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RECENT TRENDS AND PRACTICES IN INDIVIDUALIZED
ARITHMETIC INSTRUCTION

by 6791

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TABLE OF CONTENTS

	Page
INTRODUCTION	1
STATEMENT OF THE PROBLEM	4
LIMITATIONS OF THE STUDY	5
DEFINITION OF TERMS	5
REVIEW OF THE LITERATURE	5
DESCRIPTION OF INDIVIDUALIZED PROGRAMS	5
SUMMARY OF THE RESEARCH	14
A SELF-PACED MATH PROGRAM SET UP AS A FIRST STEP TOWARD INDIVIDUALIZING INSTRUCTION	21
INTRODUCTION	21
OBJECTIVES	21
ORGANIZATION OF THE PROGRAM	21
CLASSROOM ORGANIZATION	23
STUDENT ATTITUDES	23
STUDENT PROGRESS	25
SUMMARY AND CONCLUSIONS	26
BIBLIOGRAPHY	29

INTRODUCTION

For many years teachers have talked about the individual differences of their students. Various methods have been tried to provide for these differences; some have produced a degree of success. The problem is one that should be high on the priority list of every educator, for until it is solved quality education for all students can be only a dream of the future.

Historically, the method of instruction used in American schools before 1850 was one of individual progress. At that time few people could go to school, and those who could were not always able to attend regularly. Each student progressed page by page through his text in each subject and at the end of the term the teacher recorded his progress. The next term he started at the terminal point of the previous term.¹

Since the mid-1800's American school procedures have followed two general theories: (1) the Grade-Standard Theory, and (2) the Continuous Pupil Progress Theory. In the former, schools are organized by grade levels and students are placed in certain grades according to age and academic achievement. As it became feasible for more people to attend school, the organization of students into "grades" provided a way to accommodate the ever increasing numbers. This system led to such practices as graded texts, whole-class methods of instruction, common achievement standards, competitive evaluation, and non-promotion. The second theory, that of Continuous Pupil Progress, has influenced

¹Henry J. Otto and Dwaine M. Estes, "Accelerated and Retarded Progress," Encyclopedia of Educational Research, ed. Chester W. Harris (3rd ed.; Macmillan Co., 1960), pp. 4-11.

many of our recent practices in education. This theory has been the basis for the development of such practices as the non-graded school, individualization of instruction, varied media to meet the requirements of individual differences and independent study, non-graded curricula, and changes in marking and reporting practices which show concern for the individual.²

Edwin A. Read, Assistant Dean of the Graduate School of Education at the University of Utah, has stated that:

"The theory of continuous pupil progress is evolving, shaped and strengthened by research findings, experimental projects, and the changing educational philosophy of our times.

The fundamental assumption of this theory is that the function of the school is to promote and facilitate the optimum growth and development of each child in relation to his own potential and growth timetable and in relation to the goals of American education.

This assumption is in harmony with the dominant philosophy of American education, with our determination to provide equal educational opportunity for all, and with research findings about individual variability. It is, however, in sharp contrast to the Grade-Standard Theory of pupil progress which perceives the function of the school as that of teaching a body of essential knowledge which can be parceled out according to some kind of sequence and dispensed in accordance with a predetermined timetable to all children. One finds it difficult to believe that this century-old assumption still reigns supreme in many graded schools operating for children in this space-age generation."³

A nationwide study, conducted through the U. S. Office of Education and still in progress, is surveying the ways in which educators are attempting to meet the needs of students through individualized instruction. Although there are many variations in procedure,

²E. A. Read, "Educational Practice and the Theory of Continuous Pupil Progress," Audiovisual Instruction, February 1970, pp. 38-40.

³Ibid.

they have one thing in common: the traditional method of having all students taught the same skill or concept in the same way is being changed to a method where pupils are working at a self-determined pace toward self-determined goals, and sometimes on self-determined subjects. Following is a list and short description of a few of many individualized instructional programs.

The Continuous Progress Plan (CPP)--provides for the uninterrupted development of each child without restrictions as to materials or methods of instruction.

Contracts, UNIPAC's, Learning Activity Packages (LAP's), Performance Criteria Units, Teaching-Learning Units (TLU's) and various other names--usually consist of packages of materials that meet one or more specific objectives, including sample test items or equivalents that suggest the way the student is to be measured, and a list of materials that will aid the student in reaching the objective.

Project PLAN (Program for Learning in Accordance with Needs)--the American Institute for Research in Palo Alto, California through this project is developing and testing TLU's for many subject areas.

Individually Prescribed Instruction (IPI)--a program of the Learning Research and Development Center at the University of Pittsburgh and the Regional Educational Laboratory in Philadelphia, called Research for Better Schools, Inc.--have developed materials for elementary mathematics and language arts. IPI contains carefully sequenced objectives, materials which permit pupils to plan and proceed independently, provisions for diagnosing and monitoring progress, written prescriptions for each learner, continuing teacher diagnosis, and frequent regular feedback to learners.

Duluth (Minnesota) Public Schools--employ student contracts but emphasis is on the learner's planning his own program of studies and evaluating his own achievement.⁴

Edling, in referring to individualized plans such as those mentioned previously and others, stated:

"The effects of these efforts are impressive, not necessarily in terms of performance on standardized tests (although gains here are sometimes rather startling) but rather in terms of change in the behavior of learners and teachers. There is an almost unanimous report of renewed interest in school and educational activities. Traditional disciplinary problems have virtually disappeared. There is a major reduction in truancy and drop-out, and attendance is improved, i.e., less 'illness,' 'travel,' and other reasons for absenteeism. An increasing number of high scores are appearing on specific achievement measures. Teachers report working harder than before, but they are more satisfied because they feel they are doing more for their students."⁵

Although at present only the early adopters have accepted the method of individualized instruction, and although we may see changes in current practices as other techniques are developed and tested, the trend is apparently toward individualized instruction.

STATEMENT OF THE PROBLEM

The purposes of the study were: (1) to review the trends and practices of individualization in arithmetic, especially in the intermediate grades through (a) the literature describing individualized programs and (b) literature describing the research being done in this area; and (2) to evaluate a self-paced program set up in three

⁴Jack V. Edling, "Individualized Instruction: The Way It Is--1970," Audiovisual Instruction, February 1970, pp. 13-16.

⁵Ibid.

fifth grade rooms as a first step toward individualization of instruction.

LIMITATIONS OF THE STUDY

This study was limited to a review of various methods being used to individualize arithmetic at the intermediate grade level. The information in this report was based on library research and the experience of developing a self-paced program in arithmetic at fifth grade level.

DEFINITION OF TERMS

Individualized Instruction. An instructional method in which the student is given learning tasks geared to his interests and level of achievement. He may or may not proceed at his own pace.

Self-paced. The student sets his own rate of progression through the material to be learned, proceeding only after he has mastered the previous task.

REVIEW OF THE LITERATURE

DESCRIPTION OF INDIVIDUALIZED PROGRAMS

In looking at individualized instruction in the specific field of arithmetic, let's consider the opinions of some who have described their experience in this field. Why is it important to individualize instruction? What are some of the programs teachers have tried in the classroom? What do they consider to be the strengths and weaknesses of individualized arithmetic?

Gibb, in an article written for the Golden Jubilee Anniversary of the National Council of Teachers of Mathematics, stated:

"Let us assume that individualized instruction provides ways to teach a group of students so that each pupil can take what is for him the "next step" in his development of mathematical understandings and competencies at the time when he is ready to move ahead. Individualizing instruction requires developing ways to motivate him to think creatively in formulating his mathematical concepts and knowledge of mathematics."⁶

This is an awesome challenge for teachers. The importance of accepting the challenge is pointed out by Gagné in discussing modern concepts of learning. When asked, "if repetition or practice is not the major factor in learning, what is?" his reply was:

"The answer I am inclined to give is that the most dependable condition for the insurance of learning is the prior learning of prerequisite capabilities. Some people would call these 'specific readinnesses' for learning; others would call them 'enabling conditions.' If one wants to insure that a student can learn some specific new activity, the very best guarantee is to be sure he has previously learned the prerequisite capabilities. When this in fact has been accomplished, it seems to me quite likely that he will learn the new skill without repetition."⁷

Experienced teachers are aware of the wide range of ability found in any classroom. In an upper grade classroom, a 3 to 6 year range in arithmetic ability and achievement is not uncommon. The average student in such a room will probably move through the course mastering the material step by step and will learn the rules and skills with varying degrees of success. The below average student will find it difficult to keep up and unless his more capable classmates are

⁶E. Glenadine Gibb, "Through the Years: Individualizing Instruction in Mathematics," The Arithmetic Teacher, May 1970, pp. 396-402.

⁷Robert M. Gagné, "Some New Views of Learning and Instruction," Phi Delta Kappan, May 1970, pp. 468-472.

"held back" until he understands the concepts, the achievement gap will grow wider each year. As this kind of child faces the continual frustration he must face in a situation where he does not have the background and skills necessary for success, he may quit trying. The above average child, who learns the basic skills and uses them accurately in much less time than his average or slow classmates, may become bored because the pace is too slow. A situation in which a child receives no challenge can be as frustrating to him as is the situation of the child who cannot understand the work being done. Those students at both ends of the scale who have totally different learning rates suffer the most when they are kept in a single-ability grouping system. This type system pushes (or pulls) all children toward the average ability level. As a result, many of our children are receiving a mediocre arithmetic education in elementary school.⁸

Teachers have tried many ways of individualizing instruction in an attempt to alleviate the problems created by individual differences. True individualization of instruction requires that much of the instruction provided for the learner be on an individual basis. This must take place within a given group of children and cannot be accomplished by restructuring the groups. Basically, individualization is not a problem that can be solved by an administrative rearrangement.⁹

An article written by Caroline C. Potamkin describes an individualized program tried by the author in her classroom. The program

⁸Walter L. Whitaker, "Why Not Individualize Arithmetic," The Arithmetic Teacher, Vol. 7 (December, 1960), pp. 400-403.

⁹Gerald C. Ubben, "A Look at Nongradedness and Self-Paced Learning," Audiovisual Instruction, February 1970, pp. 31-33.

was set up so that each child could go on to the next assignment as soon as he had correctly completed the previous one. Lists of assignments were dittoed and one provided to each student. Answer sheets were made so the students could check their own papers. No answer sheets were prepared for tests; the teacher checked these. Tests were graded and returned quickly. Students were then either permitted to go on to the next step or were given instructions for review. A student who was ready for a new concept was taught individually or, if several were ready at the same time, in a small group.

The author, in replying to questions about cheating, indicated that it was not a problem. She felt that the atmosphere was not conducive to cheating because there was no stigma attached to asking for help or for working more slowly than someone else. Another deterrent was the test that was always coming along and in which basic failures in comprehension were inevitably discovered.

The positive reactions of the class indicated the success of the program. They showed increased interest in arithmetic and began using spare time to work on it. They acquired independent work habits and a sense of responsibility that carried over to other subjects.¹⁰

Whitaker described a program he used with a sixth-grade class in Washington School, Culver City, California. Each child was taught at his level of achievement regardless of ability. He was placed at a point where he could experience success and make progress. The student met with the teacher to determine assignments. After he had completed

¹⁰Caroline C. Potamkin, "An Experiment in Individualized Arithmetic," Elementary School Journal, Vol. 64 (December, 1963), pp. 155-162.

and checked the work, he wrote a description of any error he had made. Next he conferred with the teacher for an explanation of any part of the assignment he did not understand. If at any time during the work he needed help, he could ask for it. A check list of skills was maintained for each student to avoid overlooking a skill. This program was based on having a wide range of textbooks and materials in the classroom. The assignments were moved from text to text in order to use the best ideas from each book.

The author felt the results in terms of the children's attitude and class control were gratifying. The slow learner was relaxed and learned more easily because he was not compelled to meet the standards of the group. The average student could learn as much above the basic skills as he was capable of learning. The above average child had the opportunity to extend his knowledge in any area of interest and was not held to the pace of the others in the class.¹¹

The individualized arithmetic program carried out by fifth and sixth grade teachers in Kilby School, the campus laboratory school at Florence State College, Florence, Alabama was described by William Graham, director of the school. To start the fifth grade program, the teachers determined (by testing) what skills each student had mastered. If several needed the same help, they were taught in a small group. When they had mastered these skills and were ready to go on they were given assignment sheets. If, after completing the work and checking it, the pupil showed evidence that he understood the work, he was given a new lesson. The sequence was planned carefully. Work material was

¹¹Whitaker, loc. cit.

kept where each student could get the specific items he needed. If several students were working on the same thing, they were encouraged to work together. The completed units were checked, corrected, and filed in individual files. Tests were given and these were corrected by the teacher.

The sixth grade program was much the same, except students who had mastered the fundamental processes used them to solve problems in area, volume, made charts and graphs, planned trips, and solved a variety of written problems. Tests given every two weeks reviewed the fundamental processes and determined the needs and future assignments of each individual.

The teachers felt the most evident outcome was increased interest in mathematics, greater independence, and a wider range of growth. The classes were more heterogeneous at the end of the year. Dependent children were watched carefully to see that they did not become confused. They tended to group themselves together and the teacher worked with them in small group sessions. These teachers also reported that children elected to do arithmetic during free-time periods.¹²

The IPI (Individually Prescribed Instruction) program administered by Research for Better Schools, Inc., a regional research laboratory funded under Title IV of the Elementary and Secondary Education Act of 1965, was used in 97 schools during 1968-1969. RBS planned to add 86 more schools for 1969-1970. Richland Elementary School, a demonstration

¹²William A. Graham, "Individualized Teaching of Fifth- and Sixth-Grade Arithmetic," The Arithmetic Teacher, Vol. 9 (April, 1964), pp. 233-234.

school, in Quakertown, Pennsylvania illustrates how an IPI program operates.

IPI classes at Richland are ungraded. Placement tests help to determine pupil groupings. Although the child is a part of a group, emphasis is on the pupil working on his own. At times when it seems advisable some group instruction is given. This occurs more frequently at the primary grade level when children are at about the same level of development. As individual differences become greater, work and assignments are prescribed for each student. After studying and completing the assignments for a particular step, each student is tested. If he fails to score 85% or better, equivalent assignments are given or tutoring is done in the deficient area until he is able to raise his score to the required level. It is necessary to have ample and diverse resources available to the teacher for use in prescribing suitable work for the pupil.

School board, principal, staff, and pupils at Richland agree that the system has improved instruction and made it more interesting. Fourth grade pupils, when asked to indicate which they preferred (the traditional method or IPI) unanimously voted in favor of IPI. No thorough test results are yet available for the RBS-directed program; however, lab officials feel confident that the program will be proved successful.¹³

Proponents of the system of individualizing instruction point out many advantages. A quite complete list of these is found in an article by Noddings. She includes the following: (1) students and

¹³K. G. Gehret, "Richland's Teachers Prescribe Instruction the Way Doctors Prescribe Pills; Individually Prescribed Instruction," The American School Board Journal, August, 1969, pp. 24-25+.

teachers work together in a common goal—the individual student's growth; (2) fear of tests is largely eliminated; (3) the brightest, most ambitious students complete more work than they might in a conventional classroom; (4) the slowest students learn something and achieve a sense of satisfaction; (5) we no longer have the effect of cumulative ignorance because a student does not undertake work for which he is not prepared; (6) failures have almost disappeared; (7) students learn how to study, how to pace themselves, and how to evaluate their own strengths and weaknesses."¹⁴

Gurau indicated absences had ceased to be a problem since it was possible for the student to continue his work at home and he never missed a vital lecture. Short teacher absences were less of a problem since each student could continue with his work. Another advantage listed was improved class discipline.¹⁵

Zeitz included the advantage of increasing student self-confidence. A situation in which the learner experiences success gives him more confidence in attacking the next level.¹⁶

While most of the teachers and administrators found many advantages, some criticisms of the system were also listed.

Ubben felt an extremely heavy requirement was placed on the quality of materials used. He also pointed out the lack of materials

¹⁴Nellie L. Noddings, "Providing for Individual Rates of Learning in Mathematics," Mathematics Teacher, November, 1969, pp. 543-545.

¹⁵Peter K. Gurau, "Individualizing Mathematics Instruction," School, Science, and Mathematics, Vol. 67 (January, 1967), pp. 11-26.

¹⁶F. Zeitz, "Individualized Curriculum," School and Community, November, 1969, p. 46+.

available, and thus the requirement for schools to develop their own materials.¹⁷

The criticisms of the IPI program listed by Gehret were: (1) Prescription writing requires too much time during the teacher's work-day. (2) Individual attention in an average size IPI class (25 pupils) takes too much teacher time. (3) Costs put IPI out of reach for the typical elementary school district.¹⁸

A limitation suggested by Flournoy and Otto was that research evidence is too meager to tell us how much and in what direction individualized instruction affects motivation and ultimate achievement.¹⁹

Those who listed criticisms seemed to feel that the program was worthwhile, but that there are flaws to be corrected—certain aspects that make the program impractical at this time, and evaluations that we simply must wait for research to verify or determine.

The programs described seem typical of most individualized programs. They may differ in the procedure used to progress from one step to the next. They may use varied materials and techniques such as programmed texts, learning packages, contracts, phases of instruction, teaching machines, team teaching, media center, and many more. However, all have one thing in common: they are striving to provide equal educational opportunity for all children regardless of individual differences.

¹⁷Ubben, loc. cit.

¹⁸Gehret, loc. cit.

¹⁹Frances Flournoy and Henry J. Otto, "Types of Class Organization for Meeting Individual Needs," Improving Mathematics Programs: Trends and Issues in the Elementary School. M. Vere DeVault (ed.) Columbus, Ohio: Charles E. Merrill Books, 1961.

They attempt to do this by placing the child at his level of achievement and allowing him to progress to the more complex at his own pace, thus building a solid foundation and, at the same time, providing a sense of accomplishment.

SUMMARY OF THE RESEARCH

A series of five studies concerned with the use of programmed instruction in the classroom was conducted by Robert Glaser and others at the University of Pittsburgh Learning and Research Development Center, Pittsburgh, Pennsylvania. The studies, carried out in third, fourth, and fifth grades, evaluated individualized procedures in the teaching of spelling and various arithmetic topics. A sixth study was made at fifth-grade level in which programmed materials were used to individualize the review of fourth-grade material before beginning fifth-grade work.

More than fifty teachers and 2,000 pupils participated in these studies, not all of which are reported here. However, all of the studies were similar in design and procedure. Groups of students received individualized programmed instruction as part of their work. They were matched with control groups on such variables as IQ and academic achievement. A battery of tests was selected for each grade level and administered as pre- and post-tests in order to compare control and experimental achievement.

These studies indicate that programmed materials appear to be an effective means of providing individualized instruction. In all of the studies the experimental groups were able to cover considerably more material than the control groups who received conventional instruction. The achievement level of the experimental groups was in most cases equal to or above the achievement level of the control groups. The various levels of achievement and the different rates of progress through the

materials seem to indicate the need for development of instructional practices which provide for these differences and for adapting the instructional program to the needs of the student.²⁰

A study of an IPI program in mathematics and reading achievement was made in Urbana, Illinois. One group of 200 pupils was given IPI math and reading programs. The experimental group was paired with a control group consisting of 200 children enrolled in Urbana's regular ungraded primary program. At the end of the test period (which lasted one school year, 1966-1967) the pupils were given the California Achievement Test.

IPI students at almost all IQ levels scored better on the test than non-IPI students. In a few instances IPI students scored lower.

Although IPI officials at Urbana are personally convinced that use of IPI programs will result in greater student achievement, they are reluctant to make definite statements until they have more evidence. In fact they warn that IPI pupils may not compare favorably on standardized tests with students who have been exposed to more skills. IPI students do not proceed to new skills until they have mastered (85% achieved on tests) the previous skill.

Other outcomes which IPI officials feel may be more significant than improved skills are improved attitude, self-motivation, and independence.²¹

²⁰ Robert Glaser, and others, Studies of the Use of Programmed Instruction in the Classroom (University of Pittsburgh, Learning Research and Development Center, Pennsylvania, ERIC--ED 010 208, May, 1966), 194 pp.

²¹ George W. Neill, and others, Individually Prescribed Instruction (Education U.S.A. Special Report #8, National School Public Relations Association, Washington, D.C., ERIC--ED 031 815, 1968), 68 pp.

The purpose of a study designed by Lewy was to measure the effect of individually prescribed instruction on the cognitive achievement of fourth and fifth graders. The sample was composed of fourth and fifth grade students from four schools. Two schools served as a control group and two others as an experimental group. All students in fourth and fifth grades in the control schools were included in the control groups. The experimental group included only those students in fourth and fifth grades who had completed two years of IPI instruction. The control group had 198 students, the experimental group 141. The schools were matched on geographic and socioeconomic factors.

Several tests were administered to each participant. Data analyses divided students into grades, sex, schools and IQ levels. No significant differences between groups was established. This indicated that IPI and non-IPI students achieve equally well in the areas tested.²²

A study of self-initiation was conducted by Scanlon at Oakleaf Elementary School, Baldwin-Whitehall School District in Pennsylvania. The district as a whole tends to be upper middle class. Oakleaf Elementary School is in a somewhat lower socioeconomic area than the district as a whole and could be considered lower middle class.

The study included 28 fifth graders and 22 sixth graders. Student behavior was observed during math, science, and social studies. The experimenter categorized the source of initiated behavior: from the teacher, from another pupil, or from the student himself. Only math classes received treatments during the study. The purpose of the treatments was to increase self-initiation. Treatment one consisted of having

²²Rafael A. Lewy, Individually Prescribed Instruction and Academic Achievement: A Report on an Experimental Project. (Illinois Department of Program Development for Gifted Children, ERIC—ED 033 082, March, 1969), 157 pp.

student volunteers help organize a math materials center. Treatment two permitted students to explore areas of math that interested them and treatment three provided special reinforcement or rewards.

Three measuring instruments were developed and used for this study: (1) an instrument to categorize the source of initiation; (2) an instrument to measure student interest in the three subjects; (3) an instrument to measure peer ratings of the extra work each student contributed to his class. Student interviews were also used to collect data.

The following conclusions were drawn: (1) individualized instruction seems to be more self-initiated than non-individualized; (2) the amount of self-initiation can be increased by the use of specific techniques; (3) self-initiation has little relationship to intelligence, achievement, or sex of students; (4) expressed interest in math did not change during the four months of the study; (5) the treatments had no measurable effect on expressed interest; (6) the procedures used to encourage self-initiation in math had little carry-over to science and social studies; (7) pupils expressed a desire to continue some of the treatments.²³

Bartel conducted a study to determine the feasibility of building a mathematics program including both new math and individualized instruction. A review of the literature established the need for incorporating a multiple text library and enrichment materials with the individualized program.

²³Robert G. Scanlon, Factors Associated with a Program for Encouraging Self-initiated Activities by Fifth and Sixth Grade Students in a Selected Elementary School Emphasizing Individualized Instruction. (University of Pittsburgh, School of Education, Pittsburgh, Pennsylvania, ERIC—ED 015 785, 1966), 99 pp.