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ABSTRACT

This directory contains comprehensive descriptions of diagnostic-prescriptive mathematical programs, for which some success has been demonstrated in the classroom, as shown by statistical evidence of significant improvement of student learning. The table of contents is designed to provide easy identification of programs related to specific grade levels. The descriptions offer information related to program rationale, materials, classroom organization, inservice training, cost, evaluation data on achievement, and where possible, the location of New Jersey school districts using the program. (JP)

Math Programs That Work
A National Survey

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Introduction

In an effort to respond to the needs of New Jersey school districts, the Office of Program Development of the New Jersey State Department of Education has funded an E.S.E.A. Title III project entitled Project TAP (Technical Assistance Program). This directory is one of the products of Project TAP. It contains comprehensive descriptions of diagnostic-prescriptive mathematics programs, for which some success has been demonstrated in the classroom, as shown by statistical evidence of significant improvement of student learning. These descriptions provide basic program information essential to prudent decision making. It is the hope of the Office of Program Development that teachers and administrators will avail themselves of this document when making developmental and operational decisions related to their needs in mathematics instruction.

The reader should take note that the programs chosen to appear in this directory do *not* constitute all the diagnostic-prescriptive mathematics programs available to schools; nor should the reader assume that all diagnostic-prescriptive mathematics programs were considered for inclusion. In order to initially identify programs, the authors used such comprehensive sources as the *Eighth Report of the International Clearinghouse on Science and Mathematics Curricular Development, Title III and the IVD Process* (102 nationally validated Title III programs), and *Alert: A Source of Elementary Programs and Projects*. In addition to the aforementioned sources, individuals regarded as mathematics education experts were contacted to provide further insight about existing programs and projects that might be considered for inclusion. In the final analysis, 50 programs were initially considered for inclusion. The final decision as to which programs would appear in the directory was based on available evaluation data that indicated that the programs had demonstrated a positive impact in the classroom.

The use of this directory is but one step in a total decision making process. The table of contents is so designed as to provide the reader with easy identification of programs related to specific grade levels. The descriptions offer information related to program rationale, materials, classroom organization, in-service training, cost, evaluation data on student achievement and, where possible, the location of New Jersey school districts using the program. In addition to the directory, the project staff accumulated sample materials for each program. These materials have been disseminated to the N.J. Educational Improvement Centers—Northwest and South. It is suggested that administrators and teachers contact the EIC for their district if they are interested in previewing materials related to the programs. It is hoped that the combination of using the directory, previewing sample materials, and acquiring appropriate technical assistance will result in school districts implementing programs that best meet the needs of their students.

Acknowledgements

An undertaking such as this requires the time and effort of a large group of people. It would be impossible to list the names of all the individuals who contributed to the success of this directory. Our appreciation is extended to the directors of the Title projects and commercially produced programs that appear in this directory.

Of course, the success of Project TAP would not be a reality without the support of the Office of Program Development, New Jersey State Department of Education. We would like to extend our deepest appreciation to Mr. Robert Ward, Director of the Office of Program Development, and his staff for the time, effort, and energy they have commited to Project TAP. Their insight into the needs of New Jersey school districts and their desire to bring about meaningful and systematic change stands as a major contribution to the product herein.

A special note of thanks is extended to Dr. Jean Finnerty, Professor of Education, Seton Hall University, South Orange New Jersey, for editing the manuscript of the directory. Furthermore, we are most appreciative of the help we received from a number of New Jersey administrators and teachers who wrote the first draft copies of the programs. They were:

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Arithmetic Proficiency Training Program

Science Research Associates, Inc.
Chicago

Summary

The Arithmetic Proficiency Training Program (APTP) is a computer-assisted instructional program for supplementary use in the development of computational skills, and is compatible with any elementary mathematics program, grades one through eight. Based upon diagnostic testing, skill analysis, personalized practice, and immediate reinforcement, APT seeks to develop the student's speed and accuracy in computing through sequences of timed practice problems. The program's twenty-nine computational skills cover operations on whole numbers, fractions, decimals, mixed numbers, and percents. The program provides two computer tapes and a variety of supporting guides and manuals.

Nature of the Program

For whom is the program designed?

The program is designed for use with students in grades one through eight who are in need of additional proficiency in computational skills.

On what rationale is the program designed?

APTP was designed to individualize the learning of computational skills by helping students master such skills through practice at their own level and at their own rate. The program frees the teacher from having to supervise student practice, so that teacher time may be utilized for presenting ideas and working with individual students. The fundamental assumption of APTP is that skill proficiency is a function of individualized practice.

What are the general goals and objectives of the program?

The objectives of APTP are to help students achieve mastery of the computational skills customarily introduced in grades 1-6; to provide for personalized practice after individual diagnosis has indicated where practice is needed; and, to develop students' speed and accuracy in computing through sequences of timed practice problems.

Organization and Materials

How is the Program organized?

APTP consists of two computer tapes and a variety of supporting guides and manuals. These are divided into a set of licensed materials available as a package leased by SRA to the user, and a set of unlicensed materials which may be purchased separately. The licensed materials include the basic tape (statements and assembly language functions needed to actually run the programs on the computer), the optional tape (source card images, assembly listings, and flow charts), and operating instructions. The unlicensed materials include the Teacher's Guide, the Procter's Guide, and the Student's Record Book.

The twenty-nine computational skills are divided into five areas covering operations on whole numbers, fractions, decimals, mixed numbers, and percents. Each skill has been subdivided into subskills ("atomic" skills) arranged into hierarchies with associated mastery criteria constituting behavioral objectives.

What specific objectives are involved?

The student must master "atomic" skills covering addition, subtraction, multiplication and division of whole numbers; reducing fractions to lowest terms; multiplication and division of fractions; putting fractions into higher terms; finding sets of fractions with a common denominator; addition and subtraction of fractions; comparison of fractions; addition, subtraction, multiplication, and division of decimals; conversion of decimals to fractions and fractions to decimals; conversion of fractions to mixed numbers or whole numbers; addition, subtraction, multiplication, and division of mixed numbers; conversion of decimals and fractions to percents, and conversion of percents to fractions; finding percentage from rate and base, finding rate from base and percentage, and finding base and rate from percentage.

How much student time is devoted to the program?

The student spends about twenty minutes a day at the terminal through which he communicates with the computer program. A longer amount of time may be spent if deemed appropriate by the teacher.

What materials are provided for the Student?

The student receives an APTP Student Record Book in which he maintains a record of the skills he has completed.

What materials are provided for the teacher?

The teacher uses a Teacher's Guide, and a Procter's Guide. When a special problem develops for a student, the computer issues a Teacher Call Message.

How open is the program to supplementary and teacher-made materials?

There are four options of operation. Under the "M" option, the teacher can make adjustments of mastery speed, block size, and accuracy criteria. In the spiral curriculum option, the student follows a spiral curriculum of the teacher's choice through any or all of the twenty-nine skills.

Since this is a supplementary program, the teacher is responsible for teaching concepts and basic ideas, and may give additional assignments and tests.

What student assessment materials are provided or suggested?

A computer printout of a student's performance is given at the completion of a session at the terminal. The student keeps a cumulative record of his performance in his APTP Student Record Book.

Classroom Activities

How are the classes organized?

For twenty minutes each day, the students work at the terminal. There must be a sufficient number of terminals so that a segment of a class can work at terminals, while the other segment is learning concepts. If the number of terminals is limited, the arithmetic period must be modular in format.

How are the materials used?

If a student cannot master a particular skill, the program searches through the prerequisite skills in the skill hierarchy until it locates some skill where the student cannot meet criteria for mastery, but for which he has demonstrated mastery on the immediately preceding prerequisite skill. At this point, the program shifts from diagnosis to prescription and the student receives as many practice problems as he needs to meet mastery criteria. He types his responses and receives immediate reinforcement. When he has demonstrated mastery of the original skill, the program reverts to the diagnosis mode for other skills in the same unit.

Are Teacher aides used?

It would be advisable to have a teaching assistant, parent, or intern teacher responsible for the care of the machines and records. A Proctor's Guide is provided.

How is student progress assessed?

The program continually assesses student progress. When a student completes a session at the terminal, a record of his performance is printed out. To keep a cumulative record of his progress, the student enters completed skills (by check mark) in an APTP Student Record Book.

Implementation Requirements And Provisions

Are special facilities needed or suggested?

There must be a computer available to the school system, and a room which can be locked for the terminals. Telephone connections between the computer and terminals must be installed.

Is special equipment needed?

Terminals and computer programs are necessary.

Is in-service training needed or suggested?

Some in-service training in the use of the program is mandatory.

What provisions are made for the special training of teachers?

A training service by Science Research Associates is provided for an additional fee at the customer's option. The Computer Related Instructions Systems Center offers consulting services to teachers using the APTP program. Instruction consists of the use of the Teacher's Gulde and supervised practice in the system as desired.

What provision is made for training of teacher aides?

None.

What is the cost of implementing the program?

Unless a computer is available to a school system, a computer must be rented at several thousand dollars per month. The basic cost of $9000 purchases the necessary soft ware, and allows the customer to use the program on one terminal which can service only fifteen to eighteen students a day. Additional terminals would have to be rented. Assuming that a school district already has access to a central processing unit of the size of the IBM System/360 Model 30, an annual outlay of between $15,000 and $18,000 would be realistic.

Program Development And Status

How was the program developed?

Funding arrangements for the development and testing of APTP were internal to IBM and Science Research Associates. Initial work on a formal development plan for APTP occurred in late 1967. Individuals on the development team were specialists in mathematics, mathematics education, curriculum design, evaluation, management techniques, and computer programming. The team sought to find ways in which a computer could be used to achieve maximum individuallzation, immediate reinforcement, and high motivation. APL/360 was chosen as the computer language. Development activities evolved in three phases: informal tryout, development and testing of the APL version, and reprogramming in Coursewriter III. The APL version was tested in 1968 in the Chicago Public Schools. Changes were made as a result of these tests, and the revised version passed IBM's systems standards test with minor changes. Further evaluation and testing were completed in Chicago and Memphis.

Program Evaluation

How has the program been evaluated?

After internal development, a pilot test was run in Chicago involving an ethnically mixed student population of about 230 students. In the course of the seven month study, the daily performance of students was recorded, and subjective opinions of students, teachers, administrators, and parents were collated. Pre and Post achievement results were obtained for the involved students and a comparison group.

In a Memphis field test, APTP was given to fifteen sixth grade students who were matched to fifteen other sixth grade students. The Thorndike-Lorge IQ Score of November, 1968 and the April 1969 Arithmetic Computation Score on the Metropolitan Achievement Test were used simultaneously for the matching. The experimental and control groups did not differ in their arithmetic problem-solving and concepts scores on the April 1969 Test. A different form of the Metropolitan Achievement Test was administered to both groups in April, 1970.

What were the indicated strengths and weaknesses of the program?

In the Chicago evaluation, the mean scores of sixth grade experimental students differed significantly on the standardized SRA Achievement Test, but not those of the seventh and eight grade students. The sixth grade group results indicated that the program took the experimental students from below national norms, at the beginning, to well above them. The comparison group remained below the norms in both testings. Student opinionaries indicated that 95% of the students liked the program, 82% reported that the program helped their work in arithmetic, and 81% liked arithmetic more. Eighty-two percent of the teachers noted increased student interest in mathematics and improved performance. Seventy-seven percent of the teachers reported that they believed all students would benefit form APTP.

In the Memphis field test, the experimental group performed significantly better than the control group on the post-test computation, problem-solving and concept scores. No significant correlations were found which related the amount of growth to either IQ or length of time in the program.
The major drawback to this supplemental program is the cost. To obtain even ten terminals, the cost would be over $15,000, and to run the program with only one or two terminals would not justify implementation expenditures.

Useful Information

Where can the program be obtained?

Science Research Associates, Inc.

What school districts in New Jersey are familiar with the program?

It was used in Newark in 1971.

References

Rehula, R.J., Beckman, D., Pakin, S., and Stith, C. *Field Test Report of the Arithmetic Proficiency Training Program Prepared for the Chicago Board of Education By Science Research Associates.* Chicago: Science Research Associates, Inc., 1969

Staff of the SRA Computer Related Instructional Systems Center. *A.T.P.T. Teacher's Guide.* Chicago: SRA, 1969.

Bilingual Continuous Progress Mathematics

Developed by Southwest Educational Development Laboratory

Summary

Bilingual Continuous Progress Mathematics (BCPM) is a program at the developmental level which provides a complete first year of basic mathematics instruction in an aural-visual mode. It is designed so that any child, even a transfer pupil, can begin mathematics instruction whenever he or she enters the first grade. The basic part of the program consists of 93 objectives, arranged into mathematical areas at two levels of difficulty. The objectives are organized into 14 mathematical areas each of which has specific skills that children must master before moving on to the next area. All areas consist of a diagnostic test, games, instructional cassette tapes with accompanying work bookiets, and mastery tests. The cost for installing the program is approximately $500 for setting up a math center, plus $300 per classroom for consumables (work bookiets).

Nature of the Program

For whom is the program designed?

This first grade level program is especially designed for the Spanish-speaking child who does not read or understand English, but is also appropriate for the child who reads and speaks English.

On what rationale is the program designed?

The basis of the Southwest Educational Development Laboratory's first efforts in mathematics was the individually Prescribed Program developed by Research for Better Schools and published by Appleton-Century-Crafts. Testing the IPI program with migrant Mexican American pupils showed that the first grade component of the IPI math program did not work with the target population. It was decided to begin preliminary planning and development activities for an alternative mathematics program that would work with first grade Spanish-speaking Mexican American children in the Southwest. Each pupil's program was to be determined by results of diagnostic tests administered before such mathematics areas as numeration, addition/subtraction, and fractions. Program goals were to be accomplished through the use of varied, bilingual instructional media, and effective staff training.

What are the general goals and objective of the program?

The four basic goals of the program are: (1) to allow all students in first grade to participate in mathematics instruction before learning to read; (2) to facilitate the participation of non-English speaking students in a program of mathematics before they attain a working vocabulary in English; (3) to develop in each child the mathematical competency he is capable of attaining; and (4) to prepare the child for a grade two mathematics program.

Organization and Materials

How is the program organized?

The program, which uses an aural-visual mode, is based on 93 objectives arranged into mathematical areas at two levels of difficulty. Each area has specific skills that children must master before moving on to the next area. Each area consists of a diagnostic test, games, instructional cassette tapes with accompanying work bookiets, and mastery tests. Meeting individual needs is assured through the use of diagnostic tests, individualized assignments, varied instructional approaches, and a choice between two languages of instruction—English or Spanish.

What specific objectives are involved?

Objectives are organized into the following mathematical areas: Readiness, Number, Numeration/Place Value, Addition/Subtraction, Multiplication, Division, Fractions, Money, Time, Systems of Measurement, Geometry, and Applications.

How much student time is devoted to the program?

To achieve individualization, the teacher coordinates and guides the proper use of the materials in an atmosphere where children are permitted to work at various tasks, at the pace best suited to each child. Proper class management depends on complete grouping flexibility.

What materials are provided for the student?

The children use prerecorded cassette audio tapes and workbooks. A manipulative activity introduces each concept. Then, each objective is presented in a workbook, with instructions for the child given in either Spanish or English on an accompanying cassette audio tape.

What materials are provided for the teacher?

A teacher's manual includes suggestions for classroom management, a glossary of Bilingual Continuous Progress Mathematics terminology, and a Prescription Chart which sequentially lists the minimal assignments for each lesson. Also provided are diagnostic and mastery tests and answer keys. A Math Activities Manual contains instructions for constructing the manipulative devices used in the activities.

How open is the program to supplementary and teacher-made materials?

To introduce concepts, a set of 24 games has been devised. The games are simple to construct, and instructions for preparing them are included in a teacher's manual. Through the games, children can actually see and manipulate as they are learning. The games can also serve as an enrichment activity. Teachers may supplement these games with those of their own making.

What student assessment materials are provided or suggested?

A diagnostic instrument is administered to each pupil before he undertakes each area of work. Based on the child's diagnosis, the teacher records needed skill assignments in the Assignment Chart. When the pupil masters an area, the date is entered in the appropriate block on his Achievement Profile Sheet which provides a record of his pace and achievement.

Mastery tests are available for pupil demonstration of each content objective.

Classroom Activities

How are classes organized?

The program is designed to allow a child to begin mathematics instruction at whatever time of year he or she enters first grade. The child can enter the program without interfering with the progress of the rest of the class or feeling pressured in "catching up." Close contact between the teacher and the child is important to the success of the program. The teacher must closely monitor each child's progress and, on the basis of assessment and mastery data, assign the next day's activities. Children may work in small groups, independently, with a peer tutor, or with the teacher or aide.

How are materials used?

The program begins with a series of basic preparation lessons called Readiness. These lessons familiarize the child with the program's aural-visual method of instruction by acquainting him with the cassette playback equipment employed, and by providing activities to sharpen listening and observation skills. Individualization is achieved through the use of diagnostic tests, individual assignments, instructional cassette tapes with corresponding work booklets, and mastery tests.

Are teacher aides used?

It seems advisable to have a teaching assistant or aide who can be responsible for recording clerical data, tutoring, and helping in the distribution of materials and equipment.

How is student progress assessed?

The system of diagnosis allows children to enter the program at their own level and progress at their own pace, filling in gaps in their learning and avoiding repetition. Skill checks at the end of each work booklet measure the pupil's progress. If the objective is not reached, supplementary work is prescribed. This may be in the form of a game, tutoring, and/or additional pages included in the work booklet. Children are assigned to work with the kind of instruction and with materials that will be of most help to them individually. The pupil is given a Measure for Mastery which tests his ability to apply the knowledge learned in each area. The Achievement Profile sheet provides a record of his pace and achievement.

Implementation Requirements and Provisions

Are special facilities needed or suggested?

An effective way to avoid costly duplication of equipment is to confine all BCPM instruction to a math center, which may be a room or a smaller area, that has space for work stations and for storage of all materials. The physical arrangement and equipment of the math center is an important consideration for the success of this program. The plan should allow separate areas for independent work, cassette work, tutoring and games.

Is special equipment needed?

The following equipment and furniture are needed for the math center:

1. Playback units (cassette players)—six playback units are recommended for each math center. It is best if these units are not designed to record and erase tapes.
2. Listening bars—a center should have at least two listening bars. Each bar should contain enough outlets to allow up to five children to listen to the same tape simultaneously.
3. Headphones—because no more than 10 children and the teacher will work with cassettes at any one time, eleven headphones are recommended. The headphones should cover the ears completely to eliminate classroom noises.
4. Storage space—provision must be made for storing instructional materials, games and supplies used in the program.
5. Visual dividers (optional)—the center should be provided with partitions or dividers of some type to insure proper testing.
6. Extension cords—several heavy-duty extension cords may be required to operate the playback units.

Is in-service training needed or suggested?

Staff development is built into the program through a teacher's manual which includes suggestions for classroom management, a plan for organization, instructions for the construction and playing of games, and an Assignment Chart which includes a sequential listing of minimal assignments for each lesson.

What provisions are made for special training of teachers?

The Southwest Educational Development Laboratory has provided the following services to area school districts: 1. staff development activities to acquaint participating teachers with the instructional materials and their implementation; and, 2. evaluation instruments and activities to assess staff development success, program effectiveness, user satisfaction, and, program modification needs.

What provision is made for training of teacher aides?

None.

What is the cost of implementing the program?

The cost for installing the program is approximately $500 for setting up a math center, plus $300 per classroom for consumables (work booklets). The math center includes six playback units, two listening centers, one set of cassettes, and a staff development manual.

Program Development and Status

How was the program developed?

Product development began February 1, 1971, under the direction of Walter Stenning of the Southwest Educational Development Laboratory. The Texas Education Agency was the source of funding. Until product development ended August 31, 1973, The Texas Education Agency, through its funds to the Texas Migrant Educational Development Center, continued to provide full financial support to the program.

Socorro Lujan, Program Coordinator, and Mary Elizabeth Mefin, writer, directed development activities. Games for the project were designed by Jose Lopez. Other members of the SEDL staff, as well as outside consultants, assisted reviewing the materials and making recommendations for revision. School districts in Texas provided experimental school settings for field testing and formative evaluation.

What is the status of the present program?

The system is considered to be complete and usable.

Program Evaluation

How has the program been evaluated?

Evaluation data were collected from five of the eight project classrooms in which CCPM was implemented and two comparison classrooms with pupils of similar age and ethnic characteristics where the IPI Mathematics program was being used. The project population was composed of 70 pupils and the comparison population of 32 pupils. The Cooperative Primary Mathematics Test, a publication of ETS, was administered to both project and comparison classes.

What were the indicated strengths and weaknesses of the program?

Analysis of variance between pre test and post test performance of the project indicated that the pupils in the program made statistically significant gains. Results from an analysis of covariance in comparing raw score gains of the project and comparison groups indicated that the project group made significantly greater gains on the test than did the comparison group.

The mean percentage of pupils showing mastery for eight of the curriculum content areas was 79% at the first skill check; in most cases. the remaining pupils mastered the objective by the second skill check.

Based on a 60% return, 100% positive response was indicated toward staff orientation. The least positive response was directed toward the curriculm materials (67% positive, 10% negative, and 23% no opinion). The mean percentage of responses was high (84% positive reaction) while the overall mean negative reaction to the six program features was only 4.5%. All respondents indicated that they would like to teach the program again next year.

The program is especially designed for the Spanish-speaking child, although it may also be used with English speakers. This represents a strength in overcoming the traditional lag experienced by such children in mastering mathematics. The children in the program experienced little difficulty moving into traditional second grade mathematics programs.

Useful Information

Where can the program be obtained?

Director, Field Relations and Dissemination
Southwest Educational Development Laboratory
Austin, Tx. 78701

What school districts in New Jersey are familiar with the program?

None

References

Lujan, Socorro, and M.E. Mefin, *Teachers Manual, Bilingual Continuous Progress Mathematics.* Austin. Southwest Educational Development Corporation, 1973.

Staff of the Southwest Educational Development Laboratory. Printed resumes of program.

Texas Migrant Education Center. *A Chapter Report for Texas Education Agency.* 1973.

Conceptually Oriented Mathematics Program

Columbia Public Schools
Columbia, Missouri

Summary

The Conceptually Oriented Mathematics Program (COMP), developed under an ESEA Title III grant, is a management program that is diagnostic and prescriptive. Comprehensively designed to meet individual needs through small group instruction, it provides for continuous progress from first grade mathematics until the student is entering an algebra class. Student test results are used to determine strengths and weaknesses for grouping purposes. Program materials support the role of the classroom teacher as a manager rather than a lecturer. Materials include Teacher Guide Books, Placement Test, Post-Tests, Individual Profile Sheets, and references to commercially produced textbooks. The cost per pupil is estimated at $8.50 which includes the cost of providing one commercial textbook for every three students.

Nature of the Program

For whom is the program designed?

This continuous progress program is designed for all students in grades one through eight.

On what rationale is the program designed?

The program developed out of a recognition that the instructional strategies which characterize traditional subject-centered approaches fail to reflect individual differences in children, and tend to encourage fitting students to textbook molds.
The Conceptually Oriented Mathematics Program was developed to assist elementary teachers in diagnosing children's needs in terms of mathematics concepts, and prescribing appropriate activities for a given level of competency. By providing teachers with tools for diagnosis and prescription, the developers of the program hoped to overcome teacher's tendencies to consecutively follow textbook pages while using an identical program for all children in a class. COMP, by its design, provides diagnostic and prescriptive tools for the teacher, and allows for a considerable range of student competency and achievement.

What are the general goals and objectives of the program?

The objectives of COMP are to allow teachers to work with students on an individual basis, and to help students achieve mastery of the mathematics skills customarily introduced in grades 1-8 according to a sequence which reflects individual competency and achievement. The program is broken down into ten broad concept areas which are developed vertically through twenty-five levels of complexity. Predetermineo sequences at each level individualize the learning of mathematics skills for students, and allow them to master the skills at their own rate.

Organization and Materials

How is the program organized?

A Scope and Sequence Chart is the visual organization of COMP into ten broad concept areas. These areas are developed vertically through twenty-five levels of complexity which have been broken down into two or more steps. The inclusion of a step Z in levels 10 - 25 provides for horizontal enrichment. A complete lesson has been prepared for each concept, and presented for each step at every level. Each lesson has the following format:

The concept
The behavioral objective
The mathematical ideas
Vocabulary
Activities
Textbook References: Houghton Mifflin, Addison-Wesley
Worksheets
Other References: Film Strips, Commerical Tapes, Enrichment Books
As the student progresses through a level, the teacher offers quidance and uses innovative teaching aids which are suggested in the Teacher Guide Book.

What specific objectives are involved?

Student skills are developed in ten concept areas with the intent of preparing students for a successful encounter with algebra after they have completed the sequential levels encompassed in the program. The ten concept areas include Numerals, Order, Addition, Subtraction, Multiplication, Division, Function and Graphs, Geometry, and Measurement. Anywhere from two to seven concepts may be incorporated into a single step. An example of this would be:

Level 14

Step B	Sets:	Comparing cardinal numbers of two disjoint sets as a rate or ratio
	Multiplication:	Multiplying a whole number by a fraction
	Functions & Graphs:	Locating a point on a a number plane, using a numbered pair
	Geometry:	Idenitlfying similar and incongruent figures

Students must reach a mastery of 80% on each of the steps on a given level before proceeding to the next level of learning. They may skip a complete level, including all its steps, if they can score 80% on a placement test which is available for each level.

How much student time is devoted to the program?

Lower grade students would spend about forty minutes a day, but this would vary for individual cases. In the upper grades, sixty minutes would be the average.

What materials are provided for the students?

The student is provided with vocabulary, activities, and textbook references for sample problems and assignments. There is also

an individual mathematics record sheet so that each student may track his own progress.

What materials are provided for the teacher?

A Teacher's Guide Book, which serves as a handbook, provides instructions and suggestions to supplement the teacher's knowledge of mathematics, and to relieve her of some of the pressures involved in finding appropriate activities for concept development. Suggested activities for developing and reinforcing concepts, and innovative teaching aids are included in the manual. Textbook references include multiple grade levels for each reference. Placements tests are available to help the teacher determine a student's pre-lesson of competence, and post-tests are included to evaluate student learning.

How open is the program to supplementary and teacher-made materials?

There are no direct provisions made for this. With this type of structure, however, supplementary or teacher-made materials may be added at every step.

What student assessment materials are provided or suggested?

The program provides for Post Test I to be given after the instruction for a level has been completed. If a student doesn't succeed on Post Test I, review work is available which includes Post Test II. In general, the post-tests consist of five items for each behavioral objective in a given level. Space is provided on the post-tests for the student to work. Post Test II, available for levels 7 - 25, was developed to relieve teachers of the task of developing new tests for levels which must be reviewed. It is similar in content to Post Test I, and requires the same degree of proficiency. A student's progress is recorded on an Individual Profile Sheet which illustrates the areas in which a student does well.

Classroom Activities

How are classes organized?

Placement tests are used at the beginning of the school year or when a new student enters the program to determine the competency level of individual students in a school population. The tests include ten questions for each behavioral objective in the level. Tests for levels seven through twenty-five consist of ten multiple choice items for each concept. After the student's instructional level has been determined, teachers confer to place the students in instructional groups. Some schools cross grade lines, while others exchange students within grade levels. The purpose of the grouping is to allow teachers to attend to students' strengths and weaknesses more effectively.

How are the materials used?

The student receives the introduction to a given level from the teacher. Students then work with the materials of a particular level, according to the format provided, take Post Test I, and either move on to a new level, or work with review material followed by Post Test II.

Are teacher aides used?

Teacher aides are not required. However, they would greatly facilitate record-keeping and classroom management.

How is student progress assessed?

The cycle of post-tests is utilized to determine student proficiency at each level. Data are recorded on an Individual Profile Sheet which is designed to illustrate the student's level of proficiency.

Implementation Requirements and Provisions

Are special facilities needed or suggested?

No.

Is special equipment needed or suggested?

Filmstrip and movie projectors, and tape recorders are required.

Is in-service training needed or suggested?

An in-service program in diagnostic-prescriptive techniques and classroom management procedures would be helpful.

What provision is made for special training of teachers?

No special provision is provided. However, the Teacher's Guide Book serves as a handbook for implementing the program.

What provision is made for training of teacher aides?

None.

What is the cost of implementing the program?

The estimated cost to implement this program would be $8.50 per pupil, which includes the cost of providing one commercial textbook for every three students. This cost is based on the expense involved for implementation in the Columbia, Missouri schools where approximately 7,000 students are using the program. These students are housed in thirteen elementary schools, three junior high schools, and one non-public school. The Missouri State Department of Education, and the report of the E.S.E.A. Title III national validation also quote an estimated cost of $8.50 per pupil.

Program Development and Status

How was the program developed?

Funding arrangements for the development and evaluation of COMP came from E.S.E.A. Title III and the Columbia Board of Education. It is an internally developed management program based upon research information and contributions from classroom teachers. Pilot schools were set up in Columbia, Missouri which is an urban setting with a diverse student population. Results from the pilot were used as data for revision. Outside teacher-consultants aided in the evaluation prior to the final rewriting which took place in August, 1973.

What is the status of the present program?

Final rewriting of the program was completed in August, 1973. Materials for dissemination are to be available by November, 1973.

Program Evaluation

How has the program been evaluated?

Student achievement data were collected from three elementary schools (grades 1-6) and a junior high school where the program had been implemented. Evaluation was undertaken at all levels, using the Metropolitan Achievement Test for grade 1, and the Iowa Test of Basic Skills for grades 2- 8 after one year of participation in the program.

What were the indicated strengths and weaknesses of the program?

Post-test results for grades 2- 8 showed that the mean increase for 77% of the participating students was 16.5% percentile points. The mean increase for the total population was 10.5 percentile points. Twenty percent of the population had a mean decrease of 10.5 percentile points. Table 1 summarizes the post-test results, and indicates the mean percentile gain or loss for students at each grade level.

On the E.S.E.A. Title III national validation ratings, this project

received ninety-nine out of a possible 100 points in categories related to Innovativeness, Effectiveness, Cost, and Exportability, and received the "Educational Pacesetter Award." The program does require paperwork and record keeping on the part of the teacher, but this type of activity can be accomplished by teacher assistants.

Useful Information

Where can the program be obtained?

Alta M. Harness, Director
Conceptually Oriented Mathematics Program
Columbia Public Schools
1002 Range Lane
Columbia, Missouri 65201
(314) 443-4013

What school districts in New Jersey are familiar with the program?

None.

References

Descriptive information and evaluation data released by the Columbia, Missouri Public Schools on *"Conceptually Oriented Mathematics."*

Heath Elementary Mathematics Program (K - 6)
Heath Mathematics Program (7 & 8)

D.C. Heath and Company
Lexington, Massachusetts

Summary

The Heath Elementary Mathematics Program for grades K-6, and the Heath Mathematics Program for grades 7 and 8 provide an activity-oriented mathematics approach based on behavioral objectives. Learner-oriented, the total program stresses the structural characteristics of mathematics, and places much emphasis on computational skills. The primary focus of the program is the active involvement of the learner as he works from the concrete to the semi-concrete to the abstract stages of mathematics. Many practical applications of mathematical skills characterize the experiental development of concepts and structures, and the program utilizes manipulable objects, projects, puzzles, and games as foundational models. The program provides for individual differences, and for the diagnostic evaluation of students. Heath Mathematics Program for grades 7 and 8 was designed to complement other K-6 programs as well as the Heath K-6 program.

Nature of the Program

For whom is the program designed?

The program is designed for use with students in grades K-8.

On what rationale is the program designed?

The active involvement of the learner is the primary principle on which this program is based. An experiential rationale by which students learn through exploring and applying characterizes the program. The textbook provides the springboard from which the children move to activities beyond the text.

What are the general goals and objectives of the program?

The basic intents of the program are to (1) foster self-motivated learning through active involvement, (2) facilitate the development of computational proficiency, (3) provide for developmental understanding of concepts and structures through basic applications, and (4) provide for diagnostic analysis and individual differences.

Organization and Materials

How is the program organized?

The program is organized around a comprehensive list of behavioral objectives for each textbook in the program, and for each chapter in the texts. Long term objectives dealing with attitude, creativity, and initiative are also included. Characteristic of the program are many problems that apply mathematical skills to everyday situations. Projects, puzzles, and games are scattered throughout the texts which require active learner involvement and provide for individual differences.

Each chapter section provides practice through oral and written class exercises, and individual exercises. The bulk of the exercises in the Heath program are written for the middle 75% of a class. However, sections marked with an asterisk or labeled "for experts" are more difficult and provide a deeper insight into a concept as well as more difficult problems. Sections labeled "keeping skills sharp" provide drill exercises for those students needing additional practice in basic computation. Vocabulary lists accompany each chapter. However, vocabulary that is too technical or rigid is avoided. Accompanying the program are basic worksheets for remedial use, and supplementary worksheets for enrichment. These are available in workbook form or on duplicating masters. Twelve drill cassettes, designed to provide practice in basic addition, subtraction, multiplication, and division facts, are provided. Diagnostic tests for each chapter, and cumulative tests which may be used as pre or post-tests are available.

What specific objectives are involved?

This program seeks to introduce basic mathematical concepts and principles to children in ways that are applicable to their world. The children work from the concrete to the semi-concrete to the abstract stages of mathematics.

Levels 7 and 8 weave a concise reteaching of basic arithmetic into a study of number properties, functions, and equations. The treatment of equations and positive and negative numbers furnishes solid groundwork for the study of alegebra, and a foundation for high school geometry is also provided in an introduction to coordinate geometry.

How much student time is devoted to the program?

The amount of time devoted to this program varies according to individual student abilities and interests, as well as teaching methods.

What materials are provided for the student?

Student texts provide detailed lists of behavioral objectives, activities which include exercises, games, puzzles, and projects, and diagnostic tests. Students use Basic Worksheets for remedial work and Supplementary Worksheets for enrichment.

What materials are provided for the teacher?

The Teacher's Edition of the text includes a Programmer which correlates the behaviroal objectives for each chapter with the Diagnostic Tests, textbook materials, Basic Worksheets, and Supplementary Worksheets. An Assignment Guide suggests basic, average, and enriched programs A Skill Maintenance Guide suggests a sequence for using the games and Supplementary Exercises in the student text, Supplementary Exercises and Word Problems in the Teacher's Edition, and the Cassettes. Diagnostic tests for Levels 3 - 6 are available on duplicating masters.

How open is the program to supplementary and teacher-made materials?

Manipulable objects and supplementary or teacher-made materials for student projects are an integral part of this program.

What student assessment materials are provided or suggested?

The student text includes diagnostic tests called "Ready or Not."

The Teacher's Edition lists testing activities, and includes paper and pencil tests for each chapter. In addition, there is one Diagnostic Test for each chapter and four cumulative Diagnostic Tests for each grade.

Classroom Activities

How are the classes organized?

The arrangement of the classroom facilitates management of student learning activities in this program. Several learning centers may be set up as well as tables for individual and small group use, desks for written work, listening areas with tape recorders, and a game corner.

How are the materials used?

The use of the diagnostic tests in this program enables the teacher to identify skills and diagnose weaknesses. Individualized student lessons are prepared on the basis of listed behavioral objectives. Students are referred to appropriate textbook pages, Basic or Supplementary Worksheets, or activities described in the Teacher's Edition. Such features as projects, games, puzzles, picture problems, "problems for experts" and "keeping skills sharp," provide for individual differences.

The projects are intended to give students opportunities to explore mathematical topics on their own. Many of the suggested games and puzzles provided fun-oriented drill work. The "for expert" sections are designed for the better students, and "keeping skills sharp" sections are essentially drill exercises on computational skills. Students also utilize manipulable objects and apply their skills to a wide variety of practical problems. Posttests are used to assess student achievement.

Are teacher aides used?

The use of teacher aides would greatly facilitate classroom management in this activity-oriented program. The use of aides is not necessary, however.

How is student progress assessed?

The comprehensive evaluation program of entry tests, pre-tests, post-tests, and testing activities provide tools for assessing student progress in relation to the program objectives. Groups of items on the Diagnostic Tests are keyed to the pages of the student textbook, and subscores for these groups reveal student and class ability in the various skills. The Diagnostic Tests may be used as pre-tests followed by individually prescribed assignments, or as post-tests followed by remedial and enrichment assignments. Testing activities provide opportunities for individual students or small groups of students to demonstrate concept understanding and application. Teachers keep a record of each student's progress.

Implementation Requirements and Provisions

Are special facilities needed or suggested?

No

Is special equipment needed or suggested?

No

Is in-service training needed or suggested?

No

What provision is made for special training of teachers?

None

What provision is made for training of teacher aides?

None

What is the cost of implementing the program?

The cost of the Heath Mathematics Program varies for each level. Based on a class of 30 level three students, the average per pupil cost for implementation would be $7.00. The subsequent per class cost for replacing consumables at this level would be about $77.00 per year. A set of twelve drill cassette tapes may be purchased for $99.00. These sets are available for levels K-6.

Program Development and Status

How was the program developed?

Clyde Dilley and Walter Rucker, coauthors of the Heath Elementary Program, were active participants in the UICSM Slow Learner Junior High School Project in mathematics during the 1960's. The purpose of the project was to find a way to teach basic arithmetic to slow learners at the junior high level. Although a publication resulted from this project, it did not incorporate the ideas of the author team. During 1968 and 1969, they developed a three level remedial program entitled Modern Concepts and Skills for junior high school students. At this time, they began to focus on the needs in elementary programs that led to problems at the junior high level. They were assisted by Dr. Ann E. Jackson.

Consultation with teachers, mathematics supervisors, principals, and curriculum directors across the nation revealed the need for a program that would be learner-oriented instead of content- and language-oriented. A need for a greater emphasis on computational proficiency was also stressed. These insights led to the development of the Heath Elementary Program with its emphasis on models, the real world, and student involvement. The Heath Mathematics Program, coauthored by Gerald R. Rising and Sigmund A. Smith, extended the philosophy of the K-6 elementary program to Levels 7 and 8.

What is the status of the present program?

The program has been completely developed, and is being distributed nationally.

Program Evaluation

How has the program been evaluated?

During 1972-73, D.C. Heath collected achievement data in Washington, D.C. on the Comprehensive Test of Basic Skills for students in grades one, two, and three in over 300 classrooms in 14 schools where the Heath Elementary Program was used exclusively. Median grade equivalents were determined (large city norms) as well as pre and post-gains for grades two and three.

What were the indicated strengths and weaknesses of the program?

Over a seven month period of time, the average median grade equivalent gain for second graders was 1.0, and for third graders, 1.1. Students utilizing the Heath Elementary Program thus showed positive achievement growth gains.

The program has an attractive and interesting format, and provides many avenues for stimulating student involvement in learning.

Useful Information

Where can the program be obtained?

D.C. Heath and Company
125 Spring Street
Lexington, Massachusetts 02173

What school districts in New Jersey are familiar with the program?

Metuchan, K-8; Perth Amboy, K-6; North Haledon, K-3; North Arlington, K-8; Westwood, 7&8; Hasbrouck Heights, K-6; Wanaque, K-8; Newark: Chancellor Avenue Annex, 1-4; Hawkins Street School, 4&6; Waverly Avenue School, 1&2;

Individualized Computational Skills Program

Houghton Mifflin Co.
Boston, Mass.

Summary

The Individualized Computational Skills Program (ICSP) is a supplementary ungraded mathematics program designed to help students in grades 1 - 9 who are weak in computational skills. It can be used with any basic mathematics program in a graded or ungraded setting. The heart of ICSP is the Sequential Skills Outline which lists and describes 123 sequential computational skills from those taught in the primary grades to those involving operations with whole numbers, fractions, decimals, and percents. All other program components are keyed to this outline.

Nature of the Program

For whom is the program designed?

ICSP is designed for use with students in grades 1 - 9.

On what rationale is the program designed?

ICSP is founded upon a rationale that allows a student to move back and forth and in and out of any skill area according to his individual needs. Designed as a supplementary program that is diagnostic-prescriptive, its flexibility permits its use in both ungraded or graded classroom settings.

What are the general goals and objectives of the program?

The primary goal of ICSP is to provide a supplementary mathematics program to help students who are weak in specific computational skills, however, it may also be used with students at or above grade level.

Organization and Materials

How is the program organized?

The program is organized around the following components:

Sequential Skills Outline - lists and describes the 123 skills covered in ICSP. These are grouped into twelve basic skill areas which are arranged in order of difficulty.

Arithmetic Skills Inventories - assess student abilities in each skill area.

Student Arithmetic Record Card - indicates the number of skills for each of the twelve skill areas and provides spaces where teachers place a check or date to show a student has completed a skill.

Drill and Practice Sheets - provide a total of 460 pages of computational skill practice.

Teaching Models - student oriented explanations and examples of how to perform in relation to each skill.

Computation Tests - standardized tests that can be used to determine a student's grade equivalence and proficiencies.

Optionally included in the program are a *Student Arithmetic Record Sheet, Class Profile Chart, Student Prescription Sheet,* and *Student Monthly Work Record.*

A Computer-Assisted Instruction Version of ICSP exists if a computer is available. This component can be used to maintain records on each class and each student.

What specific objectives are involved?

The specific objectives of ICSP involve the acquisition of skills which are grouped into the following areas:

Skill Areas	*Number of Skills*
Basic Skills	25
Whole Number Addition	9
Whole Number Subtraction	10
Whole Number Multiplication	12
Whole Number Division	9
Fraction Basic Skills	15

How much Student time is devoted to the program?

Because ICSP is by nature a supplementary program, the amount of time a student devotes to it is primarily a reflection of his individual needs and competencies.

What materials are provided for the student?

The student is provided with the drill and practice sheets needed to master a designated skill. If desired, a student can be supplied with a record sheet to chart this own progress.

What materials are provided for the teacher?

The teacher is supplied with all the necessary packaged tests, record forms, and instructional models needed to implement the program fully.

How open is the program to supplementary and teacher-made materials?

Due to the fact that ICSP is a supplementary program, it is compatible with any textbook series. Other teacher-made or supplementary resources may also be used in conjunction with it.

What student assessment materials are provided or suggested?

Computation tests are provided as well as a Student Arithmetic Record Card on which a teacher records skill completion data on each student. A student may record his own rate of progress on a Student Arithmetic Record Sheet. A Student Monthly Work Record form and a Class Profile Chart are also available.

Classroom Activities

How are classes organized?

There is no set classroom organizational policy. The program may be used in graded or ungraded arrangements.

How are materials used?

The Arithmetic Skills Inventory is administered to determine a student's level of skill proficiency, and the results are recorded in the Student Arithmetic Record Card. A student then begins to work on the drill and practice sheets for the appropriate skill area. The sheets are developmental, and if a student can complete the last sheet in a given area with an acceptable level of proficiency (80% or better), he does not need to complete the preceding exercises. As the student progresses in the program, review tests are available in each skill area which may be administered to the student who (1) has completed a skill area, or (2) needs to review the skills. A computation test is used to determine a student's grade equivalence or mathmatics skill proficiency.

Are teacher aides used?

It is not necessary to use teacher aides.

How is student progress assessed?

The teacher monitors student progress through the use of tests which are packaged with the program components. Test data are recorded on appropriate forms.

Implementation Requirements and Provisions

Are special facilities needed or suggested?

No special facilities are needed unless the computer assisted instruction version is implemented which requires a computer terminal.

Is special equipment needed?

A computer is needed for the computer assisted instruction version of ICSP.

Is in-service training needed or suggested?

Orientation-type training is suggested by the distributors of the program.

What provisions are made for special training of teachers?

Introductory conferences are provided for staff members using the program by Houghton Mifflin Company.

What provision is made for training of teacher aides?

No special provision is offered.

What is the cost of implementing the program?

The initial cost of the program is about $30 per class. This cost is reduced in subsequent years when an entire school uses the program, since the basic kits can be shared by three or four classes with no loss of efficiency.

Program development and Status

How was the program developed?

The program was originally developed under Title I in Flint, Michigan where it was called the Continuous Progress Elementary Mathematics Program. The developers, Bryce R. Shaw and Petronella M. W. Hiehle, focussed on the creation of a supplementary program in computational skills with diagnostic, practice, review, and assessement components.

What is the status of the present program?

Program development is complete and it is being distributed nationally by Houghton Mifflin Co.

Program Evaluation

How has the program been evaluated?

During program development, the Mathematics Department of the Flint Community Schools, Flint, Michigan, monitored the actual growth in participating students' computation scores as measured by both the ICSP Computation Tests and The SRA Standarized Achievement Tests.

What were the indicated strengths and weaknesses of the program?

ICSP Computation test data revealed that for grade levels three through six, the actual gain in computation exceeded the elapsed time between pre and post-tests. The average gain for students in grades three through six over a seven month period of time was 10.2 months. SRA Standardized Achievement Test data showed that the introduction of the Continuous Progress Elementary Mathematics Program resulted in improved computation achievement in the Flint Community Schools from 1966-67 through 1971-72. At the sixth grade level, students were eight months below grade level in 1966-67 and reached national norms by 1971-1972.

Third grade students tested in 1968-69 were tested in the sixth grade in 1971-72. Normal gain expectancy for these students (one month achievement for one month instruction) would have been 21 months. These students gained 22 months in Reasoning, 17 months in Concepts, and 20 months in Computation or 105%, 81%, and 95% actual to expected gain. These average gain of 19.8 months is 93% of normal expected gain. There data must be interpreted in light of the fact that ICSP is a supplementary program for under achievers. The data revealed that the students who benefited most from the program were those who were one or more years below grade level on arithmetic computation achievement.

ICSP strengths are that the program readily adapts to any mathematics program, requires minimal record keeping, does not require teacher aide assistance, and implementation costs are low. However, motivational charts, posters, or tapes are lacking, and adequate challenges for the gifted student are not provided.

Useful Information

Where can the program be obtained

Houghton Mifflin Company
Boston, Massachusetts

References

"ICSP Test Scores and Validation" (Field Note F-546), Houghton Mifflin, June, 1973
"Teacher's Manual, Individualized Computational Skills Program" Houghton Mifflin, 1972.

Individualized Mathematics System (IMS)

Ginn and Company
Lexington, Massachusetts

Summary

The Individualized Mathematics System (IMS) is a comprehensive mathematics curriculum for grades 1 - 6. The basic component of IMS is not the traditional textbook, but a carefully coded series of more than 6000 reusable, laminated pages. Skills are taught by employing concrete, pictorial, and abstract presentations. Illustrations, activities, games, and manipulative devices play an important part in the program.

The program is divided into eleven content strands, ranging from topics on numeration to those on geometry. Each major topic or strand is then subdivided into nine progressive levels of difficulty, whereby the student utilizes previously acquired skills to aid in mastering the concepts which follow in the learning sequence.

The materials of the IMS program are well organized and visually appealing. There are various types of testing devices which include an initial screening test, placement tests, pre-tests, and post-tests to determine whether a student has successfully mastered a specific topic.

Sets of instruction pages related to each objective are contained in durable, laminated skill folders which are color-coded by topic and neatly stored on a mobile cart. The color-coded materials are not only attractive, but also simplify filing.

Nature of the Program

For whom is the program designed?

This program is designed for students of all abilities in grades 1- 6.

On what rationale is the program designed?

The purpose of IMS is to build upon previously acquired skills and prepare the student to master the skills of each subsequent learning level. Since the program uses initial diagnostic testing, each student begins the program on the level in which he has shown the least amount of proficiency. At this point, specific assignments are prescribed to meet each student's needs. When he indicates, through additional testing, that he has mastered the skills prescribed to him, he is allowed to progress until he has mastered the same number-level in each content strand. Progress is closely monitored by the teacher. Each student keeps a record of his own progress on a chart, and eventually should be able to prescribe for himself. In effect, IMS emphasizes the responsibility each child has for his own learning.

What are the general goals and objectives of the program?

The objectives of IMS are mastery and continuous progress through six grades of contemporary mathematics content. Each student is able to make use of his mathematics learning potential through special prescriptive practices after individual diagnosis. The skills of the program cover eleven strands which are introduced through nine levels of mastery. The teacher offers assistance when Student problems are encountered.

Organization and Materials

How is the program organized?

The IMS program consists of eleven basic components. All items are included in the cost of the program. Materials include the following: placement tests, pre-tests, post-tests, answer keys, skill booklets, skill folders (laminated and color-coded), IMS pencils (designed for use on IMS laminated pages), record-forms masters, System Management Guide, trainer training workship kit, and teacher training kit (materials to train 10 additional teachers who will participate in the program). A specially designed mobile cart serves as a systems storage device, and accomodates enough materials for 100 students.

What specific objectives are involved?

The strands of math content for IMS include the following: numeration, addition, subtraction, multiplication, division, fractions, applications of mixed operations, money, time, measurement, and geometry. The range of numbers taught in a particular level become more difficult as the levels progress.

How much student time is devoted to the program?

Student time input is comparable to the amount of time ordinarily devoted to a school's mathematics program.

What materials are provided for the student?

All students have complete access to skill booklets and skill folders. Special IMS pencils are provided so that students may write on the laminated pages. In addition, each student is provided with forms (profile sheets) on which individual progress and prescription are recorded.

What materials are provided for the teacher?

A "Systems Management Guide" is provided for the teacher. This manual serves as source of reference throughout the program by suggesting material for small group seminars, explaining the maintenance of the program, and supplying the answers to placement tests.

How open is the program to supplementary and teacher-made materials?

When a student encounters difficulty on any level of skills, the teacher assists him by assigning prescribed exercises which could be from supplementary or teacher-made sources.

What student assessment materials are provided or suggested?

The entire IMS program consists of individual diagnosis based upon the results of a placement test, pre-tests, and post-tests.

Classroom Activities

How are classes organized?

All learning materials are neatly organized on a mobile storage cart. Materials are easily accessible, and color-coded to expedite location of booklets and tests. Students solve problems at their seats, take appropriate tests, and either progress to a new unit, or work on prescribed skills. Each student is responsible for obtaining and replacing the materials he uses. Individual students also score their own workpages, select appropriate tests, and eventually prescribe for themselves.

How are materials used?

Students are administered diagnostic placement tests to initiate their individual programs. The results of the placement test determine the level on which a child begins his work. A profile sheet is constructed, and pre-tests are given to determine which skills should be prescribed. The student utilizes appropriate skill booklets, and is then given a post-test to determine whether mastery of the skill has been achieved. If the student is successful, the profile sheet is updated, and the student proceeds to the next unit. This cycle of testing and prescription is used throughout the program to ensure sequential skill development through the levels of the eleven strands.

Are teacher aides used?

A teacher aide would be beneficial to the program, especially where classes of younger children are involved. The teacher aide would primarily be concerned with the mechanics of the system, thus allowing the teacher to give special assistance to individual students and prescribe necessary learning activities.

How is student progress assessed?

The IMS program continually diagnoses progress through the cycle of testing and prescription. A visual record is kept for each child on a Profile Sheet.

Implementation Requirements and Provisions

Are special facilities needed?

There must be available space for the mobile storage cart.

Is special equipment needed or suggested?

If the cart accommodating 100 students is not adequate, a larger storage cart would have to be constructed.

Is in-service training needed or suggested?

The contract signed by participating schools requires that two or three teachers attend the IMS training workshop.

What provisions are made for special training of teachers?

The participating schools assume costs for attendance at the IMS workshop. This workshop covers the mechanics of IMS operation and maintenance, and provides communication exercises designed to help teachers deal with individual student problems and needs. Participating teachers receive special materials to train their fellow teachers.

What provision is made for training of teacher aides?

No special provision is made.

What is the cost of implementing the program?

Approximately $14 per child is needed. However, since certain booklets, tests, and IMS pencils are consumable, they would have to be replaced. Replacement of materials would cost about $1.50 per student for each subsequent year.

Program Development and Status

How was the program developed?

The development of IMS evolved from actual classroom experience with Individually Prescribed Instruction (IPI) which had been produced by the Learning Research and Development Center at the University of Pittsburgh in collaboration with Research for Better Schools. IMS was created from suggestions related to the revision of the IPI program. As an essential step in the developmental process, IMS was pilot tested in a number of schools in 1969-70, and full scale evaluation took place in 1970-71.

What is the present status of the program?

The program is completely developed and is being distributed nationally by Ginn and Company, a Xerox Education Company.

Program Evaluation

How has the program been evaluated?

During 1970-71, the first six levels of IMS (two thirds of the curriculum) were field tested with over 5000 students in 23 elementary schools in the Carolinas and Virginia. The participating schools represented a wide range of educational situations including urban disadvantaged, rural, middle class urban, and upper middle-class suburban.

Results of the field test were assembled to determine the success of IMS in achieving four major goal areas related to curriculum adequacy, materials effectiveness, cost effectiveness, and learning effectiveness. These areas were broken down into fourteen goal statements specifically addressed by the evaluation effort. The elements of the evaluation included reports by consultants, information from teachers, system test assessment, cost records, pupil progress measurement, and standardized testing.

Four of the schools were chosen for collection of detailed data on pupil progress. The Iowa Test of Basic Skills was selected as the standardized test instrument, and scores obtained during the field test were examined in conjuntion with ITBS norms for the southeast region. A follow-up evaluation effort in the four schools was undertaken during 1971-72 to determine if math achievement as measured by a standardized test accelerated after the first year. Also, performance on the standardized test and progress in IMS were correlated.

What were the indicated strengths and weaknesses of the program?

The 1970-71 field test data revealed that twelve of the fourteen goal statements had been achieved. Agreement by experts substantiated that: (1) the IMS Behavioral Objectives and materials are satisfactory from the standpoint of mathematical correctness and consistency, and preparation for further study; and (2) IMS Behaviroal Objectives and materials are satisfactory from the standpoints of learning theory and the study of child development.

Ninety percent of the teachers who participated in the program agreed that the materials were attractive as well as educationally sound and mathematically correct. Students were able to assume responsibility for operating the system with fifty percent of the participating fourth grade students able to write their own prescriptions.

IMS materials proved to be sufficiently durable to be reusable with a 2% non-reusability rate. One of the important conclusions drawn from the evaluation is that teacher training is vital to the program. Almost every one of the teacher problems encountered was found to be due to lack of training. Another outcome of the evaluation which appears quite definite is that a large proportion of students cannot complete the first nine levels of IMS during the six years of elementary school.

Evaluation goals which were not met dealt with adequate availability of materials and gains in grade equivalent scores on standardized tests. Pupil learning delays resulted from inadequate stocking procedures which have since been revised. The goal of one-year grade equivalent gain was not met during the first year of operation for students at or above grade level. They exhibited gains of approximately .80GE over the seven month period between tests. However, students in the lowest achievement group (who ordinarily fall farther behind each year) did demonstrate score gains equal to approximately a one year GE score change.

The IMS Evaluation Report points out that the low achievement students had been placed in IMS topics at approximately the same grade level that their standardized scores reflected. High achievement students, however, had been placed back into IMS

topics they had covered. There is thus a need for a long range study charting pupil progress over a period of years.

The mean GE gain for IMS pupils on the ITBS was .64 as compared to the regional norm of .57. This indicates that the yearly achievement gains for the IMS sample were slightly above those for students in the region.

Change scores over a two year period for both parts of the ITBS, Arithmetic, for grades three, four and five in the four school sample are found in Table 1. Regional averages are presented in parentheses.

Table 1

Average Grade-Equivalent Gains on ITBS
By Grade Placement
(Southeastern Regional Norms in Parentheses)

Concepts

Grade Placement at 1st Administration	Mean 1st Year Gain	Mean 2nd Year Gain	Overall Gain
3	.72 (.64)	.85 (.76)	1.57 (1.40)
4	.73 (.49)	.70 (.92)	1.43 (1.41)
5	.85 (.58)	.82 (.98)	1.67 (1.56)
Mean			152 (1.46)

Problem Solving

Grade Placement at 1st Administration	Mean 1st Year Gain	Mean 2nd Year Gain	Overall Gain
3	.76 (.60)	.25 (.87)	1.01 (1.47)
4	.38 (.47)	.45 (1.00)	.83 (1.47)
5	.77 (.62)	1.04 (.98)	1.81 (1.60)
Mean			1.02 (1.51)

Table 1 shows that over the two year period, the IMS pupils made conceptual gains quite consistent with (or slightly above) children in the region. The mean GE gain in concepts was 1.52 for IMS pupils while the regional norm for the same measure is 1.46. On the other hand, the scores reflect a lower mean gain (1.02) on problem solving for IMS students than that for children in the region as a whole (1.51).

The IMS Evaluation Report points out that IMS has been believed to foster growth in the knowledge of mathematics concepts. These data support this notion. However, the IMS approach is pictorial rather than verbal, and the developers feel that the highly verbal aspect of the problem solving subtest of the ITBS program has been to reduce the amount and level of reading required in the program, and to focus on the teaching of mathematics skills.

Achievement with IMS was quite different among the four intensive evaluation schools, even for groups initially comparable in terms of standardized test scores. This implies that policies or procedures within a school environment may enhance or retard achievement in IMS.

Useful Information

Where can the program be obtained?

Ginn and Company
191 Spring Street
Lexington, Massachusetts 02173

What school districts in New Jersey are familiar with the program?

Individual schools in the following New Jersey school districts have implemented IMS: Leonia, Lawrenceville, Medford Township, Riverdale, Camden, and Franklin Township (Hunterdon County)

References

IMS User Guide Durham: Center for Individualized Instructional Systems, 1972.
Fuller, Victoria. *Evaluation of IMS.* Durham: Center for Individualized Instructional Systems, 1972.

Individually Prescribed Instruction

(IPI - Mathematics)

Summary

Individually Prescribed Instruction - Mathematics, is a non-graded, independent mathematics program based on sequences of specific instructional objectives designed for use by all students in grades K - 6. Its long range goal is to allow all students to proceed through sequenced objectives at their own pace. Since the program requires total restructuring of the elementary school mathematics curriculum, training of teachers and administrators is an integral part of the plan. Special materials are required.

Nature of the Program

For whom is the program designed?

The program is designed for all students in grades K - 6.

On what rationale is the program designed?

The program is designed on the rationale that children should be permitted to proceed through a sequenced set of objectives in mathematics at a pace determined by their individual abilities and interests. This requires a restructuring of the elementary school curriculum and the traditional instructional management system to allow the student to move through sequences of instructional objectives, unbroken by grade levels or classes.

What are the general goals and objectives of the project?

Individual progress through sequenced objectives is the major goal of the program. The project definition of individualization is founded upon reliable assessment of individual differences among learners, and mastery of subject matter through procedures that provide for self-instruction and self-evaluation. The program actively involves the child in the learning process in order to motivate self-initiated and self-directed learning.

Organization and Materials

There are 363 instructional objectives in each of ten content areas. The behaviors leading to the attainment of each objective have been sequenced in hierarchical order so that each behavior builds on the objective immediately below it in the sequence, and is prerequisite to those that follow it.

The actual instructional content consists of learning tasks organized into units through which a student can proceed to achieve command of the terminal behavior, with little outside help. Placement tests determine the level at which the student should begin the program. After placement, but before beginning work assignments in a given unit, the student is given the pre-test for the lowest unit in which he failed to demonstrate mastery. If mastery of a particular skill is demonstrated on a pre-test, the student is moved on to another skill for which he does not show mastery. The teacher generates unit prescriptions, and the student works until mastery is achieved as demonstrated by his performance on the unit post-test.

What specific objectives are involved?

The 363 instructional objectives are found in each of the following content areas: numeration/place value, addition/subtraction, multiplication, division, fractions, money, time, systems of measurement, geometry, and applications. Varying numbers of objectives are allocated to levels which roughly correspond to grades within the elementary school.

How much student time is devoted to the program?

The program is flexible. Although a student may engage in work with IPI mathematics materials for about one hour a day, depending upon grade level, the materials are designed to be used within a total IPI context. In this case, students would work on IPI materials in other subject areas throughout the entire day.

What materials are provided for the student?

The students use Standard Teaching Sequence Booklets, one of which exists for each objective or set of objectives in each unit at each level. There are several hundred such booklets.

What materials are provided for the teacher?

Placement tests, pre and post-unit tests, curriculum-imbedded tests, student progress profiles, placement profiles, prescription writing sheets, and teacher guides are provided for the teacher.

How open is the program to supplementary and teacher-made materials?

Teachers are urged to construct lists of teaching resources available in their own classrooms and key them to the objectives of the various units of IPI Mathematics. Teachers may also prepare audio-visual materials to use in the program.

What student assessment materials are provided?

Placement tests, pre-tests, post-tests, and curriculum-imbedded tests are provided.

Classroom Activities

How are classes organized?

Students are placed into the sequence of objectives indicated by their scores on the placement tests, and typically work individually or in small groups. No artificial class divisions should prevent a student from moving flexibly from one sequence or unit to another. The student fills his prescription by first obtaining materials from the learning center and then proceeding to accomplish his tasks. It is desirable to build in opportunities for peer-tutoring and student self-assessment. It is best if teacher aides are available to score curriculum-imbedded tests and to record progress.

How are materials used?

The student is given the Standard Teaching Sequence Booklet appropriate to his placement scores. Using materials from the learning center, teacher and teacher-aide assistance, textbooks, peer help, and his own ingenuity, the child works on the sequential tasks assigned. The pre and post-test comparisons indicate student progress. When a child finishes a work sequence and has had his work corrected, he receives a prescription for a new sequence, based upon the level of mastery he demonstrates on the post-test.

Are teacher aides used?

It is advisable to have teacher aides available to score curriculum-imbedded tests, record progress, and help students with minor problems.

How is student progress assessed?

The placement tests, pre-tests, and post-tests indicate mastery of the sequenced objectives.

Implementation Requirements and Provisions

Are special facilities needed or suggested?

This non-graded mathematics program requires learning centers where materials and textbooks are available to students.

Is special equipment needed or suggested?

No

Is in-service training needed or suggested?

Teacher training is essential. One of the components of the IPI materials is the set of instructions used for training teachers and administrators in the proper techniques for using IPI. The training packages are generally individualized so that the head administrator or principal at a school can lead his faculty through the program. In addition, most teachers attend a summer training workshop in IPI procedures.

What provisions are made for special training of teachers?

Summer training workshops are conducted by Research for Better Schools at several locations around the country. Teacher training materials include programmed booklets and audiovisual materials suitable for in-service training which may be conducted by the principal or head administrator. The basic teacher training course is contained in six volumes entitled "Teaching the IPI Mathematics." These materials contain guidelines for using all of the IPI materials, and suggestions for organizing the classroom and writing student prescriptions. The packages are individualized.

What provisions are made for the training of teacher aides?

No special provisions are made.

What is the cost of implementing the program?

The cost for the student materials component is currently (1973) about $7.00 per student per year. Costs for the teacher training component are borne by Research for Better Schools as part of their continuing attempt to revise and improve the strategy of training teachers for IPI. This policy may be terminated at any time, however. Several weeks are minimally required for in-service.

Program Development and Status

How was the program developed?

The program had its roots in the doctoral work of Dr. Robert Glaser, and in a series of exploratory studies at the University of Pittsburgh. The passage of Title IV of the Cooperative Research Act enabled the Learning Research and Development Center (LRDC) to be founded at the University in 1964. During the 1963-64 academic year, the LRDC and the Baldwin-Whitehall Public Schools of suburban Pittsburgh initiated an experiment to investigate the feasibility of converting an entire K - 6 school to a system of individualized instruction.

Research for Better Schools was founded in 1966 as the regional laboratory for Eastern Pennsylvania, Delaware, and New Jersey. This unit conducted an investigation which demonstrated that a primary need of elementary school teachers in the area was the development of programs which placed heavy emphasis on individual diagnosis and programming.

Funds for the development of IPI came primarily from the United States Office of Education, the University of Pittsburgh, the Baldwin-Whitehall School District, and the Appleton-Century-Crofts Publishing Company. Research for Better Schools (RBS) became the major development agency. RBS personnel functioned in areas of curriculum writing, material production, training, field engineering, and evaluation. They were assisted by the LRDC at the University of Pittsburgh. LRDC served as the major initiator of IPI mathematics projects, installing these products in the Oakleaf School of the Baldwin-Whitehall School District during 1965-66 as part of a feasibility study. RBS staff took materials which were being used in the Oakleaf School and produced them in quantity for use in RBS demonstration and development schools. Necessary revisions were made under the aegis of the RBS staff with input from LRDC and Appleton-Century-Crofts.

The dissemination and adoption process involved identifying cooperating school districts, establishing a demonstration training school in the Baldwin-Whitehall school district in addition to the Oakleaf School, training cooperating school district staff, evaluation and revision, and diffusion of the program to other schools. High nationwide interest led to the establishment of fifteen pilot schools during 1967-68. Continued revision and evaluation resulted in the publication of the Mark II version which has been marketed since September, 1972.

What is the present status of the program?

Continual modifications are being made to improve the program as evaluation data are assembled. The LRDC is now involved in developing and piloting what has been called the Mark III version which stresses a more modern approach to the mathematics curriculum.

Program Evaluation

How has the program been evaluated?

Research for Better Schools has consistently provided both formative and summative evaluation data on Individually Prescribed Instruction since the program's inception. These data have included IPI-control group comparisions on standardized achievement tests, as well as information related to students' self-concepts and attitudes toward mathematics.

The RBS publication entitled *Progress Report II*, March, 1971, cites over twenty IPI-control group comparisions for mathematics achievement which were determined between 1967 and 1970. Sections of the Iowa Test of Basic Skills, Stanford Achievement Test, and Metropolitan Achievement Test, as well as the IPI Mathematics Placement Test were used to measure student achievement. Pupil opinionnaires were used to gather data on student attitudes.

During 1971-72, Research for Better Schools conducted an evaluation of the outcomes of IPI programs in an eleven school sample from Nationwide Network Schools (NWN). The NWN schools are fairly representative of the nation as a whole. The sample IPI schools represented a spectrum of community and student types, and included some that had used IPI for as many as six years, and one which had used it for only one year. Control schools were selected by IPI school principals with the

guideline that the school be the area school most similar in all respects to the IPI school. Three instruments were constructed to measure the achievement of affective program goals with parents, teachers, and students. In assessing achievement outcomes, the Iowa Test of Basic Skills was used on a pre and post-test basis.

What were the indicated strengths and weaknesses of the program?

Evaluation data reported as of March, 1971, indicated that in the majority of cases, there were no significant differences between IPI and control group achievement on mathematics sections of the Iowa Test of Basic Skills, Stanford Achievement Test, and Metropolitan Achievement Test. However, IPI students were equal to or scored higher than control pupils on the IPI Mathematics Placement Test in almost all cases.

The 1971-72 Nationwide Network Evaluation Study emphasizes that evaluation focussing on basic skills achievement test scores does not adequately assess the attainment of the total goals of the IPI program. What is needed is a comparision instrument which is both specific to IPI goals and common to other programs' goals. This would necessitate a population of items representing the objectives of IPI programs, and the objectives of programs reasonably assumed to be competitive with IPI. RBS reported, but did not provide an analysis of data on the mean grade equivalent scores for each of the IPI and control schools. Directions for assigning students to subtests were ignored in several schools, and an adequate number of class means were unavailable for use.

IPI schools pre and post achievement data (Fall, 1971 to Spring, 1972) based upon national norms for the Iowa Test of Basic Skills indicated that the median for math increased by one level in four of the seven schools, increased by two levels in one school, and remained the same in two schools. However, in all of the schools, there was a marked decrease in the proportion of students scoring in the lowest three levels, and a corresponding increase in the proportion in the upper levels. Table 1 presents pupil progress data from the IPI schools included in the study.

Affective measures indicated that IPI and control teachers showed no significant differences in (1) perception of teaching roles, (2) attitude toward students, (3) perception of the teacher-student relationship, and (4) perception of the student-student interaction. Analysis of the responses to the Parent Opinionaire indicated that IPI students were highly motivated, more self-directed, and more independent than non-IPI students.

Table 1

Pre-Post Summary Data: IPI Pupil Math Progress*

School #	N		Median Level		Pre-post Percentages Per Level													
					A		B		C		D		E		F		G	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
7	317	266	B	D	28.4	3.8	24.0	10.9	16.4	27.8	21.5	28.9	9.1	22.9	0.6	5.3	0.0	0.4
20	339	308	C	D	20.9	1.3	15.9	13.3	18.6	16.9	29.8	29.9	10.9	20.8	3.4	14.3	0.6	3.6
17	423	457	B	C	31.0	15.5	23.2	19.0	16.8	19.0	22.5	27.6	6.4	17.1	0.2	1.5	0.0	0.2
8	394	432	C	D	7.1	3.2	22.8	20.8	23.1	20.6	31.2	31.9	14.7	20.4	1.0	3.0	0.0	0.0
13	391	566	D	D	7.4	9.4	18.2	17.7	16.4	12.7	35.0	24.9	22.5	27.4	0.5	8.0	0.0	0.0
7	493	502	D	D	19.9	3.0	9.1	10.4	8.7	10.4	31.6	26.7	28.4	33.7	2.2	14.3	0.0	1.6
6	482	456	D	E	17.2	.2	8.1	10.7	11.8	13.4	21.2	20.0	32.6	32.0	8.3	19.1	0.8	4.6

*Achievement data based upon the Iowa Test of Basic Skills:
I-Fall, 1971; II-Spring, 1972
A-G levels range from lowest to highest

Middle level students had significantly higher scores on the three measures of creative tendency, self-concept, and attitude toward school than control students. At the third grade level, there was no significant difference between control and IPI students on creative tendency, the control students had a significantly better attitude toward school, and IPI students had a better self-concept. The data support the hypothesis that Individually Prescribed Instruction has a positive effect on pupil self-concept. However, other IPI effects were not felt at the lower grade level as much as the upper.

Useful Information

Where can the program be obtained?

Appleton-Century-Crofts, Inc.
New York, New York

What school districts in New Jersey are familiar with the program?

Individual schools in the following districts have implemented IPI-Mathematics: Teaneck, Cherry Hill, Wildwood, Wayne, Newton, Trenton and Secaucus.

References

Carrol, J.B. *"A Model of School Learning," Teacher College Record,* 1963, *64:* 723-33

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Research for Better Schools, Inc. *Individually Prescribed Instruction Nationwide Network Evaluation Study, 1971-72.* Philadelphia, February, 1973.

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The Pennsylvania Retrieval Of Information For Mathematics Education Systems

Established by Pennsylvania Department of Education

Summary

The Pennsylvania Retrieval of Information for Mathematics Education System (PRIMES) is an information storage and retrieval system designed to assist local school districts within the Commonwealth of Pennsylvania with curriculum development activities in elementary school mathematics. PRIMES uses computer and microfilming processes to make extensive data available to local school districts in order to facilitate wise curriculum decisions. To assist schools in utilizing such data meaningfully, PRIMES has developed systematized services and teacher manuals for training and supporting local leadership in curriculum development activities. The data base includes information about textbooks, proper use of achievement tests, modification through behavioral objectives, viable curriculum practices, relevant audio-visual materials, manipulative devices, significant research studies, and useful instructional models for curriculum implementation.

PRIMES services are free of charge to all school districts within the Commonwealth of Pennsylvania. Out of state school districts may receive free consultation from PRIMES at various regional centers. A school district may contract for use of the system for a rate between one and two thousand dollars.

Nature of the Program

For whom is the program designed?

The program is designed for all elementary school districts interested in either improving or totally revising their present mathematics program after an assessment of student and community needs.

On what rationale is the program designed?

Changes in mathematics instruction have been motivated by the recognition that mathematics is a system and, therefore, the teaching of mathematics must reflect systematic ways of thinking. Traditional instruction, with its emphasis on rote memory for skills and problem solving, has not stressed this "systems" aspect of mathematics. In many instances, secondary students confronted with abstract processes and concepts have been unable to make necessary applications of the concrete to the abstract. This would have been relatively simple if concepts process and structure had been an integral part of the elementary mathematics instruction. Piecemeal changes in curriculum or instruction cannot accomplish the objectives which would result from systematically restructuring the total mathematics program. PRIMES activities are intended to facilitate a comprehensive, systematic design for a mathematics curriculum.

What are the general goals and objectives of the program?

PRIMES aims are: 1. to develop and maintain a data base of instructional and evaluation materials in elementary school mathematics; 2. to assist mathematics committees of local school districts in systematic curriculum development; 3. to effect changes in classroom instruction by implementing stimulating curriculum materials produced by committees; 4. to outline the major responsibilities of the agencies collaborating within the system as shown in Table I.

Organization and Materials

How is the program organized?

The Pennsylvania Department of Education is responsible for the development of PRIMES as a system involving services and materials. Regional centers have been established to provide advisors and program materials to local school districts. In summary, development activities at the Department of Education include:

1. Creating a data base by analyzing or classifying the instructional and evaluative materials which were commercially

Table 1

PRIMES

Pennsylvania Retrieval of Information for Mathematics Education System

Responsibilities of Participating Agencies

PRIMES Department of Education	Regional Center	School District
1. Develops and maintains the system.	1. Determines mathematics curriculum needs and develops a plan of action for curriculum services.	1. Develops, implements and evaluates the curriculum activity.
2. Trains consultants and provides consultative support.	2. Tests and refines systematic curriculum procedures.	2. Provides time for committee meetings.
3. Develops and maintains computer services.	3. Assists committees in preparing the final curriculum reports.	3. Provides administrative and clerical assistance.
4. Outlines procedures and forms for using the system.	4. Provides administrative support and submits periodic progress reports.	4. Duplicates the final curriculum reports.
5. Coordinates regional centers.		5. Follows the curriculum procedures manuals.
		6. Conducts an orientation for the elementary school faculty and administrative staff to acquaint them with the completed curriculum reports.

produced for elementary schools. This base is divided into three analysis tools:

A. List of mathematics concepts and skills—
Mathematics Content Authority List
B. List of Behavioral objectives—
Behavioral Objectives Authority List
C. List of mathematical terms—

Vocabulary Authority List
2. Analyzing textbook series and other instructional materials.
3. Developing procedures and manuals
4. Designing forms and other tools
5. Producing computer reports
6. Evaluating the effectiveness of the system

The regional center provides a mathematics adviser who:
1. Helps the school district to determine what curriculum products are needed and to set a schedule for completing them
2. Visits school districts to orient and train committee members to function easily within the "system"
3. Conducts conferences to assess committee progress
4. Gives suggestions for refining and maintaining developmental activities to the Department of Education

What specific objectives are involved?

The computer at the department is capable of processing a large volume of information and selecting that which is pertinent to the needs of a single school district. School district staff are trained to apply procedures and the computer analysis reports to their own local situation.

How much student time is devoted to the program?

This depends completely on the final curriculum created with the help of PRIMES and is thus very flexible.

What materials are provided for the students?

Materials provided for the student include student manuals, textbook reference lists, achievement tests, and study guides. To what extent materials are used is completely dependent on the type of curriculum developed in the local school level.

What materials are provided for the teacher?

A manual replete with complete lessons is provided for all topics in elementary mathematics, with textbook references and supplementary materials. Also included are sample techniques and examples of methodolgy for the presentation of material.

How open is the program to supplementary and teacher-made materials?

PRIMES main function is that of an advisory service. For this reason, its degree of openness is limited only by the staff decisions regarding curriculum at the local level.

What student assessment materials are provided or suggested?

None. Program depth is completely dependent on the curriculum developed at the local level.

Classroom Activities

How are classes organized?

The program works well in any pattern of organization.

How are materials used?

PRIMES materials are used to the extent that district faculties feel a need for them as part of an integral program, or choose to use them in a supplementary way.

Are teacher aides used?

This depends upon the nature of the final program created with the help of PRIMES.

How is student progress assessed?

Suggestions are made through advisement and inservice (Manual VI—testing), but the extent of assessment is determined by the type of program implemented and by the choice of local school district staff.

Implementation Requirements and Provisions

Are special facilities needed or suggested?

No. However, if the program is computer-assisted, as it usually is in the planning stage, special facilities would be needed.

Is special equipment needed?

No. However, if a school district possesses special equipment, it could be utilized.

Is in-service training needed or suggested?

In-service training is an integral part of the services provided by PRIMES. Regional centers have mathematics specialists whose sole function is to train and guide local school staffs.

What provisions are made for special training of teachers?

In addition to in-service training, there are several self-training manuals produced by PRIMES which include:

Each of the manuals aims to increase staff understanding of what PRIMES can do. Recommendations are also made about curriculum development which is linked to the local district needs.

What provision is made for training of teacher aides?

Teacher aides should be included with regular staff in-service training. If not, a program should be developed by the local school district. Aid in developing this latter type of program is available from the regional center staff.

What is the cost of implementing the program?

PRIMES advisory services/and in-service training are free of charge to all school districts within the Commonwealth of Pennsylvania. Out-of-state school districts may receive free PRIMES consultation at one of the regional centers, and may contract for use of the system for rates of between one and two thousand dollars. Actual expenditures vary considerably, depending on the kind of end products chosen by a district, and its skill in utilizing existing manpower and facilities.

Program Development and Status

How was the program developed?

The original data base was collected by examining and classifying over 150 textbooks. Since this original work in 1965, hundreds of additional textbooks and curriculum programs have been classified and stored. Pilot programs were established to determine the best procedures for setting up PRIMES. A procedure was then developed which would allow each of the local districts to develop the best curriculum for specific needs and demands.

What is the status of the present program?

In the first five years that PRIMES was in operation, it served about seventy-five school districts. During the last three years this number has more than doubled. PRIMES has a system of continual improvement directly built into its organization, to the extent that new material is always being added. Evaluations are carried on by outside research teams to determine relevancy

and needed change. The number of regional centers is being expanded every year, and services offered at each are being enlarged to accommodate greater demands.

Program Evaluation

How has the program been evaluated?

Three major evaluations of PRIMES have taken place in the last four years. All three answered the same basic questions: 1. Did PRIMES meet the needs of local districts? 2. Did PRIMES answer questions and solve the problems of these districts? 3. Did the data received by local districts have a high degree of reliability?

What were the indicated strengths and weaknesses of the program?

The overall results of evaluation studies indicate that PRIMES has a reliability measure of 80% and an intra-analyst measure of 87%. This information system will satisfactorily answer questions from local districts more than 80% of the time. The user consistency of agreement measure was 70%. Other strengths and weaknesses of the program center around the local school districts ability to organize itself and make maximum use of materials and services supplied by PRIMES.

Useful Information

Where can the program be obtained?

PRIMES
Department of Education
Box 911
Harrisburg, Pennsylvania 17126
(717) 787-6016

What systems in New Jersey are familiar with the program?

As of the autumn of 1973 no school district within the State of New Jersey has taken advantage of this service.

References

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PLAN*

Westinghouse Learning Corporation
New York, New York

Summary

PLAN* is a comprehensive system of individualized instruction consisting of behaviroal objectives, placement tests, individualized lesson plans for students, and mastery tests. A computer-support system, centralized outside the school district, helps teachers to plan learning and to monitor student progress. The computer accomplishes the following: It scores tests, keeps track of daily and cumulative student progress, provides information for activity planning, and generates individualized programs of studies for students, on the basis of their placement test results.

Nature of the Program

For whom is the program designed?

The program is designed for students in grade levels one through twelve in the Language Arts, Reading, Math, Science, and Social Studies areas.

On what rationale is the program designed?

PLAN* was organized on the assumption that by use of a computer, a truly individualized program could be adapted to fit each student's needs, abilities, interests, and goals. The developers sought to create a systematic, success-oriented, individualized learning program made manageable through computer technology.

What are the general goals and objectives of the program?

PLAN* has two major goals. The first involves making it possible for each child to have an individualized program in four major subject areas which is specifically created to meet his individual needs, abilities, and interests. The second goal emphasizes the students' involvement in choosing what they will learn and how they will learn it. Students are specifically taught to make their own decisions in the classroom, and they learn to schedule their own daily time, and to set and meet goals.

Organization and Materials

How is the program organized?

The PLAN* system consists of behaviroal objectives which clearly state performance tasks which the students can accomplish within reasonable periods of time. These objectives are coded into an orderly scope and sequence so that they can be stored in the computer and related to the tests, the instructional materials used, and to student records. Teaching Learning Units (TLU is actually a sheet of paper which sets forth an assignment of about two week's work, making suggestions and references to learning experiences and currently available instructional materials. Student assessment is accomplished through criterion tests consisting of tasks and items specifically related to the behaviroal objectives.

What specific objectives are involved?

Readiness objectives require the students to start the year with orientation activities directed by the teacher. These activities prepare the student to use the TLU's, operate audio-visual equipment, and become familiar with PLAN* classroom procedure. The mathematics objectives for the primary program (grades 1-4) provide students and teachers with two alternative learning approaches. One is deductive, concrete, and number oriented. The second is more inductive, abstract, and pattern-oriented. Both approaches utilize filmstrips, resource books, manipulative equipment, and games. Students are asked to weigh, measure, count, graph, draw, tell, and experiment. In short, they are active inquisitive learners. Many of the primary objectives are organized in a developmental sequence covering the basic skills and their application. In addition to the sequenced objectives, there are objectives on selected topics in sets and number theory, measurement, problem solving, geometry, and graphics.

The intermediate objectives emphasize the development of basic math skills and add skills in fractions, decimals, and percents. Selected objectives, on previous topics, are outlined and activities become more complex. Level 7 completes the study of basic numerical operations, introduces statistics, and does not overlook previous objectives. Level 8 reviews basic operations on rational numbers through a series of objectives on layman's math. Pre-algebra studies are available as well as objectives related to such topics as probability, statistics, logic, computer math, symmetry, volume, functions, and graphing.

How much student time is devoted to the program?

The total program is organized for the four basic subject areas: Language Arts, Math, Science, and Social Studies. How a student schedules the use of his daily time is reflective of his individualized goals, and his reaction to the guidance and one-to-one help of his teacher.

What materials are provided for the student?

Each student receives a TLU which prescribes various learning activities. The TLU directs the student to a broad range of instructional materials made available to him in a media center which contains all necessary books and reading material, and an audio-visual center which contains all necessary filmstrips and tapes.

What materials are provided for the teacher?

PLAN* provides teachers with behavioral objectives to use in teaching students, placement tests to assess each student's level of development, Teacher Editions of the TLU's, test items for each objective in the system, and achievement tests to measure long term retention of material. In addition, a daily computer printout indicates the objectives each student is working on in the various subject areas. From this printout, teachers can help students find other children who are working on the same objectives and arrange for "partner work" and group discussions. The teacher is supported by a management system in

which the computer scores tests and keeps track of each student's progress, and provides the teacher with a Progress Report on each student at intervals during the school year.

How open is the program to supplementary and teacher-made materials?

A teacher can by-pass the computer to arrange a variation in a student's program. PLAN* also allows teacher-initiated changes in programs, whereby the computer will digest any changes or incorporate any numbered lesson unit devised by the teacher for a specific student.

What student assessment materials are provided or suggested?

There are placement tests for initial placement in the scope and sequence of the behavioral objectives series; criterion tests related to each of the behavioral objectives; and, achievement tests for long term retention.

Classroom Activities

How are classes organized?

PLAN* lends itself to a wide variety of staffing patterns, and is operating successfully in schools with self-contained rooms, and the newer, open-space buildings. The school building and staff, however, must be organized for individualization.

How are the materials used?

The system starts with the administration of placement tests which identify the point in the scope and sequence of objectives at which a student is best able to learn. The student is then given as assignment consisting of a module of behavioral objectives classified at his level, and several TLU's which provide individualized avenues for mastering the objectives. The student assumes responsibility for achieving the objectives through the various learning activities, and is tested at the completion of the TLU. The test results are reported in decision-making terms so that the student is either recycled through the objectives with reinforcing or remedial work, or is assigned to the next module where the cycle is repeated.

Are teacher aides used?

Teacher aides may be used, if desired, but are not necessary.

How is student progress assessed?

Measurement of attainment of each criterion objective is an internal function of the daily management process within the PLAN* system. Whenever a student completes a TLU, he takes a task-and-item test directly related to the set of objectives for the TLU. Recall over a period of time is directly assessed through achievement tests. The computer scores tests and keeps track of each student's progress, providing the teacher with a Progress Report on each student at intervals during the school district so desires, but PLAN* strongly discourages grading students by comparing them to a group norm.

Implementation Requirements and Provisions

Are special facilities needed?

No special facilities are needed except for a small room required for sending and receiving information via a small teletype.

Is special equipment needed?

Instructional audio-visual equipment is necessary for the provision of wide-ranging learning activities. The system also utilizes a mini-card-reader which sends information to the computer center, and a computer run-off receiver.

Is in-service training needed or suggested?

Yes. Administrator and teacher training related to the implementation of an individualized program for all students is needed.

What provisions are made for the special training of teachers?

PLAN* provides training sessions in which teachers learn how to use PLAN*'s individualized materials, how to help students choose appropriate objectives, how to use the computer-support system, and how to manage instruction in an individualized setting.

What is the cost of implementing the program?

The price of full PLAN* services is $42 per child at the elementary school levels and $60 per student at the secondary school levels. The current PLAN* program recommends an average of an additional $50 for each elementary student to provide for an initial inventory of support materials, and about a ten to fifteen percent replacement expenditure annually thereafter, for consumption and renewal. In addition, IBM Terminal and Telephone services range from $1000 to $1500 a month during the school year, accommodating school building enrollments as small as 250 and as large as 2000 respectively.

Program Development and Status

How was the program developed?

PLAN* was initiated as "Project Plan", in 1967, with 2000 students in twelve different schools at levels one, five, and nine. Westinghouse Learning Corporation provided funding for the initial development to the American Institute for Research in Palo Alto, California. The goal was to create a systematic, success-oriented, individualized learning program which could be made manageable through computer technology. As developed, the design of the project was to allow schools to change their strategies of organization and operation while capitalizing on currently available classrooms, teachers, and materials. The prototype system was completed jointly by AIR and WLC after four years of initial development. It included the curricular areas of reading, language arts, math, science, and social studies for levels one through twelve.

What is the status of the present program?

PLAN* was completely revised prior to the Fall of 1973. Implementation reflects decisions based upon six years of operational experiences. At the elementary school level, the changes in the system were: (1) more local school flexibility in the choice of curriculum and in the use of system components; (2) an increased use of content and graphics as motivational tools in the student-oriented TLU's, (3) a reduction in the total cost of the general-purpose textbooks, filmstrips, audio-tapes, and other learning materials which are referenced for use in PLAN* classrooms; and (4) over a fifty percent reduction in the WLC price for full PLAN* services. At the secondary level, changes focussed upon creating more flexibility in the use of textbooks and other materials currently is use within a high school, and greater ease in implementing PLAN* in a school where one or more departments, but not an entire faculty, are ready to individualize.

In addition, PLAN* TLU's are being made available on a course by course basis at the secondary level, and a PLAN* Math Starter Set at levels four through six is being offered to elementary schools. The intent of these materials is to provide assistance to teachers who wish to move toward individualization, but who are unable to make the organizational and process changes required to implement a totally individualized program. PLAN* is also now offering a preschool and Kindergarten program built around 150 learning objectives to individualize instruction for three, four, and five-year olds.

PLAN* is presently operating in grades one through twelve in more than 100 schools within twenty three states, with some 18,000 students' programs being monitored on the computer system.

Program Evaluation

How has the program been evaluated?

Formative evaluation activities conducted by the American Research Institute, during the research and development phase of the program, included evaluation of PLAN* instructional materials; evaluation of testing instruments such as the module tests, PLAN* achievement tests, and the developed abilities tests; and evaluation of instructional objectives. Both objective data from item analyses of the module tests, and subjective data from teachers and students in PLAN* classrooms were used as a basis for revising instructional objectives, their associated learning activities, and the module tests themselves.

While the primary use of item analyses data was to improve the module tests, low performance on several items would indicate the need for improvement of the objective or learning activities. When an extremely low mean value was detected, the objective and prescribed learning activites were carefully examined to pinpoint the weakness in the system, and activities would either be modified, or the objective would be assigned a different point in the sequence of modules. Also, since more than one TLU was available for each module, it was possible to compare the effectiveness of different learning activities in various TLU's for achieving the objective. Subjective evaluation data were also collected from teachers and students.

The design of studies and analyses of data for summative evaluations were done by the Evaluation and Research staff of Project PLAN* under the direction of Dr. Calvin E. Wright. This evaluation focussed upon (1) how each individual PLAN* student was progressing toward his goals, and (2) how well PLAN* students were performing on standardized tests compared with other groups of students in more traditional classrooms. For the evaluation of individual attainment of goals in PLAN*, the progress of each PLAN* student, measured in terms of mastery of a number of modules in each subject area which he successfully completed, was periodically compared against the number of modules assigned to him. PLAN*-control group pre and post-test performance comparisons on standardized measures were made for grades one, two, five and six during 1968-69, Comparability of the groups at the time when pre-tests were administered was a major problem, however, and statistical or other procedures which often had to be re-adjusted for pretest differences were not applied.

What are the strengths and weaknesses of the program?

The results of PLAN*-control group comparisons during the research and development stage of the program are difficult to interpret since the PLAN* and control groups were not comparable on the pre-tests. Generally, however, the performance of PLAN* students was comparable to the control groups in regard to both grade placement and growth. This was viewed as a positive finding by the developers, since the usual start-up problems had already occurred; moreover, materials were often not available for the brighter students to progress to the curriculum at the next higher level. There was also some tendency for students to do better the longer they were in PLAN*.

Using standardized test data to evaluate a program of individualized instruction is a problem which has been identified by the developers. In PLAN*, students do not proceed to new skills until they have achieved mastery of the units on which they have been working. They may not, therefore, compare favorably on standardized tests with students in traditional classrooms who may have been exposed to, but who have not necessarily mastered, a greater number of skills. Also, with such a comprehensive management system, actual achievement is dependent upon teacher and student variables in the selection and implementation of learning experiences. It is thus difficult to directly relate precise quantitative evaluation data to the effectiveness of PLAN*

Individual school districts using PLAN* have provided WLC with some informal evaluation data regarding process and product outcomes, and much of these data point to positive affective results in the areas of student attitudes toward learning and actual school attendance.

The strength of the program is reflected in a process which provides utmost flexibility for meeting children's individual needs. Nevertheless, while the developers of PLAN* view it as a cost effective system which enables a school district to fully individualize its program, the cost to initiate and maintain the total PLAN* system is still very prohibitive for many school districts.

Useful Information

Where can the program be obtained?

Information concerning Project PLAN can be obtained from:
Westinghouse Learning Corporation
PLAN* Educational System
100 Park Avenue
New York, New York 10017

What school districts in New Jersey are familiar with PLAN*

Atlantic City, East Orange, and Ridgewood

References

Dunn, James A. *"Project PLAN* - The Accomodation of Individual Differences in the Development of Personal Programs of Study."* Paper read at the American Psychological Association Convention, Washington, D.D., September 1, 1969. (ED 066 045)

Flanagan, John C. *"PLAN* System as an Application of Educational Technology," Educational Technology,* 12:17-21, September, 1972

American Institute of Research Evaluation Report on Evaluation during the Research and Development Stage of PLAN*

Pamphlets printed by Westinghouse Learning Corporation
a. A Look at PLAN*
b. PLAN* Answers and Questions
c. Christopher is Getting a Better Look at Math
He's Got a Piece of PLAN*
d. PLAN* Meeting Individual Needs

A filmstrip and tape prepared by Westinghouse Learning Corporation entitiled "PLAN* Can Help."

Prescriptive Mathematics Inventory

CTB/McGraw Hill
Monterey, California

Summary

The Prescriptive Mathematics Inventory (PMI) is a criterion referenced test based upon a comprehensive inventory of learning objectives keyed to standard textbooks and formulated in behavioral terms. Results are reported in terms of specific instructional objectives found in the basic mathematics curriculum. Student performance is organized and displayed in an easily interpretable diagnostic matrix.

Nature of the Program

For whom is the program designed?

PMI is designed for students in grades 4-8.

On what rationale is the program designed?

PMI is designed to provide students and teachers with specific diagnostic and prescriptive information regarding mathematics objectives mastered and not yet mastered.

What are the general goals and objectives of the program?

PMI can be used prior to instruction to provide assessment of a student by measuring his mathematical knowledge, and diagnosing his individual weaknesses. PMI can be used after instruction to evaluate student progress toward the mastery of the objectives in which he was deficient. PMI is intended to be a tool for individualizing instruction for all students, and it can also be used to develop remedial or enrichment activities.

Organization and Materials

How is the program organized?

PMI is organized around the following components:

The Practice Exercises containing sample problems which give the student experience in marking answer grids.

The Test and Answer Booklets. These are published in four levels which test objectives usually geared to grades 4-5, 5-6, 6-7, and 7-8.

The Examiner's Manuals correspond to each test and answer booklet, providing instructions for administering the PMI.

The Teacher's Guide provides a description of PMI, listing the objectives measured at each level, giving information on how to use the reports, and suggesting classroom activities for achieving some of the objectives measured by the test.

The Guide to Ancillary Materials keys the PMI objectives to specific learning materials, other than textbooks. Suggestions would be helpful to the teacher in developing a mathematics laboratory.

The Individual Diagnostic Matrix is a chart which displays, for each student, the objectives he has mastered and those yet to be mastered. It lists all the objectives which are measured by the specific PMI administered. A plus sign is printed beside each objective the student has mastered and minus sign next to those objective he has not mastered.

The Class Diagnostic Matrix is a chart which summarizes test results for the entire class by providing the percentage of students who mastered each objective assessed by the test.

The Individual Study Guide. The guide prescribes specific classroom instruction for each student for those objectives which he has not mastered. Used in conjunction with any of the dozen textbook series to which the guide has been keyed, the guide refers to pages in the text where these unmastered objectives can be found.

The Class Grouping Report is a chart which groups students in the class according to common deficiencies in mathematics skills, and provides references to pages in textbooks which teach these skills. The chart makes it easy for the teacher to identify groups of students who require special instruction in particular areas, and those who can profit from advanced activities or enrichment materials.

The Master Reference Guide provides all the references to pages in a particular textbook which teach each objective to be achieved on any single level of the PMI. It also includes a list of all pages on which the objective is reviewed and mastery of it is tested. The reference guide facilitates preparation of prescriptions for individual students who find that the reference pages listed in the individual study guide are not adequate for mastering the objective.

What specific objectives are involved?

The four levels of PMI encompass 351 instructional objectives in traditional and contemporary mathematics which represent those objectives most generally taught in schools today. The test items sample various levels of difficulty in each of the content areas represented.

How much student time is devoted to the program?

PMI components are designed to complement standard elementary mathematics programs. Thus, time factors other then the 2-3 hour testing period required for the criterion-referenced tests cannot be determined.

What materials are provided for the student?

Each student has practice exercises a test and answer bookiet, an individual diagnostic matrix chart, and an individual study guide.

What materials are provided for the teacher?

The teacher is provided with an examiner's manual, a teacher's guide, a guide to ancillary materials, a class diagnostic matrix chart, and a master reference guide.

How open is the program to supplementary and teacher-made materials?

PMI can be used to complement such materials.

What student assessment materials are provided or suggested?

Test and answer booklets are provided. Also, each student and teacher is provided with an individual Diagnostic Matrix which shows in visual form a profile of the student's mastery of mathematical objectives.

Classroom Activities

How are the classes organized?

Classrooms should be organized to facilitate individual progress, but group lessons may be given in areas in which the majority of the class is weak.

How are materials used?

The tests and matrices are used to assess and chart student progress toward mastering objectives. As objectives are mastered, progress is marked on the individual diagnostic matrices and on the class diagnostic matrix. Individual prescriptions are prepared by the teacher.

The teacher should use the guide to ancillary materials to set up a mathematics interest center. The instruction manual provides all information on administering tests and keeping records. The master reference guide permits the teacher to make special prescriptions over and above what the student can do for himself with the individual study guide.

Are teacher aides used?

They are not necessary.

How is student progress assessed?

Student progress is assessed by teacher-made tests and marked on the individual and class matrices. Progress is defined as mastery of a specific objective not previously mastered. Interim evaluation tests are available from the publisher keyed to each unit of study.

Implementation Requirements and Provisions

Are special facilities needed or suggested?

A mathematics interest center should be available in the classroom, but no special facilities are needed.

Is special equipment needed?

No special equipment is needed.

Is inservice training needed or suggested?

Teachers should be trained to manage an individualized, progress-oriented mathematics class prior to the institution of this program, since the program is intended to facilitate individual diagnosis and prescription.

What provisions are made for special training of teachers?

None

What provision is made for training of teacher aides?

No additional personnel is required. Nevertheless, auxiliary personnel can certainly be used to advantage.

What is the cost of implementing the program?

The purchase of the booklets is currently under $20 per class, per year. If interim evaluation tests are also used, the cost becomes approximately $50 per class, per year.

Program Development and Status

How was the program developed?

The author analyzed mathematics textbooks which were most widely used in the United States in Grades 4 through 8. A list of 351 objectives was organized into smaller groups to assure coherence among the objectives in each group. Tests items were prepared for each objective in the construction of the criterion-referenced test. The unique answer grid was devised to minimize the factor of chance.

What is the status of the present program?

The program is used in seven school districts in New York State. They are Babylon, Bronx, Northport, Port Washington, Setauket, Union Springs, and Vestal. It is complete and useable.

Program Evaluation

How has the program been evaluated?

The PMI reliability study was carried out during 1972-73 in two school districts, one in northern and the other in southern California. Phase I of this study involved the construction of a multi-item criterion test for each PMI test item. Each criterion test response distribution was classified in accordance with hypothetical multi-item test response distributions and determinations of the difficulty range were made. The criterion tests were then subjected to Kuder-Richardson Formula 20 to determine the reliability coefficients for internal consistency.

What are the indicated strengths and weaknesses of the program?

The Prescriptive Mathematics Inventory is a criterion-referenced test constructed in a hierarchial pattern, and consisting of a set of specific objectives which, in their entirety, measure the students mastery of a curriculum domain. Each specific objective is measured according to a single item that demands a constructed response. A positive response indicates that the student has mastered the objective. A false positive response indicates that the student has mastered the objective.

A false positive response, involving guessing, is virtually eliminated through the constructed response format. The chance factor for most items is small, 1/100 or less in most cases. A negative response indicates that the student has not mastered the objective. A false negative response is crystallized by observing the students behavior in the hierarchy of objectives.

The single item per objective design offers the freedom to test numerous objectives without over-burdening the student. Hence each objective is reduced to its most specific level and, in turn, brings to a maximum the potential that each item is capable of accurately measuring the objective. Thus the specifity of the objective defines the validity of the item, and the validity of the entire test is reduced to that level.

Of the 32 criterion tests developed, 34% yielded reliability measurements of .90 or above, 40% yielded .80 to .89, 16% yielded .70 to .79, 7% yielded .60 to .69, and 3%, or one criterion test, yielded .59 Item for item point biserial correlation coefficients were computed for all items in each criterion test. thus establishing a range of expected single item correlations. A point biserial correlation coefficient was then determined for each PMI item and its corresponding criterion test. Fifty percent of the PMI item correlations fell within the criterion test. Fifty percent of the PMI item correlations fell within the criterion test correlation range. The remaining 50% fell just below the range and

was attributed in part to the time period which separated the administration of the tests.

Phase II of the PMI reliability study took advantage of the hierarchial structure of the test. A stepwise multiple regression procedure using interdependent PMI item subscores as predictor variables to the criterion test scores was employed. The stepwise procedure was terminated when the next predictor to be added would increment the multiple correlation coefficient by less than .003. In every case, except one, the multiple correlation coefficient is substantially higher than the point biserial correlation coefficient for its corresponding PMI item, with 12% yielding correlation coefficients of .80 to .89, 41% yeilding .70 to .79, 28% yielding .60 to .69, and 16% yielding .50 to .59. The remaining 3% represents the single low correlation whose value was .26. In summary, these statistics show that the PMI single item seems to give a good indication of mastery or non-mastery of its objective.

Useful Information

Where can the program be obtained?

CTB/McGraw Hill
Del Monte Research Park
Monterey, California 93940

What school districts in New Jersey are familiar with the program?

None were identified.

References

Gessel, John. *Prescriptive Mathematics Inventory*, Teacher's Guide and Examiner's Manual. Monterey, California. CTB/McGraw-Hill.

Rondabush, G.E., Green, D.R. *Aspects of a Methodology for Creating Criterion-Referenced Tests.* A paper presented at the National Council for Measurement in Education meeting in Chicago, April 1972.

A Systems Approach To Individualized Instruction

Grants Pass, Oregon

Summary

The Systems Approach to Individualized Instruction developed by the Manzanita Elementary School, Grants Pass, Oregon, focusses upon the provision of a number of alternative learning experiences which will enable each student to progress at his own speed and according to his own learning style. The program functions well under differentiated staffing, or, at least, in a physical environment which permits flexibility of instruction. Systematic instructional procedures characterized by specification of learning outcomes in behavioral terms, pre-testing, and varied activities reflective of each student's unique learning style constitute the program. Materials include mastery units on a hierarchy of skills, instructional objectives for each skill, pre and post-tests for each objective, and questioning strategies for the development of higher level thinking skills. Program Management Units (learning packages) are a major feature of the Systems Approach. These contain three and usually more alternate routes of instruction which might include: listening to tapes, viewing filmstrips, working with peers, meeting in need groups, or working with tutors.

Nature of the Program

For whom is the program designed?

The program is designed to be implemented with teachers and students in grade levels one through six.

On what rationale is the program designed?

The program is designed to meet the individual needs of students by providing alternate routes of instruction which allow them to progress continuously toward goals which have been established through diagnostic assessment practices. A parallel emphasis in the program is a differentiated staffing pattern, wherein teachers are held accountable for the achievement of specified performance objectives.

What are the general goals and objectives of the program?

A primary focus of the program is to reverse the "downward trend" of student performance in the basic skill areas of reading, mathematics, and written communication. Other general objectives include: 1. to utilize systematic instructional procedures which reflect preventive strategies in the basic skills areas; 2. to provide for the vertical articulation of a program through ungraded activities based upon a diagnosis of each child's needs, interests, and learning styles; 3. to utilize developmental skills and readiness activities for all students, and to provide for continuous progress at the point of entry into the program; 4. to utilize a differentiated staffing pattern that provides for accountability and flexible grouping procedures.

Organization and Materials

How is the program organized?

The program is organized around a hierarchical list of skills for each concept area, with an instructional objective for each skill. Pre and post-tests have been designed for each of the instructional objectives. Program Management Units (learning packages) support each set of objectives, and provide learning activities and alternate routes of instruction.

What specific objectives are involved?

The specific objectives of this program involve mastery of hierarchical skills within concept areas through a continuous progress process characterized by diagnosis, the prescription of activities matched to a particular student's needs and learning style, and post-testing.

How much student time is devoted to the program?

The amount of time a student devotes to the program varies since it reflects his unique needs, individual style of learning, and rate of progress toward specified objectives.

What materials are provided for the student?

Program Management Units are available for each student. Each PMU is a self-contained unit of instruction, consisting of at least three associated learning activities. Materials typically consist of filmstrips, audio tapes, consumable paper items, and games.

What materials are provided for the teacher?

The teacher is provided with a hierarchical list of skills for the various concept areas, instructional objectives for each skill in the hierarchy, and pre and post-tests designed for each instructional objective.

How open is the program to supplementary and teacher-made materials?

As the program is founded upon the utilization of a wide range of instructional techniques and resources, it is very open to the introduction of supplementary and teacher-made materials.

What student assessment materials are provided or suggested?

Pre and post-tests have been designed for each instructional objective. Also, a Master Skills Diagnostic Test for each of the concept areas has been derived from pre and post-test items.

Classroom Activities

How are classes organized?

Classes are organized into instructional units under a differentiated staff team of four members. The unit is flexibly structured, with students working on a variety of individually-prescribed activities.

How are the materials used?

Concept area pre-test results are utilized to place students into appropriate skill levels. Pre-test scores are thus used to determine the entry point into the hierarchically arranged PMU's. Within each designated PMU, a specific set of tasks is assigned to a student. Instructional procedures for any single PMU might include having a student work with peers, meet in a need group,

work with a tutor, or work independently with media materials. Upon completion of a PMU, the student takes a post-test which he must pass with 90% mastery before moving on to the next designated PMU. The student takes a second post-test five weeks later, and passing of this test constitutes mastery of a skill according to Project criteria. When a student fails a post-test, he is recycled through a different set of tasks in a PMU.

Are teacher aides used?

Yes. The differentiated staff team for each unit consists of an instructional leader, a staff teacher, an instructional aide, and a general aide. The instructional aide is responsible for working with students, and also does routine supervisory activities. The general aide works with the children, but is also responsible for much of the clerical work.

How is the student progress assessed?

Monitoring of student progress is accomplished through the tabulation of pre and post-test results. The second post-tests are utilized to determine skill retention.

Implementation Requirements and Provisions

Are special facilities needed or suggested?

Although the program was developed in an "open environment" situation under a differentiated staffing pattern arrangement, it is not a requirement for the implementation of the program.

Is special equipment needed?

A large number of tape recorders and filmstrip projectors are needed to provide varied learning experiences.

Is in-service training needed or suggested?

Movement into a differentiated staffing pattern would require training for the instructional leader and staff teacher on the team. Inservice training, related to the utilization of varied instructional procedures and a wealth of multi-media resources, would be most helpful to the successful implementation of this program.

What provisions are made for the special training of teachers?

The project staff has developed an inservice training procedure. This is related to the implementation of the individualized program, within a differentiated staffing arrangement.

What provision is made for the training of teacher aides?

No special training procedures have been delineated.

What is the cost of implementing the program?

The per pupil installation cost is $20.85. No additional cost is involved in the maintenance of the program.

Program Development and Status

How was the program developed?

A Systems Approach to Individualized Instruction was developed at the Manzanita Elementary School, Grants Pass, Oregon through funds provided by the Josephine County School District, and ESEA, Title III. The project involved in service training for the instructional leaders and staff teachers of the differentiated staff teams in areas related to curriculum design, systematic instructional techniques, and materials development. Concurrent with their training, the staff members developed a hierarchical list of skills for concept areas, wrote instructional objectives for each skill and designed pre and post-tests for each of the instructional objectives. PMU's supportive of each set of objectives were then assembled.

As each PMU was developed, a series of four evaluative cycles was established. The PMU was initially reviewed by a Project consultant. A trial cycle was then implemented wherein instructional leaders documented the use of the PMU and identified defects or needs for modification before it was used widely. The third cycle consisted of a complete record of usage for each PMU, and the performance of every child who used a given PMU was documented. This information provided a basis for a review of PMU performance by grade level. The final cycle consisted of a validation step in which performance on a standardized test was compared with PMU performance.

The evaluative cycle which involved the collection of student performance data on each PMU revealed that the overwhelming majority of PMU's met the 90/90 mastery criterion level established by the project staff. However, the mastery level for the math PMU's decreased in the third and fifth grades where the percentage of PMU's meeting the 90/90 criterion level was found to be between seventy and eighty percent.

Data regarding end of year attainment levels of students in grades 1 - 6 on the PMU's in mathematics indicated a general progression of skill attainment over the grade levels, and an increase in the ranges of skill level with successive grade levels. From this information it can be inferred that, to the extent that the various grade groups exhibited successively greater attainments, the developers of the project materials have succeeding in ordering the mathematics skills hierarchically.

Table 1 shows the correlation between PMU skill level and student performance on the California Achievement Test. The entire collection of PMU's were treated as a large test, and the PMU score was derived from the highest PMU attained by a student. While the correlations between the variables show some variation across grade levels, there is no correlation below .55, and the range extends to .83. In testing the statistical significance of these correlations, all were found to be significantly greater than 0 at the .01 level.

Table I

Correlations Between Student Attainment on PMU's and Performance on a Standardized Test

Grade	N	r
1	58	.72
2	73	.72
3	63	.83
4	80	.60
5	77	.74
6	69	.61

What is the status of the present program?

At the present time, the program is fully operational at the Mazanita Elementary School. In mathematics, 230 sequential skills have been identified with accompanying instructional objectives, and PMU's have been developed across all grade levels.

Program Evaluation

How has the program been evaluated?

Project evaluation was accomplished by means of a contractual arrangement with the Audit and Evaluation Section of the Northwest Regional Educational Laboratory. The evaluation plan was jointly developed by the project staff and members of the NWREL evaluation team. Project staff members were responsible for the implementation of the data collection and data reduction procedures. The data analysis and reporting functions were carried out by the evaluation team members. The effects of the program on the participating students were measured in two ways. Alternate forms of a standardized test were administered to all students on a pre and post-test basis. Differences between pre and post-test performance were computed and tested for significance. In addition, grade level mean test scores from the years immediately preceding the project

Table 2

Arithmetic Mean Test Scores (Grade Level Equivalent) on California Achievement Test, Manzanita School, Fall of 1968, 1969 and 1971, 1972.

Grade	Fall O 1968	Fall O 1969	Fall O 1971	Fall O 1972	Fall Δ 1972	Fall ● 1972
2	N=57 Mn=2.20	N=20 2.14	N=66 2.01	N=71 2.32	N/A	N/A
3	N=36 3.83	N=58 3.44	N=47 3.23	N=79 3.63	N=49 3.75	N=23 3.35
4	N=75 4.65	N=64 4.80	N=70 4.00	N=68 4.59	N=44 4.53	N=20 4.54
5	N=59 5.43	N=69 5.07	N=66 4.89	N=83 5.28	N=59 5.24	N=20 5.30
6	N=75 6.32	N=79 6.06	N=68 5.84	N=75 6.01	N=53 6.07	N=15 5.81

O Entire Class
Δ Continuing Project Students (Students enrolled from October, 1971 through October, 1972)
● Students entering Project during Fall 1972 (students having no prior contact with Project)
*Results Reported in Terms of Group Means

Table 3

Gains in Project Students Achievement on California Achievement Test in Grade Equivalent Levels—Manzanita Elementary School, 1971, 1972

Grade Level	Mean Difference (post-pre)	N	t*
2	1.21	66	15.34
3	.95	47	16.30
4	1.06	70	15.68
5	.66	66	11.14
6	.96	68	19.57

*P .01

Test dates: October, 1971, May, 1972

were used as a baseline against which project accomplishments and measured.

What were the indicated strengths and weaknesses of the program?

Table 2 represents comparative data of Fall baseline group performance and project students' Fall 1972 mean performance on the California Achievement test. The scores indicate a general reversal of declining performance trends which were apparent in the baseline data.

Another comparison involves student performance on pre and post-tests during the project year. Table 3 indicates the gains made by the project students during a seven month period of time between Fall, 1971 and Spring, 1972.

While the average amount of gain in mastery differed from group to group, a statistically significant gain occurred at each grade level. The lowest levels of gain, while still statistically significant, occurred at the fifth grade level. Project staff members therefore felt that this finding, coupled with results of PMU performance data, indicated a need for strengthening the program at the fifth grade level.

Useful Information

Where can the program be obtained?

Information about the program can be obtained from:
Josephine County School District
Manzanita Elementary School
"A Systems Approach to Individualized Instruction"
310 San Francisco Street
Grants Pass, Oregon 97526

What systems in New Jersey are familiar with the program?

There is no indication that any school district in New Jersey is utilizing the program.

References

Manzanita Project Final Evaluation Report
Mark Greene and Judy Rece, Supplementary Evaluation Report: Audit and Evaluation Section Northwest Regional Educational Laboratory.

Utah System Approach To Individualized Learning

Salt Lake City, Utah

Summary

The U-Sail Math Project, Utah System Approach to Individualized Learning, has been an eight-district consortium effort in Utah to establish a K-12 individualized learning system. Presently, the focus has been on development at the K-6 levels. The system consists of teacher-managed, self instruction curriculum products for individualizing instruction in a diagnostic prescriptive framework, an instructional management information system, and in-service administrator and staff development programs.

Nature of the Program

For whom is the program designed?

Instructional and staff development materials have been designed to aid in the establishment of individualized instruction for children at the K-6 levels.

On what rationale is the program designed?

The project began on the premise that, within the framework of the regular classroom, it is possible to individualize instruction.

The motivation behind the program is an effort to create a reasonably low-cost program of individualization which could be implemented in varying kinds of school buildings and with different staffing patterns.

What are the general goals and objectives of the program?

The basic goal of the U-Sail Math Program is to create a humanitarian form of education, tailored to the needs of children in an individualized environment. The program also aims to reflect the range of individual dilferences among professional staff members. Other objectives involve the implementation of diagnostic-prescriptive procedures and classroom management techniques, the resourceful use of human and material resources, and the wise acquisition of additional program supports.

Organization and Materials

How is the program organized?

The essence of the U-Sail math program evolves from the philosophy of concept mastery. The program consists of seventeen broad concept areas which have been subdivided into eight-six specific concepts. These are arranged in a scope and sequence which builds from the simple to the more complex aspects of the concept area. The eighty-six specific concepts have been transformed into 134 learning pacs (lexes) for teachers and students with pre and post-tests available for each concept.

What specific objectives are involved?

The specific objectives of the program involve teaching for concept mastery through individual assessment and learning tasks appropriate to each child's needs. The systematic approach seeks to enable teachers to manage the total group while effectively teaching individual children within the group.

How much student time is devoted to the program?

A student involved in U-SAIL has several alternatives for using his time and energy during the school day. He might be involved in large-group instruction, small-group instruction, one-to-one instruction with an adult, one-to-one instruction with a student, or individual work with worksheets, books, games or audio-visual materials. The organization emphasizes structure of time and space within an environment in which the student is given guidelines and boundaries for planning and carrying out his own decisions.

What materials are provided for the student?

Learner pacs written for student use consist of lexes designed to guide the learner as he works toward concept mastery. The lex format varies, but has the following elements: a list of materials, step by step instructions, and necessary worksheets. Examples of learner lexes are the following:

a. manipulative lexes designed to guide the learner toward concept mastery by using concrete objects
b. symbolic lexes designed to provide practice or drill in using the concept
c. Interest-centered lexes which capitalize on interest centers which may be learning stations or guided discovery centers

What materials are provided for the teacher?

Teacher pacs parallel each of the learner pacs. They detail the concept to be learned and the learner objective, identify the competency needed, specify the instructional and managerial procedures, and prescribe pages from standard textbooks. Pre and post assessment tests are also included. The teacher lexes are similar to suggested activities found in many textbooks, and provide for vocabulary, general concept review, structured practice using new ideas, and reinforcement activities. The program also provides the teacher with several assessment pacs designed for review of concepts taught at a lower level.

How open is the program to supplementary and teacher-made materials?

Although the program utilizes commercial and teacher-made materials, it also encourages a teacher to create materials or activities that will enrich or extend his students' study of a particular mathematical concept.

What student assessment materials are provided or suggested?

Pre and post-tests are provided with each teaching pac to assess student mastery of concepts. Assessment tests are also

available to measure retention of concepts taught at a lower level.

Classroom Activities

How are classes organized?

The program is not dependent upon a specific kind of organization and will function equally well in open space buildings or in self-contained classrooms. However, all elements of the environment must be flexible, and time, space, and materials are organized to provide for optimal utilization. The physical arrangement must allow students to work in large groups, small groups, or independently, and to be free to move around the room. Central cataloging of materials allows teachers to share all curriculum products. A simple retrieval system must be installed in order to quickly locate resources. Within each classroom, student materials should be organized into easy access areas.

How are the materials used?

The teacher administers pre-tests to assess a student's level of concept understanding. Based upon these results, a program of study is prescribed, utilizing the teacher and learner pacs which are coded for each concept. At this point a student may be recycled for review, or moved on to a new concept cycle.

Are teacher aides used?

Teacher aides may be used, but are not necessary.

How is student progress assessed?

Student progress is assessed through pre and post-tests which are provided with each teaching pac. Retention of concepts taught at a lower level is measured through periodic assessment tests.

Implementation Requirements and Provisions

Are special facilities needed?

Special facilities are not needed.

Is special equipment needed?

Special equipment is not needed.

Is in-service training needed or suggested?

Installation procedures which involve teachers and administrators in pre-school and in-service seminars are needed. The U-SAIL program requires skill in classroom management and methods for individualizing the classroom environment.

What provisions are made for the special training of teachers?

The system consists of an individualized staff development program which provides for phasing into the program on a step-by-step basis. The heart of the in-service mathematics program centers around the process of diagnosing individual learner needs and prescribing appropriate learning experiences.

What provision is made for training teacher aides?

No provision is made.

What is the cost of implementing the program?

The cost of implementation varies in terms of what is already available in a school. The project staff has identified an approximate of $6.00 per pupil for the basic K-6 program. This does not include capital outlay items which schools may or may not choose to purchase. The developers foresee an increased cost in the program for 1974, due to price increases for paper.

Program Development

How was the program developed?

Supported by ESEA, Title III, the U-SAIL project developed as an eight school district consortium effort in the state of Utah to create a K-12 individualized learning system. The districts which represented approximately seventy percent of the children in the state were Davis, Granite, Iron, Jordan, Murray, Provo, Salt Lake, and Tooele School Districts. During March of 1973, a U.S. Office of Education special audit identified U-SAIL as a validated project of exemplary nature.

What is the status of the present program?

The mathematics program is operational in 24 elementary schools in 11 districts in the State of Utah, and in 12 elementary schools in 8 districts in Arizona. The consortium of districts are presently planning continued development and refinement at the K-6 levels and development on a K-12 basis.

Program Evaluation

How has the program been evaluated?

During 1973, the U-SAIL project staff monitored student performance in sixteen Utah elementary schools, eight experimental and eight control. Random samples of students were drawn at each grade level in participating schools resulting in a total experimental N of 526 and a control N of 556. Measurement techniques included the use of the Stanford Achievement Test administered to grades 1-6, as well as indices of affective outcomes in a project constructed measure, the Student Attitude and Activity Survey (SAAS).

What were the indicated strengths and weaknesses of the program?

Analysis of the achievement test resulted showed that the U-SAIL experimental students continued to perform as well as or better than the controls at most grade levels on the Stanford Achievement Tests. When the achievement results were analyzed in terms of the experimental students demonstrated higher mean grade scores on seven out of ten Stanford scales at grade 4, eight out of nine scales at grade 5, and seven out of nine scales at grade 6.

SAAS results revealed consistent differences favoring experimental students on scales measuring affective outcomes and various aspects of program implementation. The survey results suggested that U-SAIL students felt better about themselves, were more independent and responsible, and enjoyed school and math more than the control students.

Useful Information

Where can the program be obtained?

Individuals interested in obtaining further information about this program should contact:

Carma M. Hales
c/o Utah System Approach to Individualized Learning
1421 South 2200 East
Salt Lake City, Utah 84108
Telephone: (801) 487-1344

What school districts in New Jersey are familiar with the program?

None have been identified.

References

Descriptive information provided by the project staff.