and Standard Deviation of Pre and Post Test (1-5) Scores for Modular and Tutorial Groups

TESTS	MODULAR $\bar{x}$	s.d.	Δ	s.d.	TUTORIAL $\bar{x}$	s.d.	Δ	s.d.
PRETEST 1	1.36	1.29			1.18	1.08		
			7.64	1.2			5.82	.02
POSTTEST 1	9.00	.89			7.00	1.10		
PRETEST 2	2.00	1.34			2.00	1.10		
			7.55	.82			5.55	.06
POSTTEST 2	9.55	.52			7.55	1.04		
PRETEST 3	1.18	.75			1.09	.54		
			7.27	.38			5.55	.38
POSTTEST 3	8.45	1.13			6.64	.92		
PRETEST 4	1.36	.81			2.36	.92		
			7.91	.16			4.64	.08
POSTTEST 4	9.27	.65			7.00	1.00		
PRETEST 5	.73	.90			.73	.90		
			8.72	.12			6.63	.09
POSTTEST 5	9.45	.82			7.36	.81		

As a result of this analysis it was determined that TC and MC were essentially equivalent on the results. Any difference resulting in further analysis, therefore, can be more likely ascribed to differences in treatments.

Analysis of Difference Scores

In order to determine if a reliable difference existed between the Modular Condition (MC) and the Tutorial Condition as a result of the instructional treatments a difference score was calculated (Posttest minus Pretest) and was analysed using multivariate analysis of variance. Again, this test of significance is equivalent to the multivariate t-test between group means.

The means and standard deviation of these difference scores are presented in Table 3. The overall multivariate test was significant, $F(5,16) = 10.71$, $p < .0002$. An inspection of the mean scores (Table 3) indicates that this difference is in favor of the MC condition and suggests that Modular approach to instruction provides better support for the learning of Mathematic concepts during the course of instruction.

TABLE 3

The Means and Standard Deviations of

Difference Scores (Gains)

	MODULAR		TUTORIAL	
Variable	$\bar{x}$	s.d.	$\bar{x}$	s.d.
GAIN 1	7.64	1.21	5.82	1.40
GAIN 2	7.55	1.21	5.55	1.21
GAIN 3	7.27	1.27	5.55	1.04
GAIN 4	7.91	1.14	4.64	1.29
GAIN 5	8.73	.79	6.64	1.36

The analysis of the univariate tests provided essentially the same information as the multivariate tests. Results of this analysis are provided in Table 4. These results are supportive of the original hypothesis that a well-designed instructional package is preferable for individualized remedial instruction.

Effects estimate ω^2 (Omega squared) was used to calculate the magnitude of the effects of the difference in treatment on gain scores. It was found that the average effect on gain scores was .42. This accounts for 42% difference which is significant gain for the MC. The magnitude of each of the five tests also is significant as shown in Table 4.

TABLE 4

Summary of Univariate Anovas on

Difference Scores

DEPENDENT VARIABLE		SS	df	MS	F	p	$(\omega^2)^1$
DIFF. 1	TREATMENT	18.18	1	18.18	10.64	.004	.30
	ERROR	34.18	20	1.71			
DIFF. 2	TREATMENT	22.00	1	22.00	14.94	.001	.39
	ERROR	29.45	20	1.47			
DIFF. 3	TREATMENT	16.41	1	16.41	12.20	.002	.32
	ERROR	29.91	20	1.35			
DIFF. 4	TREATMENT	58.91	1	58.91	40.00	.0001	.64
	ERROR	29.45	20	1.47			
DIFF. 5	TREATMENT	24.05	1	24.05	19.45	.0001	.46
	ERROR	24.73	20	1.24			

1 $\hat{\omega}^2 = \dfrac{SS_A - (K-1)\ (\text{Ms Error})}{SS\ \text{Total} + \text{MS Error}}$

2 DIFF = Difference between posttest and pretest

Analysis of Immediate and Delayed Posttests

An analysis of the immediate and delayed posttests was conducted across the two treatment conditions using tests as a repeated factor. This test of significance was run to determine if the generally facilitative effects during instruction were extended past the instructional period and two weeks later.

The means and standard deviation for MC and TC on the immediate and delayed tests are shown in Table 5. In addition, Table 6 shows a summary of the two-way analysis of variance with two levels of the repeated factor, time. This analysis revealed a significant main effect for treatments, $F(1,20) = 95.84$, $p < .0001$ and a main effect for time, $F(1,20) = 55.33$, $p < .0001$. The interaction term was not significant, $F(1,20) = 2.21$, $p > .13$, although the pattern of means over time suggests a slight advantage for the TC.

TABLE 5

Means and Standard Deviation for Immediate and Delayed Test Scores

	IMMEDIATE		DELAYED	
CONDITION	$\bar{x}$	s.d.	$\bar{x}$	s.d.
MODULAR	23.18	1.33	18.27	2.28
TUTORIAL	17.09	2.07	13.82	1.33

TABLE 6

ANOVA Summary of Immediate and Delayed Posttest

SOURCE	SS	df	MS	F	p
Between					
TREATMENT(T)	305.82	1	305.82	95.84	.0001
ERROR	63.82	20	3.19		
Within					
TIME	184.09	1	184.09	55.33	.0001
TXT	7.36	1	7.36	2.21	.1300
ERROR	66.55	20	3.33		

Moreover, a 21% decrease in mean scores was noted between the immediate and delayed posttests for MC treatment, while a 19% decrease was observed in the TC treatment over time. This difference in treatment was considered negligible. These results indicate that the differences between TC and MC found on gain scores, extended to immediately afterwards and two weeks after the treatments ended.

Analysis of Lesson Completion Time

One question involved the time students spend in working on lessons in the two treatment conditions. The means and standard deviation for the time data are indicated in Table 7. Because five times were involved and are treated here as dependent variables, a multivariate analysis was necessary.

TABLE 7

Means and Standard Deviation for

Time for both MC and TC

	MC		TC	
LESSON 1	$\bar{x}$[1]	s.d.	$\bar{x}$[1]	s.d.
1.	55.91	7.01	52.73	10.81
2.	54.09	8.31	51.36	10.74
3.	57.27	6.07	51.36	8.39
4.	55.91	7.01	50.45	7.89
5.	54.55	7.57	46.36	7.10

[1] means represent completion time in minutes.

The overall multivariate effect between TC and MC for completion time was not significant, $F(5,16) = 2.019$, $p > .15$. However, one of the univariate tests was significant (Lesson 5), $F(1,20) = 6.84$, $p < .02$. As can be seen (Table 7), this difference is in favor of the Tutorial Condition, that is, students in the TC treatment took less time in Lessons 3, 4, and 5 than students in the MC treatment.

Analysis of Students' Performance in Terms of Efficiency

One final question ought to be analysed in order to determine the efficiency of the Modular Method versus the Tutorial one. Since there were 5 dependent variables (EFFICIENCIES 1-5) a multivariate analysis of variance was conducted. The results indicate that the overall multivariate effect between MC and TC for efficiency was significant, $F(5,16) = 3.225$, $p < .03$. Moreover, two of the univariate tests were significant EFF1, $F(1,20) = 5.83$, $p < .03$, and EFF4, $F(1,20) = 11.35$, $p < .003$. Univariate tests EFF2, EFF3, and EFF5, were not significant as indicated in table 8. Results of this analysis are in favor of MC.

TABLE 8

Univariate Tests for the Relationship Between Time Spent to Complete a Lesson and Difference Score Indicating Degree of Efficiency [1]

VARIABLE		SS	MS	F	p	ω^2
EFFICIENCY 1	TREAT	.004	.004	5.83	.03	.18
	ERROR	.013				
EFFICIENCY 2	TREAT	.005	.005	4.07	.06	.123
	ERROR	.260				
EFFICIENCY 3	TREAT	.002	.002	2.87	.11	.078
	ERROR	.016				
EFFICIENCY 4	TREAT	.013	.013	11.35	.003	.32
	ERROR	.023				
EFFICIENCY 5	TREAT	.002	.002	1.58	.22	.026
	ERROR	.020				

[1] EFFICIENCY = $\frac{\text{DIFFERENCE SCORE (GAIN)}}{\text{TIME}}$

The average effects estimate ω^2 (Omega squared) in respect to efficiency (Table 8), indicated that difference in efficiency between groups was only (.145). This accounts a 15% difference in efficiency in favor of MC.

Analysis of the Questionnaire

A questionnaire was administered to each of the 11 students of the MC to help the evaluator determine the students' subjective impressions of the strengths and the weaknesses of the Modular system, their subjective opinion about the usefulness of the system in a public system, the appropriateness of the system as an auto-didactic one, and their preference to this Modular instruction over the traditional one.

Basically, the purpose of the questionnaire was to find out the students' subjective impression as to whether the method:

1. Would increase students' ability to study on their own,
2. Would improve their studying habits,
3. Would be appropriate to study independently without tutor's help,
4. Would be useful in public schools,
5. Would be appropriate as a Review Material or as a main teaching material or as both,
6. Was easy to follow and of normal length.

Responses based on these six hypotheses are changed to percentage form and are as follows:

1. When they were asked as to whether they thought the method would increase their ability to study on their own, the response were:

64% (7 subjects) answered highly positive,

36% (4 subjects) answered it would.

2. When they were asked as to whether they thought the method would improve their studying habits, the results were:

100% (11 subjects) answered it would.

3. To the question as to whether the method is good to study independently without tutor's help, or with little help, the responses were:

100% (11 subjects) answered that tutor is not much needed, though he/she is necessary in case someone needs help.

4. To the question as to whether they suggest the Modular system to be used in their school, the responses were:

73% (8 subjects) highly suggest it,

27% (3 subjects) suggest it.

5. When they were asked whether they suggest this method as Review Material or as Main Instructional Material or as both, the responses were:

73% (8 subjects) said it could be used as both,

27% (3 subjects) said that was good as Review Material.

6. To the question as to whether Modules were easy to follow and of normal length:

100% (11 subjects) found it fairly easy,
100% (11 subjects) found it of normal length.[1]

In summary, the students felt the Modular System would increase their ability to study, improve their studying habits, and help them study independently. Moreover, they found this method easy to follow and of normal length. The students also felt that this method is good to be used in their public schools either as remedial help or as main instructional material. Responses, therefore, of the students who participated in the Modular sessions of this study, showed that they were highly in favor of this Modular Method versus the Traditional Tutorial Method.

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[1] 'Normal' length implies here that a Module would take an average of 45-60 minutes to be completed by a Remedial student.

Discussion

The objectives of the present study was to test the efficiency and effectivenesss of Modular Tutorial Instruction (MTI) against Individual Tutorial Instruction (ITI). Two methods of evaluation were applied; A Pilot-testing using a small sample, and Summative using a larger sample. The preliminary results offered in the Pilot-testing were in favor of MTI as to the content method and system as self-instructional and indicated that a further evaluation was necessary to test the effectiveness of the modular system using a larger sample .

Summative evaluation was conducted using a random sample of 22 students separated into 6 administration sessions. There was an equal number of subjects in each of the two different treatment conditions. There were 11 subjects in the Modular Condition (MC), and 11 in the Tutorial Condition (TC).

Five different analyses of variance were conducted to test the effectiveness of MTI versus ITI.

In the analysis of pretest score it was found that MC did not differ significantly from TC. Test results were essentially equivalent on results of pretest, and any small difference observed cannot be attributed to difference in treatment conditions. Results of the testing were expected since the subjects assigned for the treatment were all remedial Math students whose

subject score was below the passing mark (50%). Essentially all those subjects performed within a range (0-20%) in their pretest. On the other hand, the sample was not large enough to detect a significant difference between the two treatment conditions. Consequently, the cognitive skills in both treatment conditions were found essentially the same at the beginning of the administration sessions.

The next analysis, Analysis of Difference Scores (Posttest Minus Pretest) supported the original hypothesis which was in favor of a well designed instructional package for individual tutorial instruction. This analysis indicated that overall, MC, subjects gain more from pretest to posttest than TC subjects suggesting the superiority of Modular Instruction for Remedial Mathematics. This analysis also supported the validity of previous results obtained in the Pilot-testing of this study, and ascertained the first objective outlined in the 'Evaluation Section' of this paper which was to determine if students could perform better in Remedial Mathematics through the Modular Tutorial approach. Results were also in accord with earlier research findings by Parker (1963), Sherman (1978), Black and Burns (1976), and others who supported the superiority of individualized instruction in learning.

On the other hand, Analysis of Immediate and Delayed Tests, contrary to one's expectation, and

contrary to the second objective of the 'Evaluation Section' of this paper, indicated a slight advantage for the Tutorial Condition. This analysis showed that there was a decrease in performance for both treatment conditions but the Modular one showed a slight decrement (2%) in loss of knowledge, in comparison with the TC over the two weeks period. Nevertheless, this (2%) difference in favor of the Tutorial Method was only negligible and cannot actually result in any general conclusion in favor of Tutorial Instruction, especially if one considers that during the two weeks interval between the treatment and the Delayed testing, many unexpected and uncontrollable factors could have caused the present results to slightly favor Tutorial instruction. One explanation for this difference in immediate and delayed performance could be that some subjects of TC gained a little more from tutorial lessons; that both treatment groups received during the two weeks period following the treatment. Results might have been different if subjects had not followed tutorial lessons after the treatment. However, this effect did not produce a significant time by treatment interaction.

Next were the results of Analysis of Lesson Completion Time which were also slightly in favor of

The Tutorial Method. Nevertheless, row data of students' lessons completion time indicate that two subjects of the MC spent much more time to complete their assignement it took them 75 minutes in relation to all others in both conditions who ranged from 40-60 minutes to complete their assignment. This difference in time of the two subjects had contributed in causing the average time of the MC to increase significantly. And since the samples in this study were relatively small, a large deviation of time of one or more subjects from the remaining group, could have cause a significant change in the results of the analysis. On the other hand, it was expected that subjects of the MC would spend an equal or even slightly more time to complete their assignment as that of the TC. The fact that the lessons in the Tutorial Condition sessions were mainly controlled by the tutor while in the Modular Condition were only controlled minimally, would naturally result in subjects of the Modular Condition spending an equal or even more time in competing a particular assignment; especially when mastery level was expected by them. One of the most important conditions that the students were asked to meet in each Module was that of the mastery. The directions given in the Modules suggested that students should not go to a new concept before having mastered the previous one. Therefore, quite naturally students of the MC took their time to complete each Module. This has

resulted in them spending much more time than they would spend if time factor would be a requirement for the MC sessions. However, removal of this condition could invalidate MTI on a self-pacing method. In any case, the third objective of this study (see Evaluation Section) was to ascertain that students of TC would not take much more time in completing a Module than the ones would take in completing a Tutorial lesson, and results of this analysis ascertained this objective.

In the Analysis of Performance in terms of Efficiency it was found that Modular instruction was indeed more efficient that the Tutorial one. The 'time' factor in this analysis was very significant since 'efficiency' was calculated by dividing the Difference Scores (Gain) by time and the larger the time a student would take to complete a lesson, the smaller the efficiency was expected. It is therefore obvious that the extra time the two groups took in completing their lessons must also have affected the results of this analysis. On the other hand, the actual results of this analysis indicated that subjects of the Modular Condition did perform better in terms of efficiency although two tests were not significant in favor of Modular instruction. This finding tentatively implies that Modular Instruction is more efficient than the Tutorial.

The results of the effects estimate (ω^2) also indicated that the average effect of the different treatment on gain scores accounted for a large proportion of the total test variance (.43). This provides additional evidence of the effectiveness of MC. The average effect estimate in respect to efficiency was found to be only 15% difference suggesting that time has a modifying effect on the analysis. It must be noted that this last analysis using the technique of ω^2 to test the average effect of gain scores and efficiency is a more reliable indication of group difference according to Keppel (1982) since ω^2 is not adversely affected by sample as is the test of significance based upon F.

The analysis of the student questionnaire indicated that students were positively disposed toward the Modular Instructional System. Results of this analysis supported the fourth objective of the 'Evaluation' Section that students of Modular instruction could follow exact instructions of Modules, that they could be better motivated by this method, and that tutors would be less needed by students. Yet, all subjects who responded to the questionnaire agreed that tutor should not be removed entirely from a class in case he/she is needed. Otherwise, everyone

liked the Modular Method and students even suggest that it be used in their schools not only for Remedial help but as main teaching material as well.

Results of this study more or less confirmed the results of the Pilot-testing. It should be emphasized here that the Modular System tested in this study was Remedial in nature and intended for students who have previous knowledge of the subject. Consequently, testing for effectiveness of the Modular Method was intended only for testing the effectiveness of the method as Remedial Mathematics teaching alternative. It should also be mentioned that Remediation students may score zero in their pretests but are usually performing or studying differently than other students who have no previous knowledge of a particular topic. For those researchers who may wish to pursue this subject, further studies could be done to ascertain whether Remedial students could learn faster and could perform better than non-remedial ones even though there is no significant difference in their Pretest Scores. The author of this study also suggests that a further Evaluation with much larger samples of student population be conducted in this area to determine if students can retain a concept learned by Modular instruction longer than by Tutorial or other methods. It is further suggested that subjects of treatment conditions have no instruction in the subjects tested in the period between Immediate and Delayed Testing, which did not happen in this study resulting in less reliable results.

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APPENDICES

Appendix A

A Sample of Instructional Modules

MODULE 8

MULTIPLICATION OF INTEGERS

Modular Learning Package I

Modular Tutorial Instruction
in Teaching Remedial Math to
High School Students, Designed
and Produced by Marinos Razis,
Principal, Collège Tutorial,
Montréal.

MODULE 8

MULTIPLICATION OF INTEGERS

PRETEST

ENTRY SKILLS. YOU MUST HAVE NO PROBLEMS IN MULTIPLYING NUMBERS OR ELSE DON'T START THIS MODULE.

OBJECTIVE OF TEST. THE PURPOSE OF THIS TEST IS TO SHOW WHETHER YOU NEED TO STUDY ALL THIS MODULE OR PART OF IT.

Multiply

1. $(-4) \times (-3) =$
2. $+5 \times (-7) =$
3. $-4 \cdot +6 =$
4. $(-3)(+10) =$
5. $(-5) \cdot +8 =$
6. $(-3)(-5) =$
7. $-3 \cdot +1 =$
8. $(-3)(-1) =$
9. $-4 \times +6 =$
10. $+4 \cdot -5 =$

Your Score $\frac{\quad}{10}$

AFTER YOU HAVE COMPLETED THE TEST FOLLOW THESE DIRECTIONS:

1. IF YOU SCORE 8/10 OR MORE, YOU HAVE MASTERED THE CONCEPTS OF THIS MODULE. TRANSFER YOUR SCORE TO THE STUDENT SCORE SHEET PROVIDED BY YOUR TUTOR, AND START ANOTHER MODULE.
2. IF YOU SCORE 5/10, 6/10, OR 7/10, REVIEW FRAMES 4 & 5, AND TAKE THE POSTTEST WHICH IS AT THE END OF THIS MODULE.
3. IF YOU SCORE LESS THAN 5/10, STUDY ALL FRAMES(1-5) AND THEN TAKE THE POSTTEST.

MODULE 8

MULTIPLICATION OF INTEGERS

FRAME 1. OBJECTIVE: In this Frame you will relate yourself with the concepts of 'positive' and 'negative' (+ and -) 'integers' and you will develop some rules which will help you to multiply any two integers.

In the past you have used '+' and '-' signs to'add' or 'subtract' Natural Numbers. Now you will learn that these signs are used to show the 'nature' of numbers or 'ideas'. For example, when we think of Temperature, we usually say 'above' zero or 'below' zero. Here we will symbolize this idea of 'above' or 'below' as '+' or '-'. Therefore, $^{-}20C^{o}$ means "20 below zero" and $^{+}20C^{o}$ means "20 above zero", where C^{o} indicates Centigrade.

Now observe the following examples:

Positive ideas		Negative ideas	
idea	symbol	idea	symbol
I do	+	don't	-
yes	+	not	-
good	+	bad	-
fine	+	not good	-
everything	+	nothing	-
friend	+	enemy	-
above zero	+	below zero	-
I like	+	I don't like	-

If now you try to join ideas from both of the above columns, you could have the following interesting results:

not good = bad and not bad = good
\- + - - - +

FRAME 1(Cont'd)

that is, (-)(+)=(-) while (-)(-)=(+)

"negative X positive = negative" and

"negative X negative = positive"

Here is another example:

don't choose (-) the good one (+) = choose the bad one (-)

don't choose (-) the bad one (-) = choose the good one (+)

Question. Can you give the missing signs in the following relations of signs?

a) (+)(-)=( ) d) (-)(+)=( )

b) ( )(+)=(+) e) ( )(-)=(-)

c) (-)(-)=( ) f) (-)( )=(+)

ANSWERS: a) -, b) +, c) +, d) -, e) +, f) +

END OF FRAME ONE.

FRAME 2. Objective. The purpose of this frame is to give you a better or further insight of the concept of negatives and positives in multiplication.

Observe these examples:

Let '+' meaning Friend and '-' meaning enemy. Then,

a) A friend of your friend is your friend
(+) (+) = (+)

b) A friend of your enemy is your enemy
(+) (-) = (-)

c) An enemy of your friend is you enemy
(-) (+) = (-)

FRAME 2 (Cont'd)

d) An enemy of your enemy is your friend
(-) (-) = (+)

These above interesting ideas about your friends and enemies can be restated as follows:

Rule 1 When you multiply two positive (+) signs the resulting sign is positive (+):

(+) x (+) = +

Rule 2 When you multiply one positive (+) sign and one negative (-), the result is negative (-):

(+) x (-) = -

Rule 3 When you multiply one negative (-) sign and one positive (+), the resulting sign is negative (-). As in Rule 2:

(-) x (+) = -

Rule 4 When you multiply two negative (-) signs the resulting sign is negative (-):

(-) x (-) = +

Examples:

1. (+3) x (+2) = +6
2. (+3) x (-2) = -6
3. (-3) x (+2) = +6
4. (-3) x (-2) = +6

Observe that twice we obtain + answer and twice negative answer.

END OF FRAME 2.

FRAME 3. Objective. The purpose of this frame is to extend the idea of multiplying integers by giving more examples of the use of signs.

Your success in performing correctly exercises of multiplication of integers will depend on your skill in remembering these 4 rules:

Rule 1. (+) x (+) = +

2. (+) x (-) = -

3. (-) x (+) = -

4. (-) x (-) = +

Remarks

Before going further you should know that:

a) Times(x) can also be symbolized as .

3 . 2 means 3 x 2, $\bar{5}$. $\bar{2}$ means $\bar{5}$ x $\bar{2}$ etc.

b) All these products are equal: (+3)•(+2) = (+6) , and (+3) x (+2) = +6 = 6,

c) Brackets ( ) can be removed and result will still be the same.

(-3) x (-2) = -3 x -2 = +6 = 6

Now try to multiply the following example by using the 4 Rules and by considering the above Remarks of Frame 3.

a) (-2) x (-3) =

b) (-2) . (-3) =

c) -2 x -3 =

d) -2 . -3 =

e) 5 . -2 =

f) -6 x 3 =

Where 5 means +5

Where 3 means +3

Change 2 to +2 _____

FRAME 3 (Cont'd)

g) (-6) x -3 =

h) -3 x (+8) =

i) (-2) . 2 =

j) +8 . -3 =

k) +8 . +2 =

ANSWERS TO THE EXAMPLES OF FRAME 3.

a) +6 or 6 b) +6 or 6 c) +6 or 6 d) +6 or 6

e) -10 f) -18 g) +18 or 18 h) -18 i) -4

j) -24 k) +16

END OF FRAME 3.

FRAME 4 (REVIEW FRAME).

Objective. The purpose of this Frame is to help you master the concept of multiplying any two integers through revision of the concepts of this Module.

You have learned in this Module, the following 4 RULES:

1. When you multiply two positive integers the result is always positive: +3 x +2 = +6
2. When you multiply one positive with one negative integer, the result is always negative: (+3) x (-2) = (-6)
3. When you multiply one negative with one positive, the result will be negative: (-3) x (+3) = (-9)
4. When you multiply two negative numbers the

FRAME 4 (Cont'd)

result will be positive: $(-3)x(-3) = (+9)$

You have also noticed the following remarks:

1. X for times is also symbolized as a dot'!.'
2. Brackets can be removed: $(-9) = -9$
3. There are more than one way to write products:
   $(-3)x(-2)=3 \times -2=-3 \cdot -2=(+3 \times 2)=+(3 \times 2)=+6=6$

Now you should be able to multiply any two integers without difficulty. In any case, more exercises will follow to be able to master the concepts of this Module.

EXERCISES

Find the products of:

1. $(-5)(+11)$	5. -8×-3	9. -11×-1
2. $(-2)(-5)$	6. $-8(-3)$	10. $+11 \times +1$
3. $+6 \cdot +8$	7. $(-8) \cdot (-3)$	11. $+8 \times (-3)$
4. $-9 \cdot -1$	8. $-8 \cdot (-2)$	12. $(-3)(-5)$

ANSWERS TO THE EXERCISES

1) -55 2) +10 3) 48 4) 9 5) 24 6) 24 7) 24
8) 16 9) 11 10) 11 11) 11 12) -24

END OF FRAME 4.

FRAME 5 (REVIEW EXERCISES)

Objective. In this Frame a number of Review Exercises are given to you for practice purpose. After you finish every set, check your answer before going to another set. Always think of your Rules and if you have made a mistake in any exercise ask yourself "why" and try to find out where you went wrong. Only then, continue with the next set.

Find the products in each set.

Set 1	Set 2	Set 3	Set 4
a) -2 . +2	a) -5 x -1	a) (-3) . -8	a) 0 x -20
b) +3 . -7	b) +4 . +6	b) -11 x -11	b) +(9) x +7
c) +4 . -3	c) 5 . +8	c) +10 x -11	c) 10 x(-3)
d) -3 . -5	d) +5 . -4	d) -24 x +1	d) (20) (2)
e) (+4) (-3)	e) -(6) . 6	e) 48 . -1	e) (40) (-2)
f) (-3) (-6)	f) +(7) . -10	f) +25 . -2	f) -20 x -3
g) -8 x 2	g) -1 . +5	g) -25 x -2	g) 20 x -3
h) -8 . 0	h) 0 x -3	h) (-3) (-20)	h) +20 . +3

Answers to Frame 5 are found at the end of the Module in the Appendix.

END OF FRAME 5

MODULE 8

MULTIPLICATION OF INTEGERS

POSTTEST

OBJECTIVE. THE OBJECTIVE OF THIS POSTTEST IS TO FIND OUT HOW MUCH YOU HAVE MASTERED THE CONCEPTS OF THIS MODULE, WHETHER YOU ARE READY TO MOVE ON TO ANOTHER MODULE OR YOU SHOULD RETURN TO SOME FRAMES TO MASTER THE CONCEPTS.

Multiply

1. $(-3) \times (-5) =$
2. $(+3) \times -5 =$
3. $-2 \cdot +3 =$
4. $(-3)(+11) =$
5. $(-2) \cdot +5 =$
6. $(-2)(-1) =$
7. $-1 \cdot +2 =$
8. $(-2)(-3) =$
9. $-5 \times +5 =$
10. $+5 \times -2 =$

Your Score

$\frac{\quad}{10}$

AFTER YOU HAVE COMPLETED THE TEST FOLLOW THESE DIRECTIONS:

1. IF YOU SCORE 8/10 OR MORE, YOU HAVE MASTERED THE CONCEPTS OF THIS MODULE. TRANSFER YOUR SCORE TO THE STUDENT SCORE SHEET PROVIDED BY YOUR TUTOR, AND START ANOTHER MODULE.
2. IF YOU SCORE 5/10, 6/10, OR 7/10, REVIEW FRAMES 4 & 5, AND TAKE THIS POSTTEST AGAIN (OR ASK YOUR TUTOR FOR ANOTHER ONE).
3. IF YOU SCORE LESS THAN 5/10, STUDY ALL FRAMES (1-5) AND THEN TAKE THIS POSTTEST AGAIN (OR ASK YOUR TUTOR FOR ANOTHER ONE).

Appendix

ANSWERS TO REVIEW EXERCISES OF FRAME 5.

Set 1	Set 2	Set 3	Set 4
a) -4	a) +5	a) +24	a) 0
b) -21	b) 24	b) 121	b) 63
c) -12	c) 40	c) -110	c) -30
d) 15	d) -20	d) -24	d) 40
e) -12	e) -36	e) -48	e) -80
f) +18	f) -70	f) -50	f) 60
g) -16	g) -5	g) 50	g) -60
h) 0	h) 0	h) 60	h) 60

ANSWERS TO PRE AND POST TESTS

PRETEST		POSTTEST	
1. 12	6. -15	1. 15	6. +2
2. -35	7. -3	2. -15	7. -2
3. -24	8. +3	3. -6	8. 6
4. -30	9. -24	4. -33	9. -25
5. -40	10. -20	5. -10	10. -10

Appendix B

Modular Learning Package I: Contents

MODULAR LEARNING PACKAGE No I

ALGEBRA I

CONTENTS

MODULE 1. THE BASIC CONCEPTS OF SETS (PART I).

2. BASIC PROPERTIES.

3. ORDER OPERATIONS.

4. ADDITION OF INTEGERS.

5. SUBTRACTION OF INTEGERS.

6. DECIMAL ADDITION AND SUBTRACTION.

7. DECIMAL MULTIPICATION AND DIVISION .

8. MULTIPLICATION OF INTEGERS.

9. DIVISION OF INTEGERS.

10. ADDITION AND SUBTRACTION OF FRACTIONS.

11. MULTIPLICATION AND DIVISION OF FRACTIONS.

12. EXPONENTIALS,

13. SOLVING EQUATIONS WITH ONE VARIABLE.

14. INTRODUCTION TO INEQUALITIES.

15. NUMBER SENTENCES.

16. FACTORS AND MULTIPLES.

17. THE GCF AND THE LCM.

18. PERCENTAGES.

19. THE METRIC SYSTEM.

20. PROBLEM SOLVING.

Appendix C

Student Questionnaire

STUDENT'S QUESTIONNAIRE

PLEASE CIRCLE A, B, C, D or E

1. Do you think these Modules should be used as Review Material ONLY or as MAIN TEACHING MATERIAL as well?

   A- as Review Material only
   B- as Main Teaching Material
   C- both
   D- I don't know

2. How much do you think a tutor is necessary?

   A- Tutor must be present in case you need help
   B- Tutor is not necessary
   C- Tutor is necessary only in the beginning of the course

3. Did you find the Modules long?

   A- very long
   B- only little
   C- not much
   D- of normal length

4. Did you find the Modules interesting?

   A- very
   B- enough
   C- little
   D- not at all

5. Were the Modules easy to follow?

   A- very
   B- enough
   C- little
   D- not at all

6. Do you think this method would improve your studying habits?

A- I very much think so
B- I think it could
C- I don't think so
D- I am not sure

7. Do you suggest this method to be used in your schools?

A- I highly suggest it
B- I suggest it
C- I don't suggest it
D- I am not sure if it could be used

8. Do you think this method would increase your ability to study on your own and become independent of tutor's help?

A- I highly think it would
B- I think it somehow would
C- I don't think it would
D- I am not sure

9. Were the steps of the Frames easy to follow?

A- they were not as easy to follow
B- they were relatively easy
C- they were very easy
D- I am not sure

10. Were the directions and instructions of the Modules easy to follow?

A- I didn't find them too easy
B- they were relatively easy
C- they were very easy
D- I am not sure

Appendix D

Student Score Sheet

STUDENT SCORE SHEET

Directions for the Student:

After you have taken each PRETEST or POSTTEST use TABLE 1 to change your score to percent % and then insert this score in the right column of TABLE 2.

Example: Suppose you have scored 3/10 in your Pretest. This means you have scored 30% right in your Pretest. This 30% is found in Table 1, under 3. If you score 4/10, look under 4 in Table 1, etc. Suppose you have scored 8/10 in your Posttest. Look under 8 in Table 1 and you will see that you have scored 80% right in your Posttest. To find how much you have gained in studying a module Subtract your Pretest score from your Posttest score, Gain=Post-Pre. In the above example, Gain= 80% - 30% = 50%. That is, you have gained 50% knowledge by studying this module.

TABLE 1

Number of Test Items	1	2	3	4	5	6	7	8	9	10
Score in %	10%	20%	30%	40%	50%	60%	70%	80%	90%	10%

STUDENT SCORE SHEET (Cont'd)

TABLE 2

Module Number and Name	Pretest Score(%)	Posttest Score(%)	Gain Posttest-Pretest	Time[1]
Module1 Basic concepts of Sets				
Module 3 Order Operations				
Module 4 Addition of Integers				
Module 5 Subtraction of Integers				
Module 8 Multiplication of Integers				

[1]Time means the time it took to complete each Module.

Appendix E

Intermediate and Delayed Tests

IMMEDIATE TEST

STUDENT'S NAME _____

PART I

Circle T for True or F for False in the following statements:

1. Set A = {1,2,3} and B = {a,b,c,} are equivalent T,F
2. Set A = {1,2,3} and B = {a,b,c,} are identical T,F
3. Set A = {1,2,3...} is infinite T,F
4. Set X = {5,6,7...} is finite T,F
5. Set P = {0} is null T,F

PART II

Simplify the following expressions:

1. $3 \times 5 - 2 \times 2$
2. $2 \times 12 \div 2$
3. $12 \div 3 \times 3 + 2$
4. $40 \div (20 \div 2)$
5. $(40 \div 20) + 2$

PART III

For each expression name the corresponding Property:

1. $3+2 = 2+3$
2. $3x2+3x5 = 3x(2+5)$
3. $(8x9)x6 = 8x(9x6)$
4. $(8+9)+6 = 8+(9+6)$
5. $3x2 = 2x3$

PART IV

Add these integers:

1. $-100 + {}^{+}100 =$
2. $(-100) + (-200) =$
3. $+20 + {}^{-}3 =$
4. $(+5 + {}^{-}2) =$
5. $(+ {}^{-}7 + {}^{-}7) =$

PART V

Multiply:

1. (-4) x (-3) =
2. (+5) x -7 =
3. -4. +6 =
4. (-5) (-11) =
5. (-1) . +3 =

DELAYED TEST

STUDENT'S NAME _____

PART I

Circle T (for True) or F (for False) in the following statements:

1. Set M = {b,c,d} and N = {x,c,d} are equivalent T,F
2. Set P = {1,3,5} and ~ = {5,3,2} are identical T,F
3. Set A = {4,5,6,...} is finite T,F
4. Set X = {10,11,12,...} is infinite T,F
5. Set P = { } is null T,F

PART II

Simplify the following expressions:

1. 5x8 - 3x2
2. 12÷2x6
3. 2x12÷6
4. 120 ÷ (4x5÷5)
5. 80÷(40÷20)x10

PART III

For each expression name the corresponding Property:

1. 3x5+3x8=3x(5+8)
2. x+y=y+x
3. x. (z.y)=x. (y.z)
4. (4+8)+2=4+(8+2)
5. 8+0=8

PART IV

Add these sums:

1. $-7 + {}^{+}7 =$
2. $-80 + {}^{-}80 =$
3. $-5 + {}^{+}15 =$
4. $-3+(-5) =$
5. $(+8+{}^{-}2) =$

PART V

Multiply these products:

1. (-3) x (-6) =
2. +4 . -2=
3. (-2) x (+3)=
4. (-3) . (-6)=
5. -10 . +1=