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ABSTRACT

A description and discussion of the design, development, implementation, evaluation and effects of the Individualized Early Learning Program (IELP) are presented in this paper. Implemented in Project Follow Through and other school settings, the IELP gives priority to teaching basic skills and concepts needed for school performance to children in preschool and the early elementary grades. Built into the program are features such as instructional tasks, diagnostic procedures, instruments for evaluating and monitoring student learning, recommendations for the physical design of the classroom, and a learning management system. Organized into four major sections, the paper provides an overview of the IELP, discusses the process of program development, describes the field research activities undertaken, and discusses the insights gained while developing and studying the program. Selected samples of objectives included in various prescriptive curricula are appended. (Author/RH)

INDIVIDUALIZED EARLY LEARNING PROGRAM (1)

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Abstract

The Individualized Early Learning Program is the product of an extensive Research and Development effort. In this paper, the authors describe and discuss the activities carried out in conjunction with the program's design and development, as well as field research and evaluation studies conducted when implementing the program. Insights into these program processes are also presented. The intended audience includes those interested in areas related to early learning, instructional design, educational psychology, and teacher education.

INDIVIDUALIZED EARLY LEARNING PROGRAM

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The Individualized Early Learning Program (IELP), developed at the Learning Research and Development Center (LRDC) of the University of Pittsburgh, is the product of a systematic plan of research and development based on a general concept of adapting instruction to individual differences in children. In the program, priority is given to teaching children in preschool and the early elementary grades the basic skills and concepts needed for school performance. However, the IELP embodies a much broader definition of curriculum than the traditional one of subject matter content, instructional objectives, and lesson sequence. Built into the program are additional features such as instructional tasks, diagnostic procedures, instruments for evaluating and monitoring student learning, recommendations for the physical design of the classroom, and a learning management system.

Research and development work related to the IELP was initially carried out in collaboration with two public schools in the Pittsburgh

area. One of the schools is located in a working-class neighborhood in a suburb south of Pittsburgh, and the other is located in an inner-city neighborhood near a housing project in the city of Pittsburgh. Subsequent field research was conducted in collaboration with seven school districts participating in the National Follow Through Program. A list of these sites and some of their characteristics is presented in Table 1. As the table indicates, these seven school districts are located in varied geographic and cultural settings ranging from an isolated Indian reservation in Belcourt, North Dakota to an inner-city community in Akron, Ohio.

The overall purpose of this paper is to describe the process of program development and field research that was carried out in order to document the implementation and effects of the IELP in school settings. Organized into four major sections, the paper: provides an overview of the Individualized Early Learning Program; discusses the process of program development; describes the field research activities undertaken; and discusses the insights gained while developing and studying the program. All three authors have been actively involved in various stages of the program's R&D work, and each has contributed her unique perspective. Wang, as a developer, focused her work on program design, initial field testing, and documentation of program effects. Leinhardt, a researcher with an interest in field studies, conducted field research related to program implementation in the seven Follow Through sites. Boston, as an implementor, directed the implementation of the IELP in collaboration with the LRDC-affiliated Follow Through school sites.

Table 1

Characteristics of LRDC Follow Through Sites

Sites	Characteristics	Year of entry into LRDC Follow Through
Akron, Ohio	Large mid-west inner city school district with two FT schools in the Black community	1970-71
Belcourt, North Dakota	Small northern isolated Indian Reservation with the FT program in both Native American community schools.	1971-72
Keystone Central, Pennsylvania	Large eastern county school district serving this small-town semi-rural white community with the FT program in seven scattered schools.	1969-70
Montevideo, Minnesota	Small mid-west white town-farm area with all three schools in the district having the FT program.	1969-70
Randolph Co., West Virginia	Large Appalachian county school district with three FT schools in a rural-valley white community.	1968-69
Texarkana, Arkansas	Medium-sized southern city school district with FT in two of the mixed population urban schools.	1971-72
Waterloo, Iowa	Medium-sized southern city school district with three FT schools in the mixed population community.	1971-72

Overview of the Program

Most of the innovative early childhood education programs developed in the 1960's were designed with the specific intention of preparing socioeconomically disadvantaged children for school learning. While this concern was shared by the developers of the IELP, the program is based on the philosophy that there are universal characteristics of development shared by all children regardless of socioeconomic or cultural differences. The belief is that children differ as individuals, not as groups. The differences in individuals within socioeconomic or cultural groups are as great, if not greater, than the differences that exist across these subgroups. The IELP prescribes learning environments that adapt to the learning needs of the child and that include opportunities to optimize cognitive and social growth for every child.

The Individualized Early Learning Program is the product of an eclectic set of influences, derived from theories and research related to child development and learning as well as from selected aspects of instructional technology and practice. The framework that guided formulation of the program philosophy and selection of the program content represents an integration of concepts including: (a) the cognitive-developmental theory of Piaget (1963); (b) learning theory in the tradition of Skinner (1971); and (c) knowledge and practical experiences gained from the research, development, and implementation of educational programs that are adaptive to individual differences in children, as well as from observations and work with teachers and children in school settings (Glaser, 1971).

The program design was greatly influenced by the concept that certain abilities appear earlier than others and serve as the foundation upon which more complex abilities are built. The design of the IELP was also heavily influenced by the notion that it is possible to accelerate certain aspects of the child's development by focusing on the acquisition of specific prerequisite skills. It is assumed that, once the developmental tasks are identified, a child's development can be influenced in specific ways. The identification and the design of learning tasks for the IELP was based, to a great degree, on: (a) approaches and techniques related to the positive modification of children's learning; (b) techniques for the manipulation of the learning environment; and (c) instructional strategies that are effective in meeting the individual needs of the students in order to support and reinforce the attainment of the program's objectives. In this regard, the earliest formal statements by Resnick (1967) concerning the ongoing development of the Individualized Early Learning Program reflect the need for facility in the use of technical innovations in programmed instruction and task analysis, as well as a concern with the feasibility of applying new techniques to the program's content.

The concept that the acquisition of knowledge comes about through a variety of learning experiences and that it proceeds at different rates throughout the stages of the child's development also played a central role in shaping the program design of the IELP. The preschool child, as described by Piaget, "...is not satisfied with speaking; he must needs 'play out' what he thinks and symbolize his ideas by means

of gestures or objects, and represent things by imitation, drawing and construction" (1963, p. 159). Furthermore, the rate of development may vary among children, as well as among different aspects of development for a particular child. Therefore, simultaneous growth on all fronts may not occur. An individual child's rate of growth may be more rapid in certain areas than in others.

It is important to note that the purpose here is to provide a broad overview of the theoretical and pedagogical considerations underlying the development of the IELP. It is not the authors' desire, nor is it feasible by design, to pinpoint which of these principles are direct derivatives of certain specific theoretical or pedagogical influences. The theoretical and pedagogical influences considered were interrelated by nature; the principles derived represent the results of the integration of all those influences. The following is a summary of the principles that influenced the design of the IELP.

1. Children differ as individuals. They differ in learning rates, learning experiences, and entering competencies. Learning experiences should be built upon the child's strengths, past learning, and current abilities.

2. Children acquire knowledge and develop skills in many ways. In order to adapt instruction to the individual differences

in children, an effective program should include a variety of materials and learning experiences as well as opportunities to use and manipulate materials independently.

3. Children learn through actions. They learn partly through their own spontaneous activities and interactions with others and with the environment, and partly through the materials and interactions adults set up for them. Careful consideration should be given to the creation of classroom learning environments which permit each child to experiment and evaluate what happens. Opportunities should be provided for children to manipulate objects, situations, and symbols; to pose questions and seek answers; to make choices; to participate in making learning plans; to take some responsibility for making learning decisions and carrying out the learning plans; and above all, to learn from their mistakes and successes.

4. Children should experience success in school learning. The use of positive reinforcement is a powerful intervention strategy. Momentary difficulties in learning should not be viewed as the child's failure. They should be viewed as instructional design problems that the teacher and the program developer must overcome.

5. Children in the preschool and early elementary classrooms should be provided with opportunities to engage in spontaneous interactions with other children and adults. Early school learning environments provide a natural social context in which patterns of spontaneous interaction with peers and social skills are first established. Opportunities should be created to permit children to work and play together; to exchange information and ideas; to ask and give help; to resolve conflicts; to form and to resolve friendships; and to develop social skills and patterns of interaction with peers and other adults that are mutually adaptive and satisfying.

6. Children learn basic skills most effectively when learning experiences are organized sequentially. Learning experiences should be grouped hierarchically in small subsets with built-in checkpoints. The ability to perform more complex learning tasks is thus viewed as a reliable predictor of a student's mastery of simpler tasks, that is, those that are lower in the learning hierarchy.

7. A child's current competence level is the proper point at which to start instruction. To maximize the probability of success, mastery of each prerequisite subset of objectives should be required before proceeding to the next level.

8. The child's performance should be frequently evaluated, not only to make steady increments in learning possible but also to serve to reinforce the child's achievement on a regular basis. The development of diagnostic procedures and measures should be an integral part of the program design work. They are critical tools which enable the teacher to accurately diagnose the entering behaviors of the students, to monitor progress, and to evaluate learning outcomes.

The goal of the Individualized Early Learning Program is to create school learning environments in which children can effectively master basic academic subjects while becoming confident in their own ability to learn and to cope with their social and physical surroundings. The program was designed to foster the development of: (a) basic skills that allow the student to locate, learn, and retain new information; (b) skills that allow the student to extend and transfer information to situations for solving new problems; (c) motivational systems that maximize the student's situations; and (d) competencies that enable the student to gain increasing control over his or her own environment (Resnick, 1967; Wang & Siegel, 1975).

The Individualized Early Learning Program includes two basic sets of curricula. One is a set of highly structured prescriptive learning curricula aimed at teaching basic academic skills. The other is a set of exploratory learning curricula aimed at developing problem-solving and self-directed learning skills, as well as fostering personal and social growth.

The prescriptive learning curricula include several individualized curricula developed at LRDC: Individually Prescribed Instruction (IPI) Mathematics (Lindvall & Bolvin, 1966); IPI Reading (Beck & Bolvin, 1967); and the Primary Education Program (PEP), which consists of the Quantification Curriculum (Resnick, Wang, & Kaplan, 1970), the Classification and Communication Skills Curriculum (Wang, 1972), and the Perceptual Skills Curriculum (Rosner, 1972). Prescriptive learning activities are generally assigned by teachers on the basis of diagnostic test results and the teachers' informal observations of each student's performance. Appendix A provides selected samples of objectives included in the various prescriptive curricula.

The exploratory learning curricula include a variety of independent activities, centering around such interest areas as: creative writing; block construction; socio-dramatic play; music; creative arts; and exploration in math, science, and literature (Wang, 1973c). Exploratory learning activities are generally self-selected. However, sometimes they are jointly designed by students and teachers.

A unique feature of the IELP is the inclusion of a classroom management system, known as the Self-Schedule System (Wang, 1974). The Self-Schedule System was designed to serve as: (a) a classroom management support system to help teachers maximize their effectiveness in implementing the Individualized Early Learning Program, and (b) an intervention program to help students develop

competencies in taking increasing responsibility for planning and carrying out their learning in school settings. It is a system designed to facilitate the efficient use of teacher instructional time and, at the same time, maximize student learning.

During any given school day, children in classrooms where the IELP is implemented are responsible for completing all the tasks prescribed by the teacher and at least two exploratory activities of their own choice. Both the prescriptive and the exploratory learning activities are available throughout the day, and children move from one completed task to another in any order they choose and at any time. In addition to working on individual assignments, students participate in small group instruction, individual or group tutoring sessions, and other student- (and/or teacher-) planned or spontaneously developed group activities.

To provide the reader with a more concrete description of how the Individualized Early Learning Program operates in classroom settings, a description of a child's morning in such a setting is presented. A deliberate attempt has been made to focus the description on: (a) the nature of teacher-student interactions (for management, social, and instructional purposes); (b) the planned and the spontaneous interactions among students; and (c) the role of the teacher and students in planning and carrying out instructional and learning responsibilities under the program.

1. Lee arrives at 8:25 and greets the adults and individual

children as she gets ready to begin her learning activities for the day.

2. Lee goes to the prescription rack and takes out the prescription "ticket" with her name on it. She skims the ticket and looks around the room to see who is working on what, where. Lee selects one of the tasks specified on the ticket--reading--and moves to the area where the needed materials are stored.

3. Lee collects a pencil and her reading workbook and goes to a work table.

4. Lee opens the workbook to the page indicated and starts to work. (It is now about 8:45). After completing the first page, she raises her hand to indicate that she is finished and the teacher comes over to her. Lee asks the teacher if she is doing the work correctly. The teacher reads the page and responds, "Yes." The teacher briefly questions Lee on the content of the page, and discusses the rest of the work to be done. The teacher leaves and Lee continues to work.

5. At 9:00 the teacher announces that it is time to salute the flag. Lee puts down her work, stands up, and turns to face

the flag for the pledge of allegiance. The teacher then discusses the upcoming field trip and the students' weekend plans. After a few minutes of group discussion, the teacher tells the students to return to work and calls a reading group together. It is 9:15.

6. Lee returns to her reading work—reading paragraphs and answering questions. After completing five pages, Lee leans over to her neighbor, Sara, and asks her how much more work she has to do before she finishes her math assignment. Lee then comments that she is working in the measurement unit in math. After a few more exchanges, she returns to her reading.

7. At 9:40 the teacher calls Lee, Sara, Curtis, and Scott for a group story. Lee leaves her reading book, Sara leaves her math sheet, and they join the group.

8. At 10:05 the teacher finishes the reading lesson, and Lee puts away her story, goes to get a drink of water, and visits with Sara at the fountain.

9. At 10:10 Lee returns to her desk and continues her reading assignment. She finishes the last page and raises her hand.

While waiting for the teacher, she asks Sara which page she's working on in the reading workbook and discusses the possibility of working on a puppet show project later on in the morning. The teacher arrives and asks Lee to read some sight words, checks the pages she's been working on, and asks her what her plans are for the rest of her morning. Lee replies that she will do her math next and then will work with Sara and Scott to make a curtain for the puppet theater. The teacher asks if they are going to plan a puppet show as well. Lee says, "Yes, but tommorrow."

10. At 10:30 Lee puts away her reading material and gets out her math lesson. She gets the yardstick, the box of materials that are number- and letter-coded to match her lesson, and her work sheet. Lee has some trouble fitting everything on her work space, and the box falls off. This creates a certain amount of disruption and laughter in the classroom. Sara bends down and starts to put the chips and blocks up on the table. The aide comes over and helps Lee get things organized. The yardstick goes on the floor next to Lee's seat, the worksheet goes on the table, the chips and blocks get laid out next to the sheet, and the box gets placed on the rungs under the chair.

11. Lee starts working on her math. It is 10:40. She works very steadily without talking or raising her hand, as she wants to

finish quickly. At 11:10, Lee raises her hand. The teacher comes over to check off her work. Lee tells her she will finish the assignment after lunch, since she wants to go work on the puppet stage curtain. The teacher questions Lee about some of the completed math work and agrees to her plans. Lee puts away the box of materials and the yardstick but keeps the worksheet.

12. At 11:15 Lee and Sara go to the exploratory area. Scott selects the material for the curtain and Lee measures the front of the stage. The teacher comes over and talks to them about the project and ways to hang the curtain. Sara wants one that goes up and down, but the teacher thinks it will be hard enough to make one that pulls to the side. Lee brings the material and measures to the teacher to check on how the cloth should be cut. The teacher tells them that they need extra material if they want folds in the curtain. The teacher leaves.

13. Lee re-measures the stage for the curtain while Scott straightens the material on the floor, lining it up with the edges of the linoleum. Lee marks the cloth with chalk where it needs to be cut, and Sara starts to cut the material. The aide comes over to watch the procedure and she reminds the trio that the lunch period is in five minutes and they need to clean up. Lee, Scott, and Sara agree to continue their

project after lunch. They clean up and join the line for lunch.

The advantages of combining a structured approach to direct teaching of basic skills and a relatively open classroom learning environment are reflected in the brief description of how Lee spent her morning. In this type of environment, children are given opportunities to learn to make planning decisions and to take increasing responsibility for carrying out and completing their assigned and self-selected tasks with minimal teacher intervention.

Program Development

A systematic approach to program development and refinement was adopted in LRDC's work on the Individualized Early Learning Program. Figure 1 is a schematic representation of the iterative nature of the work involved in developing the IELP, and the categories of major development objectives and tasks. As indicated in the figure, program development begins with the development of program objectives. The various program components are then built in, based on these objectives. The development work is followed by evaluation research directed toward the refinement of the program and the documentation of program outcomes. The solid lines shown in Figure 1 indicate the sequential steps in the program development process and the dotted lines indicate the steps involved in program evaluation research.

The three circles shown in Figure 1 represent the three major components of the school learning environment: the curriculum, the

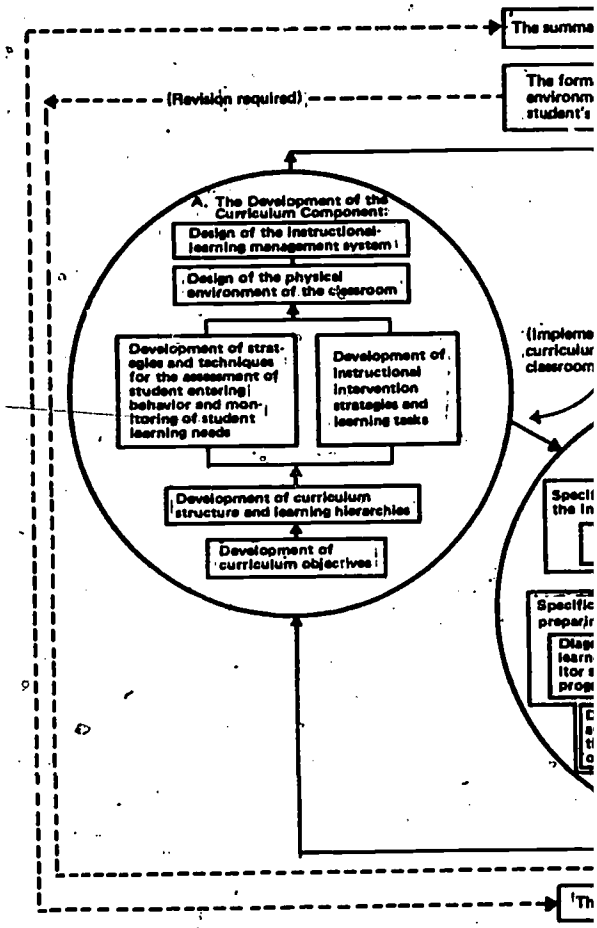
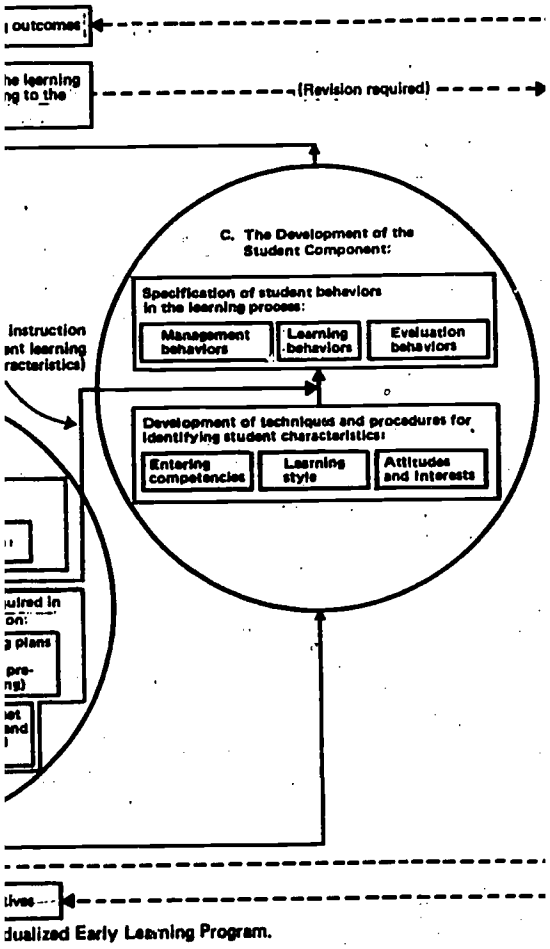


Figure 1. Sequential steps in t



dualized Early Learning Program.

teacher, and the student. The uniqueness of the approach lies in: (a) the particular tasks that have been identified for inclusion in each of the three major components of the learning environment, and (b) the consideration that has been given to the interrelationships among the three components. The tasks included in the design of each of the components are listed in the circle. The interrelationships among the three components and the iterative processes involved in designing and refining the program components are indicated by arrows between the circles.

The Curriculum

The curriculum defines the educational experiences and learning opportunities that are open to the individual student in working toward achievement of the program objectives. The work of curriculum development includes translating program goals into specific curriculum objectives, designing the substantive aspects of the learning environment (the learning tasks), and designing approaches and classroom processes (the teaching tasks) for insuring student mastery of the learning tasks.

Development of the various curricula included in the IELP generally followed the sequence outlined in the left-hand circle shown in Figure 1. These R&D tasks reflect a broadening of the definition of "curriculum". They include not only tasks traditionally associated with curriculum development (i.e., the specification of curriculum objectives and the development of learning hierarchies, learning tasks, and instructional intervention strategies), but also strategies

for monitoring student learning, guidelines for the design of the physical environment of the classroom, and instructional-learning management systems to support classroom implementation of the various curricula.

For the purposes of illustration, the sequential steps involved in the development of a beginning math curriculum, the Quantification Curriculum of the Individualized Early Learning Program, will be described below.

The development of curriculum objectives. The Quantification Curriculum was designed to teach basic number operations and concepts to children of preschool age through the early elementary grades. The design work began by identifying an extended set of specific competencies that would constitute the target behaviors for the program.

The initial set of objectives to be included in a given curriculum is generally identified through a series of repeated rational analyses. Those objectives selected are considered by program developers as representing the knowledge and skills critical to the acquisition of certain program goals. For example, in designing the Quantification Curriculum, the primary question when identifying the initial set of objectives was: "What are the skills and knowledge that a competent seven year old (second grader) would be expected to have in math in order to meet the demands placed upon him or her by the school, parents, and the immediate environment?" The results of this first series of analyses formed the basic set of

desired target behavioral objectives for the curriculum. Through this particular process of rational analysis, eight target behaviors were initially identified for inclusion in the Quantification Curriculum. They included: counting and one-to-one correspondence from 0-5 and 6-10, recognition of numerals 0-5 and 6-10, comparison of sets, seriation and ordinal positions, addition and subtraction of single digits, and addition and subtraction equations using single digits.

The development of curriculum structure and learning hierarchies. After the target behaviors were identified, analyses of these behaviors were conducted in order to develop learning hierarchies that would lead to acquisition of the specified behaviors. Briefly, the strategy is to develop hierarchies of learning objectives in such a way that mastery of objectives lower in the hierarchy (simpler tasks) facilitates learning of higher objectives (more complex tasks), and ability to perform higher level tasks reliably predicts ability to perform lower level tasks. This involves a process of task and behavior analysis similar to that proposed and elaborated by Gagne (1962, 1968). Detailed procedures of analysis have been presented in a paper by Resnick, Wang, and Kaplan (1970). This work includes: explicit descriptions of the tasks to be performed as the student acquires the target behaviors; the cognitive processes and the demands placed on the student in performing these tasks; and the knowledge and skills required (assumed to be present in the student's repertoire) to carry out the tasks.

Figure 2 represents the learning hierarchy which was developed, using such procedures of analysis, for Unit 1 of the Quantification

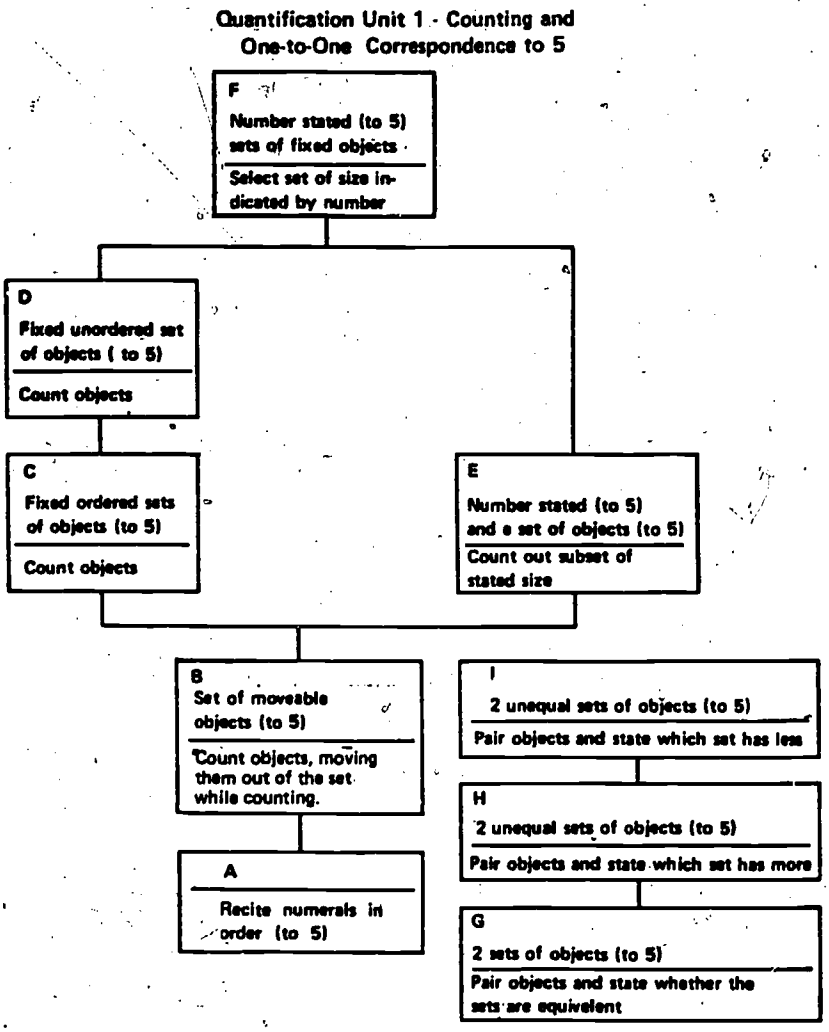


Figure 2. Learning hierarchy for Unit 1 of the Quantification Curriculum.

Note: From the *PEP Introductory Handbook*, M.C. Wang and L. Resnick, (Johnstown, PA: Mafex Associates, Inc., 1978), p. 40.

Curriculum. Each box in Figure 2 defines a learning objective and the accompanying learning task. The entry above the line describes the stimulus situation, while the entry below the line describes the response. Defining each task in this fashion assures that each box in the hierarchy will contain a behaviorally defined task, that is, one that can be tested by direct observation. The simpler behaviors appear at the bottom of the figure. The more complex behaviors appear toward the top. As shown in Figure 2, Objective B is considered a prerequisite to both Objectives C and E. Objective F is shown as having two prerequisites, Objectives D and E.

Empirical validation of the learning hierarchies was another important step in the process of program development. This aspect of our validation work was mainly concerned with the interdependencies of the behaviors included within each unit of instruction, as well as the hierarchical order between the units (Wang, 1973b; Wang, Resnick, & Boozer, 1971). Empirical evidence of the interdependencies of the behaviors was obtained through the use of tests designed to directly assess the presence and absence of each of the behaviors included in a given learning hierarchy. The test scores were then examined to determine their dependencies, that is, the extent to which passing a test on one of the learning objectives reliably predicted mastery of all objectives below it in the sequence.

The development of procedures for assessing and monitoring student progress. Effective assessment and monitoring procedures are considered vital to the successful implementation of an individualized instructional program. The use of diagnostic pretests and posttests

is integral to the instructional-learning process as the child progresses through a given curriculum. Diagnostic test results are used by teachers not only for prescribing specific learning activities for individual students in a given prescriptive curriculum, but also for communicating learning progress to students and parents.

Upon entering a new unit in a curriculum, diagnostic tests are generally given to assess student entry levels. Students are pretested initially on objective(s) appearing at the top of the unit hierarchy, that is, the criterion objectives included in each unit of instruction. This particular testing strategy was designed to take advantage of the hierarchical structure of the objectives included in a given unit of instruction. Since the assumption underlying the development of empirically validated learning hierarchies is that students who pass a test at the top of a hierarchy are capable of passing all lower level tests, only the top objectives of the learning hierarchies need to be tested to quickly assess a student's level of competence. Students who fail the top level tests in a given hierarchy can then be tested for the lower level objectives to determine specific instructional needs.

Figure 3 is a sample diagnostic test sheet for Unit 1 of the Quantification Curriculum, excerpted from a teacher's manual (Wang & Resnick, 1978). The test sheet includes a statement of the objective that the test was designed to assess, the testing situation, and the specific directions that the teacher is to use in administering the test. At the bottom of each test sheet is a list of possible diagnoses of each child's learning problems, should the child fail to

Unit 1 - COUNTING AND ONE-TO-ONE CORRESPONDENCE TO 5

Objective E - Number stated (to 5) and a set of objects (to 5); count out subset of stated size

Materials - Package "Quantification 1 E" - Moveable objects

Criterion - Must pass every item

Testing Situation	Testing Directions
1-3. Place ten moveable objects in front of the child. Put the objects back into a pile after each response. Note: When indicating the position "here" as you ask the question, allow for sufficient space to separate between the pile of chips and the "here position" where the child is to place the subset of objects counted.	Say: 1. "COUNT OUT THREE OBJECTS AND PUT THEM OVER HERE." (point) 2. "COUNT OUT FIVE OBJECTS AND PUT THEM OVER HERE." (point) 3. "COUNT OUT TWO OBJECTS AND PUT THEM OVER HERE." (point) Answers: 1. 3, 2. 5, 3. 2

Diagnosis: Child needs more work in:

1. counting moveable objects (Quantification Unit 1, objective B)
2. reciting numeral chain (Quantification Unit 1, objective A)
3. counting out subset of objects
4. remembering verbal commands

Figure 3. Sample diagnostic test sheet for Unit 1 of the Quantification Curriculum.

Note: From the *Diagnostic Tests of the PEP Quantification Skills Curriculum Manual*, M.C. Wang and L. Resnick, (Johnstown, PA: Mafex Associates, Inc., 1978), p. 12.

perform satisfactorily on the tasks specified by the objective. These diagnoses are suggested by the task analyses results and prerequisite behaviors identified from the empirically validated learning hierarchies.

Another aspect of the authors' research and development work in this area involved investigations of the use of diagnostic testing and the prescriptive learning approach in implementing individualized instruction in classroom settings. For example, in an observational study designed to investigate the effects of diagnostic testing, the nature of teacher and student behaviors associated with the tests was documented, as was the amount of teacher time required to administer and record diagnostic test results (Wang, Resnick, & Scheutz, 1970). The results of this study suggest the feasibility of adopting diagnostic testing as an integral procedure in the teaching-learning process. The teachers participating in the study were able to implement diagnostic testing as a routine classroom practice within the time constraints of a school day. Furthermore, the diagnostic test results were utilized by teachers in prescribing appropriate learning experiences for individual students.

To test the hypothesis that formal diagnostic testing is required in order to individualize instruction effectively, an investigation was also conducted to determine the extent to which a teacher can accurately assess a student's learning progress through informal interactions alone (Wang, 1973d). Every week for three months, teachers were asked to predict the diagnostic test results of objectives in the unit in which students were working. The

predictions were then compared with students' actual test results. In addition, teachers were given feedback on the accuracy of their predictions during two separate weeks to determine the extent to which feedback information would increase their prediction accuracy.

The overall results of this experiment showed a wide range of variability in the accuracy of the teachers' informal observations for diagnosing student learning needs. The accuracy of the teachers' predictions was found to vary within and among teachers. It is also interesting to note that the accuracy of the predictions improved following each feedback session . These findings seem to support the assumption about the critical role that formal diagnostic testing plays in the implementation of the IELP. However, results showed that teachers were able to predict students' learning needs with an average of 74% accuracy, as opposed to an expected chance accuracy of 50%, suggesting that some formal testing can be replaced by teacher observation (Wang, 1973d). It was on the basis of results from experimental studies such as the ones described here, combined with feedback information obtained from teachers and program evaluation studies carried out in the LRDC-affiliated Follow Through sites (Leinhardt, 1977a&b), that the diagnostic testing procedures for the Individualized Early Learning Program were further developed and refined.

The development of instructional intervention strategies and learning tasks. The learning hierarchies and the curriculum objectives provided the built-in guidelines for the development of intervention strategies and learning tasks (learning materials and

activities) to be included in the IELP. Drawing on the experiences of teachers and program developers who were involved in the development and initial field testing of the Individualized Early Learning Program, a variety of intervention strategies and learning tasks that are keyed to each of the curriculum objectives were developed. They range from the more traditional "paper and pencil" type assignments to manipulative activities designed for individual and/or group use. Several alternative tasks for teaching each objective were developed to provide flexibility in adapting learning experiences to the individual student. These tasks were compiled in a number of manuals for teacher use (Wang & Resnick, 1978). The manuals include detailed descriptions of: (a) the objective each task is designed to teach; (b) the learning task and the materials needed to perform the task; (c) procedures for carrying out the task; and (d) suggested teacher intervention strategies, including critical questions the teacher can ask the child as he or she works on the task or when evaluating the student learning outcomes associated with a particular task.

Figure 4 is an example of the prescriptive learning tasks described in the Quantification Skills Curriculum Manual (Wang and Resnick, 1978). Each task is labeled by a curricular code name which appears on the top of each page of the manual (e.g., Q1E, as shown in Figure 4, indicates the task is designed for Quantification Unit 1, Objective E). Listed on the top left-hand corner of each page under INVENTORY is a detailed description of the materials required for carrying out the learning task. On the bottom left-hand corner of each page under the word PROCEDURE is a description of the setting and procedure suggestions for the teacher. On the top right-hand corner

Box Q 1 E

Inventory:

- lesson box divided into 6 sections
- 20 blocks
- tape cassette containing lesson

Task:

The child counts a stated number of moveable objects and places them in the appropriate slot according to the taped directions.

Procedure:

The child is seated at a table with tape recorder and cassette. He/she counts out the number of blocks stated on the tape, and places the blocks in the appropriate slot in the lesson box.

To the Teacher:

1. T. checks lesson box when the child finishes tape. Each slot should contain the following number of blocks:

Record	- 4 blocks
TV	- 2 blocks
Bicycle	- 1 block
Radio	- 5 blocks
Afro-pick	- 2 blocks
Telephone	- 3 blocks

2. Have the child count out:
   a. three blocks
   b. five blocks

Questions:

1. "How many blocks are there?"
2. "How many blocks are there?"

Correct Response:

1. "Three."
2. "Five."

Figure 4. Sample prescriptive learning task.

Note: From the *Prescriptive Learning Tasks of the PEP Quantification Skills Curriculum Manual*, M.C. Wang and L. Resnick, (Johnstown, PA: Mafex Associates, Inc., 1978), p. 7.

under TO THE TEACHER are implementation recommendations for individual or small group settings. In the lower right-hand corner under QUESTIONS is a set of suggested questions for the teacher to use in determining whether the child has acquired the particular skill. In addition, on the bottom right-hand section of the page is a list entitled CORRECT RESPONSE for the teacher's quick reference. Figure 5 shows an example of a group exploratory learning game that can be used to help students acquire certain quantification skills.

The following three broad categories of considerations served as general guidelines for the design of the learning tasks included in the Individualized Early Learning Program.

1. Materials should be designed to be used by students with a minimum amount of teacher supervision and guidance. Attention is given, for example, to: the development of material management systems that permit easy access to the materials by students; the format for packaging; the display and storage of materials, and the format for communicating directions for the proper use of materials to students.

2. Students' motivation for using the materials should be promoted and maintained in order to facilitate acquisition of the skills required to achieve mastery of the curriculum

SIZE WAR: Width

OBJECTIVES:
1. Identify appropriate size dimension (width).
2. Compare two objects by width and determine which is wider.
3. Use the terms wider (or fatter), narrower (or skinnier), and width.

NUMBER OF PLAYERS: 2

MATERIALS:

A. Owls

24 laminated 5" x 4 1/2" paper cards with drawings of owls in various colors. All owls are 4" tall. Their widths vary as follows:

- 4 1/2" - 6 owls
- 3 1/2" - 6 owls
- 2 1/2" - 6 owls
- 1 1/2" - 6 owls

B. Hippos

24 laminated 5" x 4 1/2" paper cards with drawings of hippos. All hippos are 4" tall. Their widths vary as follows:

- 5" - 6 hippos
- 3 1/2" - 6 hippos
- 2" - 6 hippos
- 1/2" - 6 hippos

C. Houses

24 laminated 5" x 4 1/2" paper cards with drawings of houses in various colors. All houses are 4" tall. Their widths vary as follows:

- 4 1/2" - 6 houses
- 3 1/2" - 6 houses
- 2 1/2" - 6 houses
- 1 1/2" - 6 houses

DESCRIPTION OF THE GAME: Each child has a pile of cards. The children turn over their cards, one at a time, and compare them. On each turn, the child with the wider card is the winner. The children describe the cards using the term wider (fatter).

Figure 5. Sample exploratory learning task.

Note: From the *Unit Games of the PEP Classification and Communication Skills Curriculum Manual*, M.C. Wang and L. Resnick, (Johnstown, PA: Mafex Associates, Inc., 1978), p. 100.

objectives. This aspect of the design work focused particularly on the use of programming principles that are not only reinforcing and stimulating, but also pedagogically accurate and effective. Consideration is given to the nature and quality of the activities and materials in terms of student interests; the physical attractiveness of the materials; the amount of time offered to complete the task; the prerequisite skills (physical, cognitive, and social) needed to perform the task; the developmental levels of the students; feedback mechanisms to permit atudents and the teacher to evaluate the outcomes of their work; as well as the ease with which the materials can be handled by students in terms of organizing, manipulating, and putting away the materials.

3. It is important to consider both the time and money involved in designing and producing, the materials. As much as possible, materials should be adopted that are commonly available commercially and/or commonly stocked in classrooms. The use of readily available materials and equipment provides the flexibility required for the implementation of an instructional program such as the Individualized Early Learning Program. This approach will also permit and encourage teachers to incorporate new objectives into the program in order to adequately adapt learning experiences to the needs of their students.

The design of the physical environment of the classroom. Systematic analysis of how space can best be used is an important concern in implementing the IELP. Providing adequate work space for children, as well as space for displaying and storing materials, is not only an important practical consideration in implementing the program in classroom settings, but also makes a great difference in motivating children to develop increasing self-direction and self-responsibility for their learning. That is, the physical layout of the classroom contributes, along with the learning materials, to program effectiveness. The rationale and design of the recommended physical layout of the classroom environment has been described in detail for teachers (Wang & Resnick, 1978). Briefly, in the recommended classroom physical design the arrangement of the activity areas encourages integration. For example, the socio-dramatic play area is placed next to the construction and block area so that students can draw resources from both areas in their socio-dramatic play. The sand table is placed next to the block area so that students can share people, animals, and other block accessories with students working at the sand table. Multiple use of equipment is also a characteristic of the recommended arrangement. The bookshelves are used as dividers between the reading and listening area and the dramatic play area. The backs of the bookshelves are used to hang dress-up clothes, and the backs of the metal supply cupboards are used as display space for creative artwork.

Figure 6 is an example of how a "traditional" first-grade classroom can be rearranged in order to facilitate the implementation

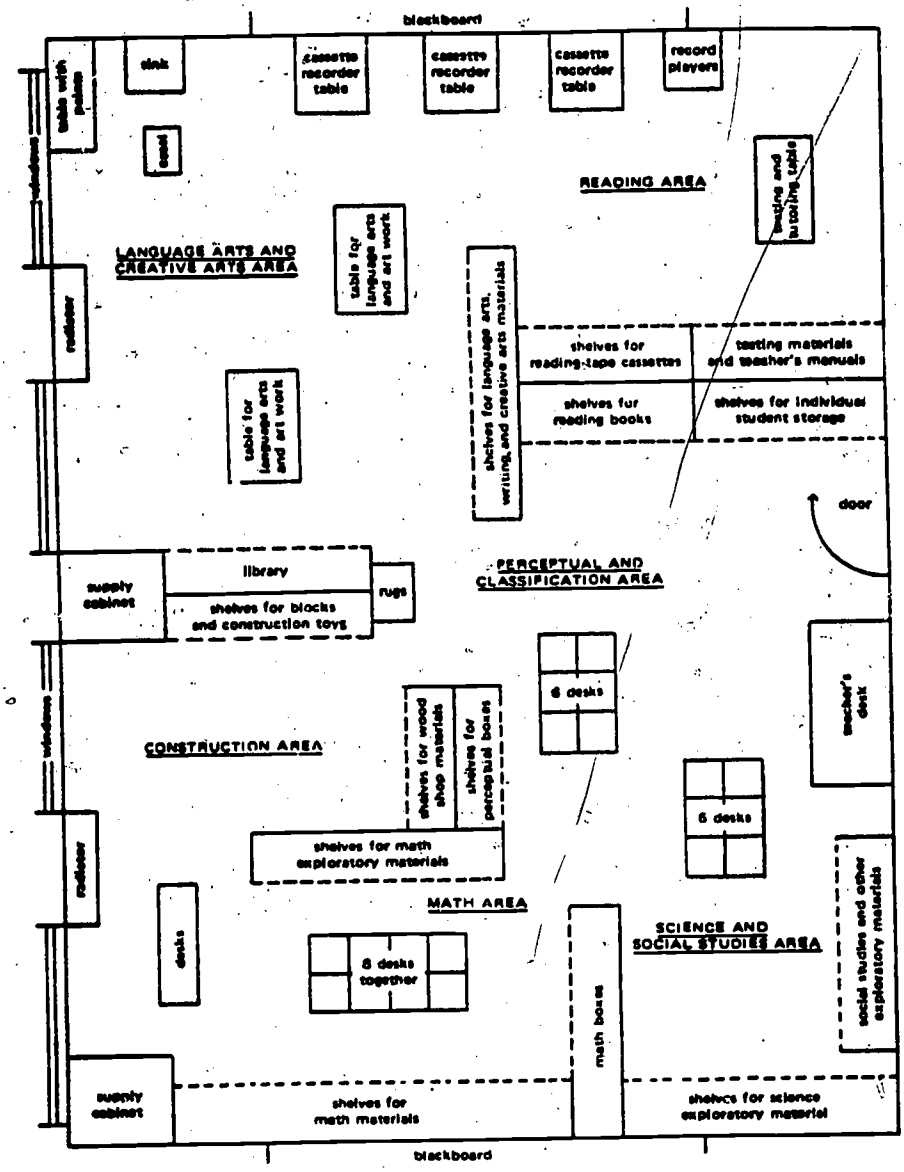


Figure 6. A redesign of a "traditional" first-grade classroom.

Note: From the *PEP Introductory Handbook*, M.C. Wang and L. Resnick, (Johnstown, PA: Mafex Associates, Inc., 1976), p. 16.

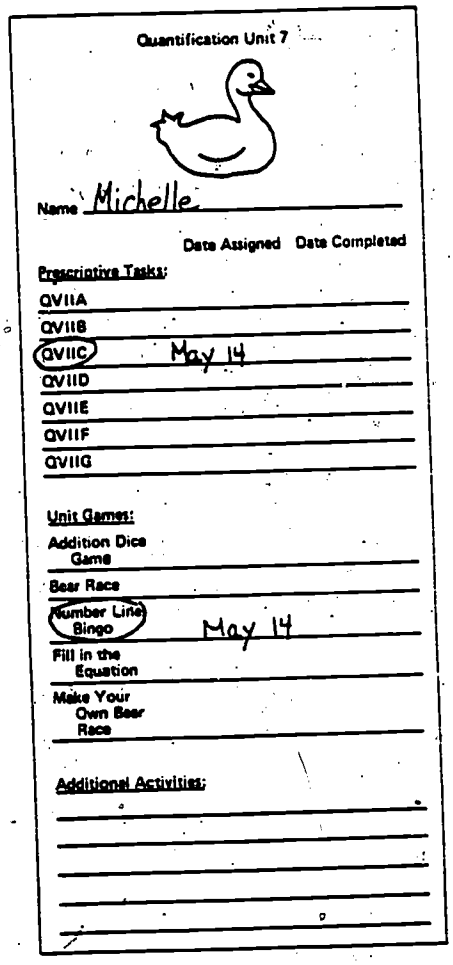
of the IELP. Note that individual desks have been grouped together to encourage group activities and interaction among children working in the same activity area. Extra desks have been taken out of the room to provide additional floor space so that children can move about and work on the floor. The supplies and equipment for the language arts and creative arts activities are set up together to encourage integration of these activities. The backs of the shelves for storing math and exploratory learning materials are fitted with a pegboard and the tools needed for the construction area are hung on the board. The math area is set up next to the science and social studies area to encourage integration of activities in these areas.

The design of an instructional-learning management system. Classroom management involves the management of curriculum materials as well as the management of the instructional-learning processes.

1. The design of a system for display, storage, and management of curriculum materials. The display, storage, and management of curriculum materials is an important program design consideration for implementing individualized programs in classroom settings. It is important because of the wide variety of curriculum materials that need to be organized in a systematic way for teacher and student use. This is accomplished in the Individualized Early Learning Program through the systematic planning and design of the physical space for material display and storage and through the development of a materials management system that is explicit and simple for students to use and maintain.

Incorporated in the design of the program is the need to categorize learning materials for each objective included in each component of the program. Learning materials are designed in either of two basic formats--learning booklets or manipulative materials. Each booklet usually includes an exercise to teach a single skill. The manipulative materials are generally packaged in small learning boxes, each of which contains the materials necessary for one activity. There are typically several sets of alternative learning materials keyed to each objective to allow flexibility and adaptiveness. These materials may be assigned by the teacher or selected by students themselves.

To guide children's use of the materials, each child is given a "prescription ticket", generally at the beginning of each day. The prescription ticket contains codes that match those on the learning materials. The child then "follows" the ticket by finding the booklets or boxes that match. Figure 7 is an example of a prescription ticket for Unit 7 of the Quantification Curriculum. As shown in the figure, the student's assignment on May 14 was to work on Objective C in Quantification Unit 7 (as circled on the prescriptive ticket). The student's assignments for Objective C were to work with number lines (task QVIIC) and play the Bingo game that was designed for that objective. The materials needed to complete these tasks would be displayed on the Quantification bookshelf in a box, labeled with a picture of a "duck" and the letter code (QVIIC) that matches the code listed on the prescription ticket. Such labeling allows the student to find the necessary materials. After the task is completed, the teacher marks the prescription ticket accordingly.



Quantification Unit 7

Name Michelle

Date Assigned Date Completed

Prescriptive Tasks:

QVIIA

QVIIB

QVIIC May 14

QVIID

QVIIE

QVIIF

QVIIG

Unit Games:

Addition Dice Game

Bear Race

Number Line Bingo May 14

Fill in the Equation

Make Your Own Bear Race

Additional Activities:

Figure 7. Sample prescription ticket for Unit 7 of the Quantification Skills Curriculum.

Note: From the *PEP Introductory Handbook*, M.C. Weng and L. Resnick, (Johnstown, PA: Mafex Associates, Inc., 1978), p. 24.

Another important concern, with respect to classroom implementation of the program, is to insure that certain areas of the classroom do not become so overcrowded as to prevent constructive use of the available materials. Teachers have used a variety of strategies to solve this problem. One is the use of a pegboard system showing each activity area. A varied number of pegs are placed under the name of each learning area listed on the board. Name tags for the children are provided at the bottom of the pegboard. When a child decides to work in a given area, the child first places his or her name tag on an empty peg under the area where he or she has decided to work. If all of the pegs for the area are in use by other children the child selects another area. There are as many pegs for each area as the teacher feels the area will comfortably accommodate. In this way, both teacher and children can see at a glance which areas are free and where each child is working.

2. The design of an instructional-learning management system. The scheduling of student learning activities and teacher instruction time has been a major implementation problem for individualized instructional programs. Typically, the choice is between group versus individual scheduling, and free choice versus teacher-prescribed activities. A truly effective program, however, can include all four alternatives for scheduling within the context of a flexible school day. This is accomplished in the Individualized Early Learning Program through the Self-Schedule System. Under the Self-Schedule System, children can be found working in virtually every area of the classroom at any given time with the teacher circulating among them.

Small groups of children can be called together at the discretion of the teacher for tutoring, testing, or other activities.

In general, data from studies relating to the effects of self-scheduling suggest that students and teachers are able to make more effective use of school time under the Self-Schedule System. Children were found to complete more tasks in less time and exhibit more purposeful and attentive behavior. The frequency of children's waiting for the teacher's attention dropped, children worked in group settings more frequently, and children exhibited less disagreement (i.e., fighting and arguments) with each other. Teachers were observed to have more substantive interactions, involving instruction and information exchange, as opposed to management interactions that deal with behavior or material management concerns. Finally, teachers uniformly reported a sense of having more time to work with and observe individual children (Wang, 1976b).

The Teacher

Work related to the development of the teacher component of the IELP was carried out with the basic assumption that innovative educational practices cannot occur without competent implementation. It was recognized that an important ingredient in the implementation of any innovative program is the teachers' ability to use the improved techniques and materials to provide effective schooling for their students. Therefore, a major concern in the development of the Individualized Early Learning Program was the design of specific implementation strategies and technical supports for teachers.

Development of the teacher component was concerned particularly with specification of teacher behaviors required in the instructional-learning process and teacher competencies required in preparing for effective program implementation. The specific categories of elements included in the teacher component of the program are listed in the center circle in Figure 1. Teacher competencies required for the instructional-learning process of the Individualized Early Learning Program include both classroom management and instructional skills. Teacher competencies required in preparing for effective program implementation include designing the physical arrangement of the learning environment, designing and displaying learning and instructional materials, diagnosing student learning needs, monitoring student learning progress, and designing learning plans for individual students.

Teachers implementing the IELP must possess the skills needed for both formalized "didactic" instruction and informal instruction. Examples of didactic instructional behaviors include administering diagnostic tests, prescribing learning tasks, checking prescriptive assignments, and giving help with assignments as required. As a didactic instructor, the teacher also assumes the responsibility for large or small group tutoring sessions as dictated by the various curricula and by the needs of the students. However, it should be noted that when implementing the Individualized Early Learning Program informal instructional interactions with students are, in many cases, considered more important than didactic instruction.

Teachers functioning in classrooms where the IELP has been implemented generally act in two modes--the "traveling" and the "tutoring" modes. In the traveling mode, the teacher circulates among the students as a resource person, helping students with their learning tasks, checking off tasks as students complete the work, and interacting informally for management or instructional purposes, usually for quite brief periods of time. The tutoring mode, on the other hand, requires the teacher to work intensively, and for longer periods of time, with individuals or small groups of students to administer diagnostic tests, instruct individual students, give group lessons, or work with a group of students on a special learning project.

The Student

Identifying elements associated with students and their learning process was a central concern in the development of the Individualized Early Learning Program. Specific elements that were identified are listed in the circle on the right hand side of Figure 1. These elements are classified into two categories: student characteristics and student behaviors associated with the learning process. Student characteristics include the individual student's attitudes, interests, entering competencies, and learning style. Student behaviors associated with the learning process include management behaviors, learning behaviors, and evaluation behaviors.

The identification of student characteristics and the specification of student behaviors in the classroom process are

particularly unique aspects of the IELP. Characteristics of students and their classroom behaviors play an important role in determining the quality of the instructional-learning process. LRDC's work in this area has been concerned not only with the causal link between the instructional process (the teacher and the curriculum) and student learning outcomes but also with the causal link between the unique characteristics of the student and the classroom instructional-learning process. In contrast to student behaviors in more conventional elementary classrooms, students are expected to play an active role in management and learning functions. To function effectively under the Individualized Early Learning Program, students need, and are taught, to acquire increased efficiency in the following management skills:

1. Independently managing classroom resources, materials, equipment, and physical space.

2. Making appropriate choices regarding the particular learning activities, the time and space in which the activity is to be assigned, and/or whether to carry out the activity jointly with peers or work alone.

3. Requesting assistance from teachers and other students when it is needed for either instructional or management purposes.

4. Carrying out the planned activities within the limits of the classroom learning situation by observing rules and following directions.

5. Giving assistance to others when it is requested.

6. Accurately estimating the amount of time required to complete the planned activities and budgeting the available school time to complete the tasks accordingly.

7. Delaying or stopping work on activities in order to work with teachers or other students on other scheduled activities.

8. Delaying teacher attention by switching to another task while waiting for teacher assistance.

9. Evaluating one's own learning progress and adjusting choices and schedules accordingly.

Field Research

Up to this point, the discussion has focused on the nature of the Individualized Early Learning Program and the process through which it

was developed. A description of the field research conducted in the LRDC-affiliatated Follow Through schools where the IELP has been implemented is presented in this section.

Field research conducted in the LRDC-affiliated Follow Through schools focused on two major areas. The first area was documentation of the degree of implementation in order to describe the discrepancies, if any, between the program as it was designed and the program as it was implemented in the Follow Through sites. The second area involved documentation of the program's impact on student learning progress. The dependent variable in the first line of research was the program as it was implemented. Information was sought to describe how and why program changes took place. The dependent variable for the second line of research was student performance. The program, as implemented, was then the independent variable.

Program Implementation

Much of the research in the LRDC-affiliated Follow Through sites consisted of studies to determine the degree to which the program had been implemented as it was originally designed (Leinhardt, 1972, 1976). The purpose of this research was to monitor and assess program operations in order to provide continuous feedback to program developers and site personnel about the implementation process.

The basic structure for research on program implementation dealt with input, process, and outcome variables. This research assessed

initial student abilities (input), the instructional procedures used (process), and student final performance (outcome). The research was conducted over a four-year period (1971-1975) in a series of studies, each of a year's duration. The studies were conducted in the second grades at those LRDC-affiliated Follow Through sites where the second-grade program was operating. The type of information collected in each successive year was based in part on the analysis of data from preceding years. The basic research structure remained the same. The questions were framed in the context of a multiple regression approach. Specifically, the research sought to explain variation in end-of-year student achievement while considering the impact of different entering abilities and different programmatic emphases (Cooley & Leinhardt, 1975; Leinhardt, 1977b).

Measurement and instrumentation. Initial measurement work focused on the development of techniques and instruments for gathering data to assess the degree of implementation in the various sites. Two types of instrumentation were used: one to reflect student knowledge and the other to reflect the instructional environment. Norm-referenced tests, criterion-referenced tests, and interviews were used to assess student knowledge. The norm-referenced tests included: the Lorge-Thorndike Cognitive Abilities Test (CAT) (Thorndike, Hagan, & Lorge, 1968); the Metropolitan Achievement Test (MAT) (Durost, Bixler, Wrightston, Prescott, & Balow, 1971); Raven's Coloured Progressive Matrices Test (Raven, 1956); and the Wide Range Achievement Test (WRAT) (Jastak, Bijou, & Jastak, 1965). The oriterion-referenced tests came from LRDC's curricula. Student interviews were included in the instrumentation developed for

classroom processes assessment (Leinhardt, 1972).

Over time, a variety of instruments were used to help assess the instructional environment in LRDC's Follow Through classrooms. The earliest instruments emerged from the field notes of LRDC's Follow Through field staff. These field notes became the basis for developing more formalized procedures to document the degree of implementation. During LRDC's initial involvement with Follow Through, Champagne (1971) developed an informal checklist for documenting the presence or absence of a selected number of program elements. As would be expected in the early implementation of an innovative instructional program, these elements were heavily weighted toward equipment, expected teacher-student behaviors, and supervisory roles.

Additional informal data-gathering instruments were developed to aid empirical research on the validity of the program. These instruments were used to identify the most significant features of the instructional environment. The ultimate goal was to integrate that information with data on student achievement. Instruments were designed to collect three types of information: (a) information on how the teacher conducted the daily activities of the classroom; (b) information on actual teacher behaviors, particularly the verbal behaviors during instruction; and (c) information on student behaviors and perceptions of classroom processes (Leinhardt, 1972, 1976, 1977a, 1977b).

All of the instruments developed were tested at local Pittsburgh

sites prior to use in the Follow Through classrooms. The observational sections of the instruments were the easiest to validate, while the sections on student academic behaviors and growth patterns were the most difficult. For example, while attempting to obtain data on students, it became evident that different sites were using very different approaches to record-keeping. Although standard record-keeping sheets were distributed, they were not used consistently. Materials such as tests, records on student assignments, diagnostic test results, and other related performance data were frequently not available. This situation was not due to any negligence on the part of the teachers. In the early years, when the teachers were under pressure to implement a new instructional program record-keeping seemed to take a backseat, as it logically should have. This experience became a lesson in program implementation. That is, paperwork should be kept to a minimum during the introduction of a program.

The reliability and validity of the observational and interview instruments were initially established by an in-depth study by Leinhardt (1972). Inter-observer reliability in classroom observation averaged .82 over all categories. The stability over a four-day period of teacher behaviors was estimated at .78 (Leinhardt, 1976). In later studies, videotapes replaced in-class observers and reliability increased to .95 across categories and observations (Leinhardt, 1978).

Assessing program features. The first set of field-based empirical studies focused heavily on the types of assignments students

received, how student and teacher time and classroom space were used, and whether implementation procedures were followed in accordance with initial suggestions and program specifications.

The basic finding of this early research was that an LRDC Follow Through classroom did indeed look very different from a traditional one. The Follow Through classrooms were also different in many respects from the developmental classrooms in Pittsburgh. The Follow Through classrooms, however, more closely resembled the developmental than the traditional classrooms.

Another finding was that modifications which were made in the field often improved rather than detracted from the program. For example, in the early stages of implementation, the Follow Through schools did not test as frequently as suggested (every four to five days). This increased time between tests (seven to eight days) was found to have a positive impact on student achievement (Leinhardt, 1976). While this finding should not be interpreted to mean that testing was an unimportant part of the program, it does indicate that the optimum frequency for testing must be established in the field (Leinhardt, 1977a).

In the early field research, there was a divergence of opinion between LRDC's Follow Through field staff and researchers about the implementation level of the program features. Initial estimates gained through our research indicated that the program features were very well implemented and fit very closely with the model. Information collected by the field staff, on the other hand, indicated

a less than optimal implementation. They felt that many sites were not implementing major features of the program. The difference lay in the definition of major features. For research purposes, it was sufficient that testing occurred at reasonable intervals, that testing information was apparently being used for diagnosing student learning needs and prescribing appropriate learning tasks, and that the teacher functioned properly in the traveling mode by moving about the room and interacting with children one at a time. However, the field staff were concerned that the testing procedures be used with greater precision. For example, they wanted to be sure that curriculum-embedded tests (CET's) were not used instead of posttests and that units which seemed to cause difficulty were not skipped. In other words, the researchers focused on a more general level while the implementors, or the field staff, focused on a more specific level.

Occasionally, however, the data from research studies did reveal some specific implementation problems. In 1973, for example, it was discovered that there was no variation in the initial placement of students in the mathematics curriculum at one site. The reason given by the teachers was the lack of time for testing children at the beginning of the year. For this reason, all students in one grade had been placed in the same unit. This information was fed back to the sites through the field staff. Interestingly, the percentage of unique student assignments at this site increased from 0 to 85% over the next four years. Presumably, this change was partly the result of data from the research studies being "fed back" to the site.

As a result of the research, some generalizations were able to be

made about the nature of implementation of the IELP at different types of sites (i.e., urban versus rural, and black versus white, or integrated). One question that was often raised was whether observed differences in the degree of implementation related systematically to some contextual variable associated with particular sites. For example, parts of the program were field tested in predominantly black inner-city schools. It is therefore possible that either the implementation mechanisms or the style of the programs that resulted would favor black urban settings over white rural ones. On the other hand, the program developers and implementors were predominantly college educated whites which suggested that the programs might be more easily implemented in white settings.

In one study of the implementation of the IELP in the LRDC-affiliated Follow Through classrooms, the effects of the geographic location and the racial makeup of schools were examined. Ten implementation variables from four domains (time usage, assignment procedures, student autonomy, and teacher attendance) were selected and contrasts were made using a Multiple Analysis of Variance (MANOVA). Table 2 shows the results of that analysis (Leinhardt, 1977a).

Table 2 lists the four domains and ten measures in the left-hand column. To the immediate right of each measure is the probability (univariate p) that the observed differences would have occurred by chance. Thus, with respect to the first measure, percentage of time in individualized activity, there were differences between urban and rural locations that could be expected by chance half the time (or no

Table 2

Effects of Geographic Location and Racial Composition on Implementation of the IELP in 52 Follow Through Second-Grade Classrooms

Domain and Variable	Urban/Rural		Racial Composition of Classes	
	Univariate $p \leq$	Comments	Univariate $p \leq$	Comments
Allocation of time				
1) % of time in individualized activity	.46	Individualized time does not vary systematically with geographic location of school	.15	Individualized time does not vary systematically with racial composition of school
2) the number of minutes in mathematics	.00	Urban schools spend more time in mathematics	.03	Predominately black and integrated schools spend more time in mathematics
3) math maintenance program used	.92	Maintenance program usage does not vary systematically with geography	.53	Maintenance program usage does not vary systematically with racial composition
Assignment Procedures				
4) % of unique assignments	.38	Assignment uniqueness does not vary systematically with geography	.75	Assignment uniqueness does not vary systematically with racial composition
5) percent of pretests	.01	Urban schools give more pretests while rural schools give more CET's	.02	Predominately black schools give more pretests while predominately white schools give more CET's
6) percent of CET's	.00		.00	
7) number of days between testing	.18	Frequency of testing does not vary systematically with geography	.28	Frequency of testing does not vary systematically with racial composition
8) student progress in math	.83	Amount of progress does not vary systematically with geography	.31	Amount of progress does not vary systematically with racial composition
Student Autonomy				
9) sum of checklist	.16	Degree of autonomy offered students does not vary systematically with geography	.09	Degree of autonomy does not vary systematically with racial composition
Attendance				
10) number of days the teacher was absent	.93	Frequency of absences does not vary systematically with geography	.87	Frequency of absences does not vary systematically with racial composition

Note. Adapted from Leinhardt, G. Evaluating An Adaptive Education Program: Implementation to Replication. *Instructional Science*, 1977, 6, 223-257.

significant difference). Immediately to the right of the p value is a statement of interpretation. To the right of that is the probability of differences associated with racial characteristics in the composition of the school, followed in turn by an explanation. The table can be read across each row without attending to the numerical information.

Essentially, the findings show few significant differences that could be expected to affect student performance. An exception is that urban and black schools spent more time in mathematics than white and rural schools. In assignment procedures, urban and black schools used more pretests while rural and white schools used more CET's. There was no difference, however, in the uniqueness of assignments (degree of individualization), frequency of testing, or student progress. These results do not indicate that there were no differences in implementation procedures among schools, only that the differences were not systematic with respect to some of the more obvious site characteristics. These findings also suggest a successful implementation of the major program features in the sites (Leinhardt, 1977a).

Student Learning Progress in Basic Skills

Data on student learning progress reported in this section were obtained from the LRDC developmental classrooms where most program design research was carried out, and from Follow Through sites where some of the components of the Individualized Early Learning Program were implemented. This discussion will include information on student

learning progress in the basic skills curricula and standardized achievement test results. Since detailed discussions of student progress have appeared in several previous reports (Eichelberger & Boston, 1976a; Rosner, 1972; Wang, 1976a; Wang, Resnick, & Schuetz, 1970, 1974), the following are brief summaries of this information for illustrative purposes.

Student learning progress in the basic skills curricula. Integrated into the IELP's recommended classroom processes is the administration of diagnostic tests to determine students' mastery of the objectives in each of the prescriptive curriculum (Cox & Boston, 1967; Wang, 1969). The diagnostic test results provide a basis on which teachers prescribe learning tasks for children. Test results also provide a record of student learning progress in the program. The purpose of analyzing the student learning progress data was to determine whether the students were able to master the program's objectives and whether previous experience in the IELP made any difference in student entering behaviors. To investigate how children make progress in the IELP curriculum, the data from the developmental classrooms and Follow Through schools were examined.

Summaries of mastery in the Quantification, Classification, and Reading curricula by students from the developmental classrooms are reported in Tables 3, 4, and 5 (Wang, Resnick, & Schuetz, 1974). The tables show the percentage of students who mastered each of the units in the various curricula by the end of the 1969-70 school year. The data in the tables were obtained from an inner-city public school at the end of the second year of program operation. As shown in Table 3,

Table 3

Percentage of Students Mastering Each Unit in the Quantification and the IPI Mathematics Curriculum at End of School Year 1969 - 1970

Unit	Age Group				
	3 Years N = 23	4 Years N = 33	Kindergarten p.m. N = 58	Kindergarten a.m. N = 52	First Grade N = 133
Quantification					
1. Counting 1 - 5	59	81	93	100	93
2. Counting 1 - 10	32	78	88	100	91
3. Numeration 0 - 5	36	75	88	90	93
4. Numeration 6 - 10	18	56	81	92	81
5. Comparison of sets	9	47	90	85	85
6. Seration	14	34	70	77	77
7. Addition and Subtraction	5 5	8 6	49	56	83
8. Addition and Subtraction equations	–	–	12	21	28
19. Counting 11 - 20	5	28	58	58	93
10. Numeration 11 - 20	–	6	47	60	86
11. Counting 20 - 100	–	–	21	27	56
12. Numeration 20 - 100	–	–	4	10	38
13. Counting 100 - 1000	–	–	–	4	19
14. Numeration	–	–	–	–	15
IPI Mathematics					
Level B	–	–	–	–	4
Level C	–	–	–	–	1

Table 4

Percentage of Students Mastering Each Unit of the Classification Curriculum at End of School Year
1969 - 1970

Unit	Group			
	3 Years N = 23	4 Years N = 33	Kindergarten p.m. N = 56	Kindergarten a.m. N = 52
Classification I				
1. Matching	77	75	95	90
2. Simple classification	41	66	95	94
3. Classification of objects varying in 2 dimensions	50	72	96	90
4. Color naming	41	59	91	98
5. Shape naming	41	56	88	92
6. Size description	9	25	68	73
7. Advanced classification	*	19	65	71
Classification II				
1. Singular and plural objects	*	19	74	75
2. Reverse order ident.	*	3	32	63
3. Prepositional statements	*	*	57	56
Classification III**				
1. Multi-dimensional classification			58	71
2. Classification of funcitonal categories			47	71
3. Category naming			53	65

* Unit not included in the curriculum for this age group.
** Classification III was not used in preschool and kindergarten.

Table 5

Percentage of Students Mastering Each Book of the McGraw-Hill, Sullivan Reading Series 1969 - 1970

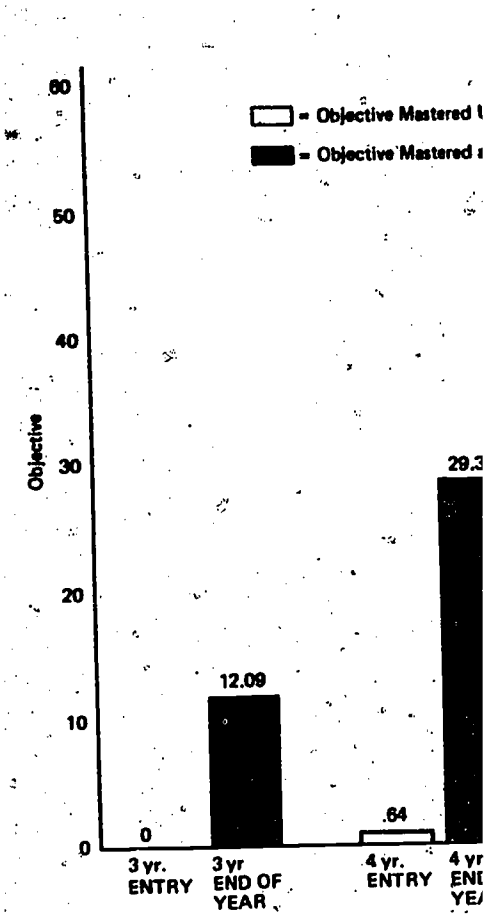
Unit	Topic	Grade 1 N = 133
1.	First transitional reader	64.4
2.	Second transitional reader	59.4
3.	Initial and final consonant clusters; contractions	48.9
4.	"ed" suffix of past tense verbs	40.6
5.	Inflectional and derivational suffixes "es" and "er"	31.6
6.	Inflectional and derivational suffixes "et" and "est"; complex sentence structure; paragraphs	22.6
7.	New initial and final consonant clusters; suffix "ay"	13.5
8.	Short "o"; "2" and "qu"; poems, descriptive paragraphs, short stories; colon	10.5
9.	Final "y"; long "a" with final silent "e"; soft "c"	6.0
10.	Long "i" and "o"; soft "g"; longer stories	6.0
11.	Long vowels not followed by final silent "e"; long "u"	6.0
12.	Words ending in "oy" and "igh"; animal sounds; concepts "bright" and "pale"	4.5
13.	"ee"; longer selections on natural sciences, with emphasis on comprehension and retention; semi-colon	3.0
14.	"ew", "oo"; descriptions of natural phenomena and human institutions, with emphasis on comprehension and retention	3.0
15.	"ow", "ea", "wh", "ph", silent "t" and "w", "kn", "ch"; suffixes "ture" and "ation"; months and seasons	1.5
16.	"ould", "dge", silent "l" and "h", "wr"; usage of "could" "should" and "would"; history, with emphasis on comprehension and retention	1.5

the typical four-year-old, for example, could perform counting, numeration, comparison of sets, and seriation, while five-year-olds or kindergarten students advanced to units on addition and subtraction operations up to 10 by the end of the school year.

To further examine student progress in the curriculum, comparisons were made between the total number of instructional objectives (in Quantification) mastered at the beginning of the school year (entry level) and the total number mastered by the end of the school year (terminal mastery) for each age group. Figure 8 shows these results graphically. A consistent pattern of positive student progress in the curriculum is clearly reflected in the data. At every age level (three years through first grade) students' mastery of the objectives of the Quantification Curriculum increased significantly between the beginning and the end of the school year.

Data displayed in Figures 9 and 10 represent student learning progress information from the seven LRDC-affiliated Follow Through sites for the 1973-74 school year. Figure 9 shows the number of IPI Mathematics units mastered at the beginning (placement) and at the end of the year (final location) by second-grade students in the sites. On the average, children at the end of the second grade had completed 20 units of the curriculum. Figure 10 shows the number of Sullivan reading books completed by Follow Through students upon entering and leaving second grade. In general, students had covered approximately half of the Sullivan Series by the end of second grade.

Standardized achievement test results. The Wide Range


60
50
40
30
20
10
0
Objective
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= Objective Mastered
29.3
12.09
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3 yr.
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Figure 8.

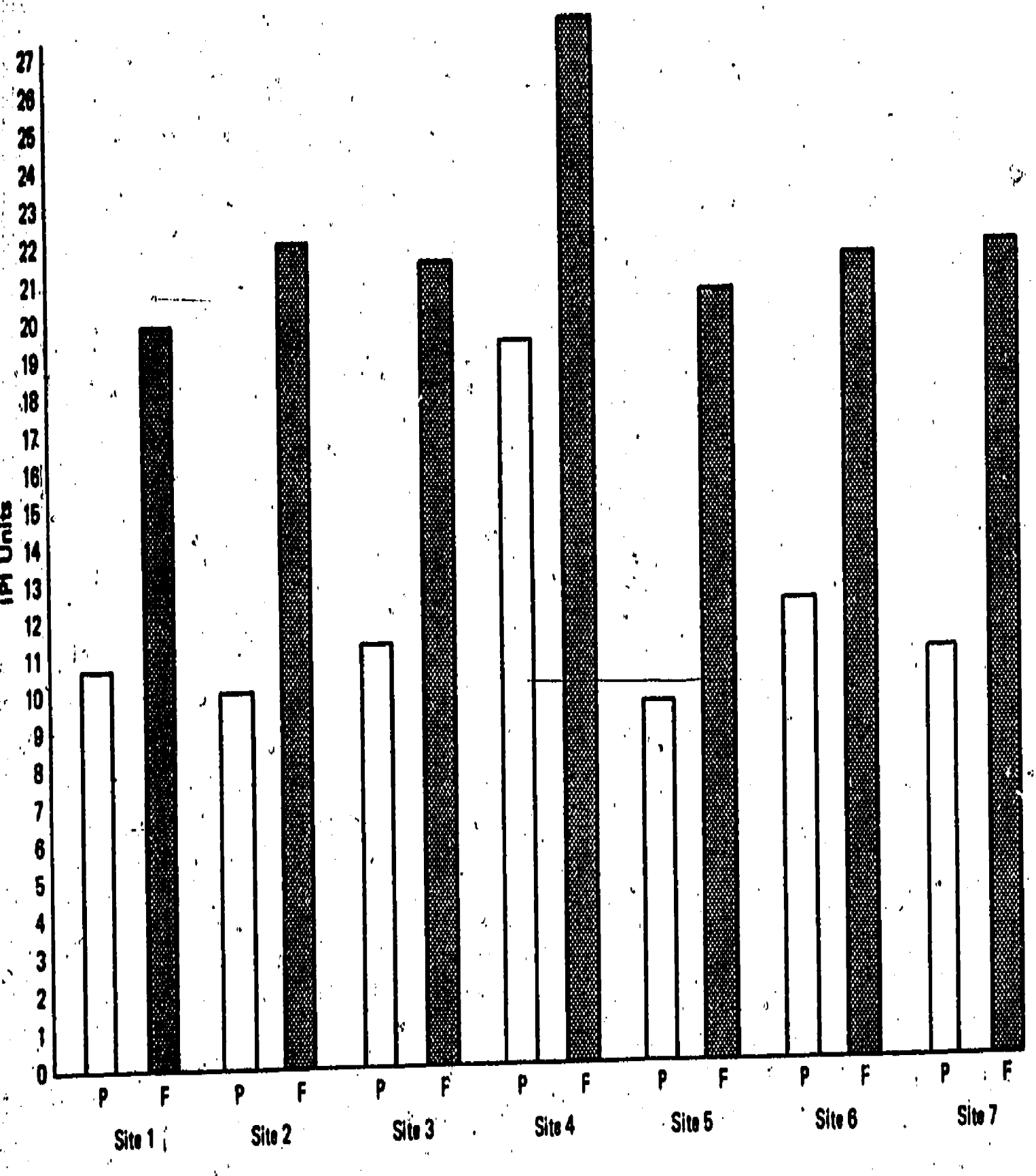

Figure 9. Student learning in IPI Math.
Second Grade Follow Through
(1973-74)

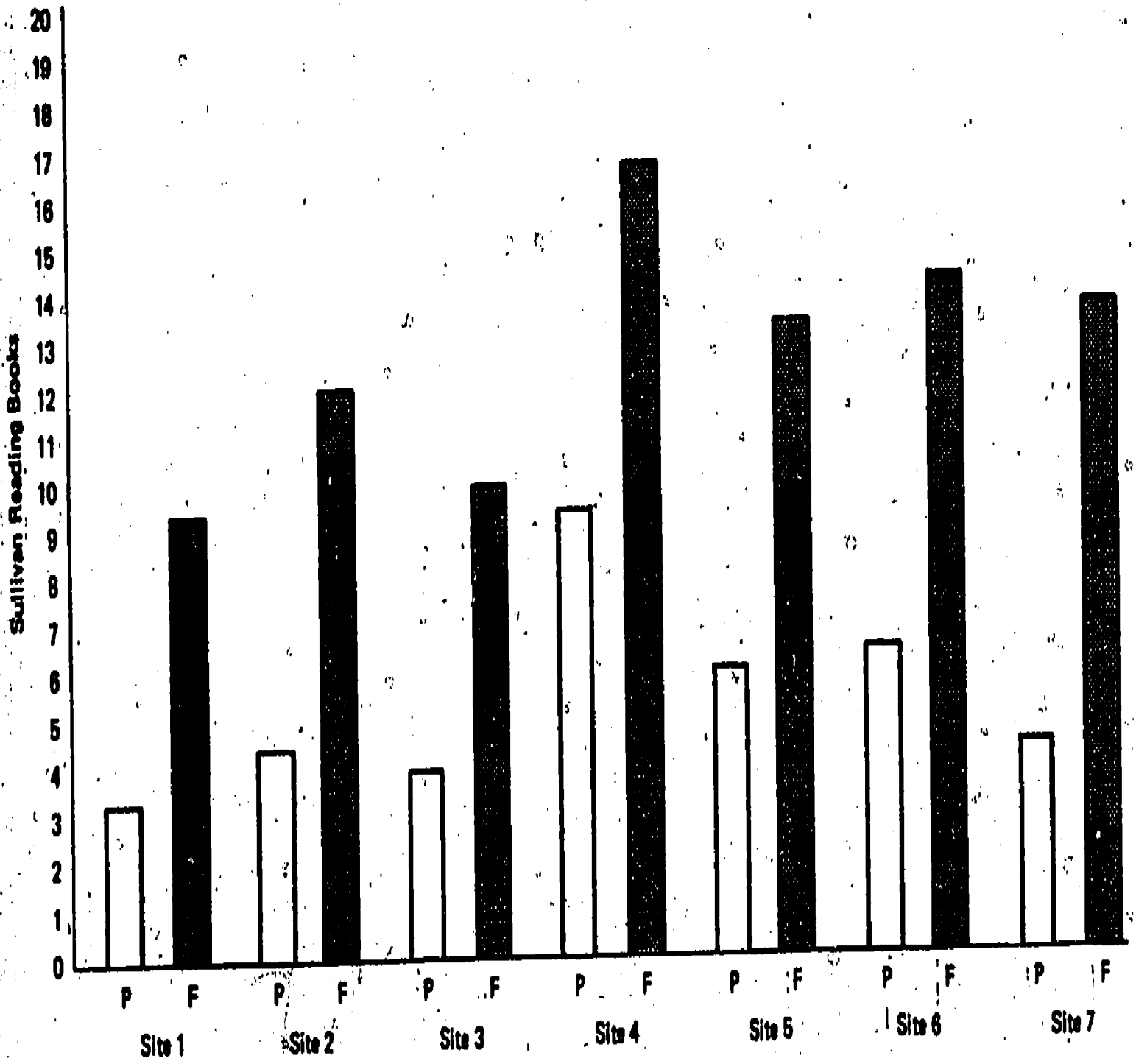

Figure 10. Student learning in Sullivan Reading.
Second Grade Follow Through
(1973-74)

Achievement Test (Jastak, Bijou, & Jastak, 1965) was one of the standardized tests used to assess the end-of-year achievement for students in developmental and Follow Through classrooms. The evaluation design (Wang, 1973a) for both the developmental schools and the LRDC Follow Through classrooms involved beginning initial testing at the lowest grade. The grade one year ahead of the grade in which the IELP was implemented was used as the comparison group for evaluation purposes. The intent was to compare the test results of program students with children from the same neighborhoods, families, and school. Thus, for comparison purposes, the WRAT was administered to children who were in the same school but had not been students in classrooms where the IELP was implemented. The central question in examining student achievement was whether the IELP made a difference.

Table 6 shows longitudinal comparisons of the Wide Range Achievement Test (WRAT) results of those Follow Through students in an inner-city school system who had the Individualized Early Learning Program and those students who did not. Data displayed in Table 6 include WRAT results from the first year in which the IELP was implemented in the schools through the 1976-77 school year. The Individualized Early Learning Program was initially implemented at this site during the 1970-71 school year. The overall results show that the mean grade equivalent scores for all Follow Through groups were close to, or above, the national norm, reflecting the positive impact of the program on student achievement. When comparing the achievement scores of the Follow Through and non-Follow Through groups in the same school system, the impact of the program is even more evident. As one reads across the rows in Table 6 to compare scores

Table 6

Summary of WRAT* Data from One Follow Through School

Mean Grade Equivalent Scores

1971 - 1977

	1971		1972		1973		1974		1975		1976		1977	
Grade	Read.	Arith.	Read.	Arith.	Read.	Arith.	Read.	Arith.	Read.	Arith.	Read.	Arith.	Read.	Arith.
Kdg.	1.0[a]	1.2	no data		1.0	1.0	K9	1.1	1.2	1.2	1.1	1.1	1.2	1.3
(n)	(139)[b]	(131)			(52)	(52)	(44)	(44)	(40)	(40)	(40)	(40)	(40)	(40)
First	1.4	1.7	1.9	2.0	1.9	2.0	2.2	2.0	2.1	2.3	2.4	2.2	2.2	2.3
(n)	(138)	(132)	(150)	(149)	(57)	(57)	(44)	(44)	(42)	(42)	(43)	(43)	(30)	(30)
Second	2.4	2.2	2.5	2.4	2.8	2.6	2.9	2.9	3.1	2.8	3.5	3.0	3.6	2.8
(n)	(71)	(73)	(149)	(149)	(145)	(148)	(43)	(42)	(44)	(44)	(41)	(32)	(32)	(32)
Third	3.0	3.0	3.2	3.1	3.5	3.1	4.2	3.4	3.8	3.4	4.2	3.3	4.5	3.4
(n)	(81)	(58)	(82)	(82)	(150)	(150)	(44)	(44)	(42)	(42)	(43)	(43)	(38)	(38)

* WRAT is given by LRDC through local administrators in spring of each year.

a - 1.0 Grade Equivalent Score

b - (139) Number Students Tested

Note: Groups above the stepped line were in the Follow Through program. Groups below it were not in the program.

from the same grades across school years, a consistent pattern of differences in the achievement scores of the two groups can be observed. In all cases, scores from the Follow Through groups far exceeded those of non-Follow Through groups of the same age for the preceding year.

It is also interesting to point out that when scores for the same group are followed across the years a pattern of progress in achievement scores can be detected. With each year of additional experiences in the program an increased gain is observed. Tracing the progress made by the kindergarten group of 1973-74 through their third-grade year (1976-77), for example, students in the Individualized Early Learning Program performed approximately at grade level in the spring of their kindergarten year. By spring of their first-grade year they scored slightly above the grade norm in both reading (2.1 instead of the expected 1.8) and math (2.3). In the Spring of 1975-76, which was their second-grade year, they again scored well above grade level in reading (3.5) and above grade level in math (3.0). This pattern of progressive increase continued in their third-grade year. Their grade equivalent scores from the spring testing of the 1976-77 school year were 4.5 for reading and 3.4 for math.

Student achievement data from each of the LRDC Follow Through sites, as measured by the WRAT at the end of each year, are in Table 7. These results were obtained from the average gain in WRAT grade equivalence (G.E.) scores for one group of students in each of the sites from the end of kindergarten to the end of the third grade. As

Table 7

Average Grade Equivalent Gains in WRAT Reading and Math Subtests for the LRDC FT Students

	Gain Scores													
	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Site 7	
Grade	R*	M**	R	M	R	M	R	M	R	M	R	M	R	M
K - 1	1.1	1.1	1.3	1.2	0.9	1.1	1.8	0.9	1.0	0.7	1.3	0.8	0.9	1.0
1 - 2	0.9	0.7	1.3	0.7	1.4	0.8	1.9	0.9	1.5	1.0	1.4	0.9	1.3	0.8
2 - 3	1.1	0.8	1.2	0.6	1.2	0.8	1.2	0.8	1.4	1.2	1.4	0.7	1.3	0.7
Total Gain	3.1	2.6	3.8	2.5	3.5	2.7	4.9	2.6	3.9	2.9	4.1	2.4	3.5	2.5

*R = Reading

**M = Math

Note: From "The LRDC Follow Through Individualized Early Learning Program" by Eichelberger & Boston, 1976.

pointed out by Eichelberger and Boston (1976b), since the expected gain for each year would be 1.0 G.E., with a total 3.0 G.E. for the three consecutive school years, the results reported in Table 7 represent above average growth. In fact, reading results which ranged from 3.1 G.E. to 4.7 G.E. not only represent above average growth for the national population, but also represent exceptionally high results for the Follow Through population. The U.S. Department of Education uses 70% of average growth as the expectation for disadvantaged students (General Accounting Office, 1975) which, in this instance, would be only 2.1 G.E.

A consistent pattern of achievement gains has been noted even though the data from the developmental and Follow Through schools varied from year to year and from classroom to classroom. Children in classrooms where the Individualized Early Learning Program is implemented generally learned what they were taught. On the average, Follow Through students in the program performed better than those with similar characteristics and backgrounds, and they scored at or above the national norm on standardized achievement tests in subjects that were explicitly taught in the program. Furthermore, the data suggest that the degree of program implementation was related to the degree of impact on students. As the quality of the program and its implementation improved over the years, an increase in student achievement gains was noted.

Discussion

Many insights related to the development, design, and evaluation

of an innovative instructional program such as the IELP were gained during LRDC's ten years of participation in the National Follow Through Program. This section will focus on discussing the information and experiences gained in four areas: the design of the instructional program, the individualization of the implementation process, program evaluation, and a contrast of instructional design and program implementation research findings.

Program Design

Although the basic goal of developing school learning experiences that are adaptive to the needs of the individual child has not changed since the inception of the IELP, ideas about what is required to accomplish that goal have gone through many iterations. One of the most significant changes was the broadening of the definition of curriculum. Another was the change in the "how to" aspect of bringing theories and research to bear on design and the requirements for utilizing research and development ideas and products to change school practices.

Curriculum development includes not only tasks of translating program goals into specific curriculum (learning) objectives, and designing the content and its sequence, but also includes tasks related to the implementation of the curriculum in classroom settings. As stated earlier, the curriculum defines the educational experiences and learning opportunities that are open to the individual student for the achievement of the program's objectives. Therefore, "curriculum" is viewed in the IELP as including learning objectives, sequence

structure, learning tasks, instructional tasks, methods and procedures for diagnosing the entering behaviors of the learner, monitoring and evaluating student learning, physical design of the classroom, and an instructional-learning management system.

Much work went into designing implementation strategies for the IELP during the initial phases of field testing. The notion that all that was needed was to provide the teacher with empirically validated curriculum packages and explicit directions about how to use the materials in order to effectively implement the innovations was soon recognized as naive. Merely supplying teachers with new ideas, products, and training was not sufficient. Teachers also needed design supports for the total operation of their daily instructional activities.

Contrary to the belief that it is possible to create teacher-proof curricula, effective implementation of innovative programs, even the most well-developed and systematically field-tested ones, cannot occur without a competent teacher. LRDC's Follow Through experiences have shown that it is the ability of the teacher to use the innovative educational programs that determines, to a large extent, the effectiveness of the programs in meeting the needs of the individual student.

The student also needs to be considered in the design process, not only for the purpose of maximizing the effectiveness of matching learning experiences and student learning characteristics and needs, but also for the purpose of maximizing effective day-to-day classroom

operations. Special attention must be given to the development of the management competencies required if the student is to function under such an instructional program. These management skills should be considered to be as important as other learning skills. The design of any innovative instructional program must include explicit statements about the role of the student, the teacher, and the curriculum, as well as the nature of the interactions among them as they are reflected in the classroom process.

Individualization of the Implementation Process

The implementation of an innovative program is not a process in which the total program, as designed by curriculum experts and R&D agencies, is installed intact initially and expected to remain so. It is a gradual process generally adapted to different schools and different teachers' classrooms. This was found to be true even in the demonstration classrooms in LRDC's developmental schools. That this happens is not surprising. Schools differ in staff, student, and community characteristics. It is unrealistic, therefore, to expect to use a uniform process to achieve full implementation of the critical features of an innovative program in all situations.

Innovations are seldom adopted and implemented as the program developers intended them to be at the outset. Installing and maintaining an innovative educational program should be viewed as a developmental process. This process includes the development of the teacher's readiness to accept and learn to implement the program (or components of it), as well as the development of the capacity of the

local school to adopt, and to adapt, the kinds of innovations that the program is designed to represent. Based upon its experience in implementing the IELP in a variety of classroom settings researchers at LRDC have come to believe that a key to effective implementation of innovations in schools is the use of an individualized approach. That is, it is important to incorporate a gradual developmental process that permits complete implementation to eventually occur through the individualization of the implementation process.

Program Evaluation

In retrospect, the most significant single lesson for program evaluators that emerges from LRDC's Follow Through experiences seems to be the need to make the evaluation process iterative and interactive. Educational evaluations should be carried out over at least a one-year period, with the results of any one study being used as the basis for revising future studies. The evaluator needs to interact with three basic groups in designing and carrying out such work: curriculum designers, school and implementation personnel, and the research community—in that order. These groups represent successive decision makers to whom evaluation information is relevant.

Early iterations of research should grow out of design specifications for programs. This assumes that early work will focus on information most useful for designers. Such an approach also helps to assure that relevant information will be available to the designer/developer when he or she is still interested and able to make modifications or build additional components.

The next iterations of research should include information that is especially relevant to the school and implementation community. Including such school-relevant data helps to assure that within the first two years (assuming each iteration is a year) of data collection, information of relevance and interest to schools is being collected and can, therefore, be made available to them.

Later iterations should include both school implementation and research interests. The increased emphasis on the research community is important in assuring that methodological procedures are maintained at a high level and causal interpretations are carefully made. In this way, the perspective of the research can be broadened and the research can be linked with parallel efforts in the field as a whole. This does not advocate doing research for groups in strictly linear succession; rather, it suggests that such research start with one emphasis that gradually alters and broadens to include other perspectives. As the emphasis changes and broadens, the context in which the research takes place should also broaden to include more classrooms and a variety of settings and grades.

A final point concerning the use of control groups in program evaluation should be made. The classical paradigm calls for the use of contrasting groups on which to base causal arguments. It should be clear from the work described earlier that LRDC does not, in general, use such an approach. Experience in evaluations conducted by the National Follow Through Program indicates that in large field studies, control groups rarely, if ever, bear any resemblence to the treatment

group and thus are of little value. One alternative is to use self-controls. Examples of such controls would include the historical or repeated measure designs, such as the multiple baseline designs, and the reversal design in ABA or ABAB formats. These approaches, however, are not always feasible on a large scale. Another alternative involves: (a) employing convincing models of how treatments bring about results, (b) including estimates of instructional processes in the data, (c) replicating the results over time, and (d) expanding the group in which research is conducted to guarantee variation in the treatment domain (Cooley & Leinhardt, 1975; Leinhardt, 1978). The point in educational research should be to develop convincing arguments as to the plausibility of results, and determine if the data are consistent with those arguments, rather than to declare immutable laws.

Contrasts of Design and Implementation Research

Two independent lines of research on the IELP have been carried out. The research focused on questions concerning the design, component fit, implementation, and impact of the program. The general procedure used for developing and implementing the program was: (a) to design and try out program components; (b) to modify the design and put the first generation of the program in developmental classrooms; and (c) to modify and implement the program in a wide range of classrooms, mostly Follow Through classrooms. This approach, however, generally created a gap of two to five years between the first and third steps. The purpose of this section is to contrast and interpret the findings from these different phases of the research.

The focus will be on three topics that have been consistently studied: assessment of student learning, the effects of teachers' verbal interactions with students, and the effects of increased student autonomy on student growth.

Assessment of student learning. A major feature of the IELP is the existence of built-in devices (i.e., criterion-referenced diagnostic tests) to assess student learning progress. In general, there are four categories of criterion-referenced tests that are used: placement tests for each level of the curriculum, administered when the student enters the program; pretests for each unit of the curriculum; curriculum-embedded tests for each objective; and posttests for each unit of the curriculum. These tests are used to assess the competency and mastery level of students and to inform the teacher about student progress. While some research has been done on the particular patterns of use for each type of test (Leinhardt, 1976), the question of common interest is, "How valuable is testing?"

Wang (1973d) addressed this question from the program design perspective in a study in which teachers were asked to estimate students' performance levels under conditions of maximum and minimum test information. The study found that even experienced teachers needed relatively frequent feedback from tests in order to predict a child's performance accurately. Leinhardt (1972, 1977b), on the other hand, addressed this question from a program evaluation perspective to determine the optimum frequency of testing. If a student is doing nothing but taking tests, it is obvious that the student will not be spending time learning new material. If, on the other hand, a student

is tested very infrequently, it is likely that the assignments will begin to diverge from the student's real needs. Results of Leinhardt's study indicated that students should be tested regularly but not too frequently. The optimum frequency for testing in the IELP's math program appears to be every five to ten days.

Teacher contact. A second line of questions dealt with teachers' verbal interactions with students. While many questions were investigated in this area, the overlap between experimental classroom studies carried out in the developmental classrooms and field research studies conducted in the LRDC Follow Through sites was on the type, duration, and frequency of contacts. Wang's experimental studies (Wang, 1976a; Wang & Brictson, 1973), which used task completion rates as the dependent variable, showed that student task completion rates increased significantly when teachers increased the frequency and length of their task-oriented contacts with students while decreasing their management contacts.

Research in field settings has shown that to improve student performance on standardized achievement tests, teachers must: focus their attention on cognitive material (e.g., reading and math); make frequent cognitive contacts (and few management contacts) with individuals, as opposed to groups; and have contacts of less than two minutes' duration (Leinhardt, 1976, 1977a&b, 1978). How can these different findings concerning length of contact be explained? While there are no data that specifically address this question, a closer review of the findings and the context of the studies can be made.

Wang's research was conducted in five to ten classrooms in LRDC's developmental schools, where the student was the unit of analysis and where both the students and teachers had received training in not only the curriculum components, but also in self-scheduling. Leinhardt's research was conducted in 30 to 60 LRDC-affiliated Follow Through classrooms, where there had not been such in-depth training. It may be that the important aspect of cognitive instruction is student contact with cognitive material at the appropriate level for the maximum amount of time. In the Follow Through classrooms this was accomplished by having the teacher contact a large number of students and focus those contacts on cognitive questions. In the developmental classrooms this was accomplished in part by the teacher and in part by student self-scheduling. Interestingly, data from both settings support the idea that an increase in management contacts leads to a decrease in student academic growth.

Student autonomy. A third topic that generated much interest in both the instructional design research and the field implementation research on the IELP was the effects of increased student autonomy on student academic growth. Leinhardt and Wang investigated the relationship between increasing levels of student independence and levels of academic growth. Data from the developmental schools consistently indicated that it was quite possible to maintain high levels of both student independence and academic growth (Wang, 1976a; Wang & Brictson, 1973; Wang, Mazza, Haines, & Johnson, 1972). Leinhardt's data from field research had more ambiguous results (Leinhardt, 1972, 1977a & b). She found that some types of autonomy (deciding when to take a test, moving from cognitive to noncognitive

areas of work at will) are dysfunctional, while other types of autonomy (deciding to work on a particular math unit, peer tutoring, and beginning work upon arrival at school) are more functional. These differences may be due to Wang's focus on student reports of autonomy and observed rates of initiation (Wang & Stiles, 1976), while Leinhardt focused on teacher reports (1977a).

As indicated in the discussion of the research, while the seeming contradiction between the results of the experimental and the field studies cannot always be directly explained by the data the differences may be attributable to the setting or the unit of analysis used. Program implementation in the developmental classrooms, where the experimental research was carried out, was monitored closely by the investigator, while implementation in the Follow Through sites did not involve the investigator. Further research to help explain these differences will contribute both to knowledge of instructional design and to an understanding of the factors affecting the implementation of the IELP. The implementation process must be adjusted to adapt to the needs and the entering competencies of the implementors (the teacher and principals) as well as to the contextual constraints of the local schools.

Some Final Remarks

The central question surrounding the development of the Individualized Early Learning Program was "how to help children learn more effectively". LRDC's participation in the National Follow Through Program has provided an invaluable opportunity to find some of

the answers to this question. A great deal is known about how learning takes place and which instructional intervention strategies tend to be more facilitating than others in fostering student learning in certain contexts. Program development and implementation experiences suggest that this knowledge can be incorporated into the design of innovative school practices that could be very effective in facilitating student learning.

The development of effective programs requires a systematically planned iterative process of design and evaluation research. Instructional experimentation as well as field research are needed to provide pertinent information regarding the effects of the components of a given learning environment on student learning. Furthermore, implementation of innovative school practices requires an adaptive process. The implementation of even the most carefully designed and empirically validated school programs must still undergo adaptations at the local level. Creative assimilation of the innovation by the user is the key to successful dissemination of innovations and effective implementation in classroom settings.

Appendix A

Selected Samples of Objectives Included

in the Various Prescriptive Curricula

Terminal Objectives of the IPI Mathematics

Level	Topics							
	Numeration-Place Value	Addition-Subtraction	Multiplication	Division	Fractions	Money	Time	Syst Mea
A	Ordering by size; more or less	Union of sets; removal of subsets; addition sentences			Equivalent parts	Matching coin names with pictures	Days of the week	
B	Numeration 10-100	1 digit numbers	Number line and groups of objects	Number line and groups of objects	Partitioned objects	Identifying coins	Hours	Mea line doz and
C	Numeration 100-1000	2 digit numbers	Products to 45 on digit factors	Relating multiplication to division	Identifying numerators & denominators	Value of coins	Minutes before and past the hour	Inch foot in a
D	Numeration to 9,999	4 digit numbers	2 digit factors three - 1 digit factors	Word problems	Equivalent factors 1/2 = 2/4	Making change	Writing time in standard form 3:15	Mea tem
E	Numeration 999,999,999	Five 6 digit sums	Four 1 digit factors; three digit dividend	Two digit divisor; three digit dividend	Common, mixed, decimal and expanded notation		Minutes and seconds past the hour	Incl yare our
F	Mixed decimal numerals	Decimals	Mixed decimal factors	5 digit dividends	Mixed numerals and common fractions		Determining elapsed time between two given times	Det are volu
G	Scientific notations	Negative integers	Decimals, signed integers	Decimals, six-digit dividend	Renaming as common, decimal, or percent			Ide- sur vol

of ment	Geometry	Applicatio
g ents nd dozens	Closed and open curves	Number se tances one digit
a ps t	Identifying plane figures	Using wha been learn
g ture	Points, line segments, rays, lines	Using wha been learn
eet illes, tons	Identifying angles	Using wha been learn
ning d	Measuring angles	Denomina numbers
ing rea	Polygons	Using wha been learn

Objectives of the Quantification Curriculum

	GIVEN:	THE CHILD CAN:
Units 1 and 2 Counting and One-to-One Correspondence[a]	A. Verbal instruction	A. Recite the numerals in order
	B. Set of moveable objects	B. Count the objects, moving them out of the set as he or she counts
	C. Fixed ordered set of objects	C. Count the objects
	D. Fixed unordered set of objects	D. Count the objects
	E. A numeral stated and a set of objects	E. Count out a subset of stated size
	F. A numeral stated and several sets of fixed objects	F. Select a set of size indicated by numeral
	G. Two sets of objects	G. Pair objects and state whether the sets are equivalent
	H. Two unequal sets of objects	H. Pair objects and state which set has more
	I. Two unequal sets of objects	I. Pair objects and state which set has less
Units 3 and 4 Numerals[b]	A. Two sets of numerals	A. Match the numerals
	B. A numeral stated, and a set of printed numerals	B. Select the stated numeral
	C. A numeral (written)	C. Read the numeral
	D. Several sets of objects and several numerals	D. Match numerals with appropriate sets
	E. Two numerals (written)	E. State which shows more (less)
	F. A set of numerals	F. Place them in order
	G. Numerals stated	G. Write the numeral
Unit 5 Comparison of Sets	A. Two sets of objects	A. Count sets and state which has more objects or that sets have same number
	B. Two sets of objects	B. Count sets and state which has less objects
	C. A set of objects and a numeral	C. State which shows more (less)
	D. A numeral and several sets of objects	D. Select sets which are more (less) than the numeral; given a set of objects and several numerals, the child can select numerals which show more (less) than the set of objects
	E. Two rows of objects (not paired)	E. State which row has more regardless of arrangement
	F. Three sets of objects	F. Count sets and state which has most (least)
Unit 6 Seriation and Ordial Position	A. Three objects of different sizes	A. Select the largest (smallest)
	B. Objects of graduated sizes	B. Seriate according to size
	C. Several sets of objects	C. Seriate the sets according to size
	D. Ordered set of objects	D. Name the ordinal position of the objects
Unit 7 Addition and Subtraction (sums to 10)	A. Two numbers stated, set of objects, and directions to add	A. Add the numbers by counting out two subsets then combining and stating combined number as sum
	B. Two numbers stated, set of objects, and directions to subtract	B. Count our smaller subset from larger and state remainder
	C. Two numbers stated, number line and directions to add	C. Use the number line to determine sum
	D. Two numbers stated, number line, and directions to subtract	D. Use number line to subtract
	E. Addition and subtraction word problems	E. Solve the problems
	F. Written addition and subtraction problems in form: $\frac{x}{+y}$ or $\frac{x}{-y}$	F. Complete the problems
	G. Addition and subtraction problems in form: $x + y =$ or $x - y =$	G. Complete the equations
Unit 8 Addition and Subtraction Equations	A. Equations in form of $z = \square + \Delta$	A. Show several ways of completing the equation
	B. Equations in form of $x + y = \square + \Delta$	B. Complete equation in several ways
	C. Equations in form of $x + y = z + \square$, $x + y = \square + z$	C. Complete the equations
	D. Equations in forms $x + \square = y$, $\square + x = y$	D. Complete the equations
	E. Complete addition equation (e.g., $x + y = z$)	E. Write equations using same numeral and minus sign (e.g., $z - x = y$) and demonstrate relationship
	F. Counting blocks and/or number line	F. Make up completed equations of various forms

[a] Unit 1 involves sets of up to 5 objects; unit 2 involves sets of up to 10 objects.

[b] Unit 3 involves numerals and sets of up to 5 objects; unit 4 involves numerals and sets of up to 10 objects.

Note: Adopted from "Adaptive Education for Young Children: The Primary Education Project" by L.R. Resnick, M.C. Wang, and J. Rosner. In *Preschool in Action: Exploring Early Childhood Programs* (2nd ed.) edited by M.C. Day and R.K. Parker (Boston: Allyn & Bacon, 1976).

Objectives of the Classification and Communication Skills Curriculum

	GIVEN:	THE CHILD CAN:
Unit 1 Basic Matching Skills	A. A set of two objects	A. State whether the pairs are the "same" or "different"
	B. Two identical sets of objects	B. Pair identical objects
	C. An array of objects varying in one dimention	C. Sort on the basis of differing attributes of that dimension
	D. Three objects – two identical, one different	D. Identify the one that is different
	E. A sample object and three disimilar objects	E. Identify the one that matches the sample
Unit 2 Shape and Size Discrimination	A. Basic shapes and matching outlines	A. Place the shapes on the appropriate outlines
	B. Irregular shapes and matching outlines	B. Place the shapes on the appropriate outlines
	C. Two sizes of rods and instructions to superimpose	C. State whether same or different size and give reason
	D. Two sizes of a shape and instructions to superimpose	D. State whether same or different and give reason
Unit 3 Color Naming	A. An array of the basic colors	A. Identify the stated colors
	B. An array of the basic colors	B. Name the colors
	C. Two identical sets of objects of different shades of a color	C. Match identical objects
	D. Several shades of a single color	D. Seriate in order from darkest to lightest
Unit 4 Shape Naming	A. An array of the seven basic shapes	A. Identify named shape
	B. An array of the seven basic shapes	B. Name the shapes
Unit 5 Advanced Matching Skills	A. Two objects, same on one dimension but different on another	A. State whether the objects are the same or different and give reason
	B. Three objects, varying in three dimensions, two alike on a given dimension and one different on that given dimension	B. Identify the object that is different and give reason
	C. A sample object and a set of objects varying in two dimensions	C. Identify object that matches sample in one dimension and give reasons
	D. An array of objects varying in two dimensions (color, shape, and size) and instructions to sort on the basis of one dimension	D. Place objects in groups according to one dimension and explain the basis for the sort
Units 6–9 Big and Little Long and Short Tall and Short Wide and Narrow	A. Two objects different in size	A. Point to the "big" ("long", "tall", "wide") object
	B. Two objects different in size	B. Verbally state which object is "big" etc. when asked
	C. Two objects different in size	C. Identify the "little" ("short", "narrow") object
	D. Two objects different in size	D. State which object is "little" etc. when asked
	E. Two objects different in size	E. Describe according to size using the term "big" or "little", etc.
	F. Two objects different in size	F. Compare and state which is "bigger", "smaller" etc.
	G. Several sizes of an object	G. Seriate in order from biggest to smallest

Note: Adopted from "Adaptive Education for Young Children: The Primary Education Project" by L.R. Resnick, M.C. Wang, and J. Rosner, In *Preschool in Action: Exploring Early Childhood Programs* (2nd ed.) edited by M.C. Day and R.K. Parker (Boston: Allyn & Bacon, 1976).

Objectives of the Visual - Motor Component of the PEP Curriculum

	GIVEN:		THE CHILD CAN:	
Level A	Unit 1:	A group of one-inch cubes arranged in a single row	Unit 1:	Superimpose matching cubes
	Unit 2:	A group of one-inch cubes arranged in a single row	Unit 2:	Construct a replication alongside the model
Level B	Unit 1:	A group of one-inch cubes arranged into an interlocking row and column	Unit 1:	Superimpose matching cubes
	Unit 2:	A group of one-inch cubes arranged into an interlocking row and column	Unit 2:	Construct a replication alongside model
	Unit 3:	A drawing of a group of one-inch cubes arranged into interlocking rows and columns	Unit 3:	Construct a matching arrangement alongside drawing
Level C	Unit 1:	A Design Board F on which two rubber bands (one horizontal, one vertical) have been stretched	Unit 1:	Superimpose two additional rubber bands
	Unit 2:	A Design Board F on which three rubber bands (two horizontal, one vertical) have been stretched	Unit 2:	Replicate pattern on second Design Board F
	Unit 3:	A drawing of a Design Board F on which two rubber bands (one horizontal, one vertical) are represented	Unit 3:	Construct the pattern on a Design Board F
Level D	Unit 1:	A drawing of a Design Board F on which two rubber bands (one vertical, one horizontal) are represented	Unit 1:	Trace accurately over the two lines
	Unit 2:	A Design Board F on which two rubber bands (one vertical, one horizontal) have been stretched	Unit 2:	Replicate pattern on second Design Board F
	Unit 3:	A drawing of a Design Board F on which two rubber bands (one horizontal, one vertical) are represented	Unit 3:	Construct the pattern on a Design Board F
	Unit 4:	A drawing of a Design Board F on which three rubber bands (one horizontal, two vertical) are represented	Unit 4:	Copy (draw) the pattern on a second printed representation of the Design Board F
Level E	Unit 3:	A drawing of Design Board I on which three rubber bands (one vertical, one horizontal, one diagonal) are represented	Unit 3:	Construct the pattern on a Design Board I
	Unit 4:	A drawing of Design Board I on which three rubber bands (one horizontal, one vertical, one diagonal) are represented	Unit 4:	Copy (draw) the pattern on a second printed representation of Design Board I
Level F	Unit 3:	A drawing of Design Board P on which three rubber bands (one vertical, two diagonal) are represented	Unit 3:	Construct the pattern on a Design Board P
	Unit 4:	A drawing of Design Board P on which three rubber bands (one horizontal, one vertical, one diagonal) are represented	Unit 4:	Copy (draw) the pattern on a second printed representation of Design Board P
Level G	Unit 3:	A drawing of Design Board P on which five rubber bands (vertical, horizontal, diagonal) are represented	Unit 3:	Construct the pattern on a Design Board P
	Unit 4:	A drawing of Design Board P on which five rubber bands (horizontal, vertical, diagonal) are represented	Unit 4:	Copy (draw) the pattern on a second printed representation of Design Board P
	Unit 5:	A drawing of Design Board P on which four rubber bands (vertical, horizontal, diagonal) are represented	Unit 5:	Copy (draw) the pattern on a second printed representation of Design Board P from which 8 dots have been faded (PF8)
Level H	Unit 3:	A drawing of Design Board P on which eight rubber bands (vertical, horizontal, diagonal) are represented	Unit 3:	Construct the pattern on a Design Board P
	Unit 4:	A drawing of Design Board P on which eight rubber bands (horizontal, vertical, diagonal) are represented	Unit 4:	Copy (draw) the pattern on a second printed representation of Design Board P
	Unit 5:	A drawing of Design Board P on which seven rubber bands (vertical, horizontal, diagonal) are represented	Unit 5:	Copy (draw) the pattern on a second printed representation of Design Board P from which 16 dots have been faded (PF16)
Level I	Unit 4:	A drawing of Design Board P on which ten rubber bands (horizontal, vertical, diagonal) are represented	Unit 4:	Copy (draw) the pattern on a second printed representation of Design Board P
	Unit 5:	A drawing of Design Board P on which ten rubber bands (vertical, horizontal, diagonal) are represented	Unit 5:	Copy (draw) the pattern on a second printed representation of Design Board P from which all dots have been faded (PF25)

Objectives of Auditory - Motor Component of the PEP Curriculum

	GIVEN:		THE CHILD CAN:	
Level A	Unit 1:	March tempo music	Unit 1:	Clap hands in synchrony with the music
	Unit 2:	A series of claps	Unit 2:	Ranging from one to four, draw a horizontal dash for each clap, from left to right
	Unit 3:	A series of claps	Unit 3:	Ranging from one to four, reproduce the clapping pattern
Level B	Unit 1:	Music with changing tempo, clap hands in synchrony with the music	Unit 1:	Adapting to changes in tempo
	Unit 2:	A series of long and short musical tones, ranging from one to four in total	Unit 2:	Draw an appropriate horizontal dash for each sound, from left to right
	Unit 3:	A series of long and short claps, ranging from one to four in total	Unit 3:	Reproduce the clapping pattern
	Unit 4:	A spoken phrase of numerals	Unit 4:	Clap hands once for each word in the phrase
	Unit 5:	A spoken phrase of numerals	Unit 5:	"Write" the phrase, using a horizontal dash to represent each numeral (from left to right), and "read" aloud any numeral on request
Level C	Unit 4:	A spoken phrase of one-syllable words	Unit 4:	Clap hands once for each word in phrase
	Unit 5:	A spoken phrase of one-syllable words	Unit 5:	"Write" the phrase, using a horizontal dash to represent each word (from left to right), and "read" aloud any word requested.
	Unit 6:	A series of spoken one-syllable words	Unit 6:	Indicate the presence or absence of a specific word in that series
	Unit 7:	A series of spoken words followed by the same series from which one word has been omitted	Unit 7:	State the omitted word
Level D	Unit 4:	A spoken phrase of one- and two-syllable words	Unit 4:	Say and clap hands simultaneously for each syllable in phrase
	Unit 5:	A spoken phrase of one- and two-syllable words	Unit 5:	"Write" the phrase, using a horizontal dash (from left to right) to represent each syllable, and "read" aloud any syllable on request
	Unit 6:	A spoken two-syllable word	Unit 6:	Indicate presence or absence of a specified syllable in that word
	Unit 7:	A spoken two-syllable word followed by a statement of only one of the syllables	Unit 7:	Say the syllable that was omitted
	Unit 8:	A spoken two-word series or compound two-syllable word	Unit 8:	State single remaining word or syllable by omitting the other as designated
Level E	Unit 4:	A spoken phrase of one-, two-, and three-syllable words	Unit 4:	Say and clap hands simultaneously for each syllable in phrase
	Unit 5:	A spoken one-, two-, or three-syllable word	Unit 5:	"Write" the word, using a horizontal dash (from left to right) to represent each syllable, and "read" aloud any syllable on request
	Unit 6:	A spoken three-syllable word	Unit 6:	Indicate presence or absence of a specified syllable in that word
	Unit 7:	A spoken three-syllable word followed by a statement of only two of the syllables	Unit 7:	Say the syllable that was omitted
	Unit 8:	A spoken three-syllable word	Unit 8:	Restate the word omitting a designated syllable
Level F	Unit 6:	Three spoken words and a specified consonant or vowel sound	Unit 6:	Indicate which word begins with that sound
	Unit 7:	A spoken word, followed by a restatement of the word with the initial consonant sound omitted	Unit 7:	State the omitted sound
	Unit 8:	A spoken word	Unit 8:	Repeat the word omitting its initial consonant sound
Level G	Unit 6:	Three spoken words and a specified consonant sound	Unit 6:	Indicate which word ends with that sound
	Unit 7:	A spoken word, followed by a restatement of the word with its final consonant sound omitted	Unit 7:	State the omitted sound
	Unit 8:	A spoken word	Unit 8:	Repeat the word omitting its final consonant sound
	Unit 9:	A spoken word	Unit 9:	Substitute one beginning or ending sound for another
Level H	Unit 6:	Three spoken words and a specified consonant or vowel sound	Unit 6:	Identify which word contains that sound
	Unit 7:	A spoken word, followed by a restatement of the word with one consonant sound of a two-consonent blend omitted	Unit 7:	State the omitted sound
	Unit 8:	A spoken word	Unit 8:	Repeat the word omitting one consonant sound of a two-consonent blend
	Unit 9:	A spoken word	Unit 9:	Substitute any consonant or vowel sound for another

Objectives of General - Motor Component of the PEP Curriculum

	GIVEN:		THE CHILD CAN:
Level A	Unit 1:	Verbal instructions	Unit 1: Stand with one foot crossed in front of the other for 5 seconds; then repeat with other foot forward
	Unit 2:	Verbal instructions	Unit 2: Walk forward a distance of 10 feet with feet crossing over in front of each other
	Unit 3:	Verbal instructions	Unit 3: Jump forward: feet together
	Unit 4:	Verbal instructions	Unit 4: Click teeth while lips are together: move eyes freely to far left and far right
	Unit 5:	Verbal instructions	Unit 5: Use scissors to cut paper
	Unit 6:	Verbal instructions	Unit 6: Identify named body parts
	Unit 7:	Verbal instructions	Unit 7: Move only one arm, then the other, while in supine position. (Angels in Snow posture)
	Unit 8:	Tempo set by teacher and verbal instructions	Unit 8: Tap right and left hands, alternately, in tempo, run in place
Level B	Unit 1:	Verbal instructions	Unit 1: Balance on one hand and opposite knee and foot for 6 seconds; then repeat with other hand, knee and foot
	Unit 2:	Verbal instructions	Unit 2: Hop in place on one foot, while supporting self with hands; then with other foot
	Unit 3:	Verbal instructions	Unit 3: Broad jump - 12 inches
	Unit 4:	Verbal instructions	Unit 4: Move tongue (inside mouth) from one cheek to the other. Move eyes laterally, looking from own right hand to own left hand
	Unit 5:	Verbal instructions	Unit 5: Draw a single line connecting two dots that are three inches apart
	Unit 6:	Verbal instructions	Unit 6: Name designated body parts
	Unit 7:	Verbal instructions	Unit 7: Move one leg, then the other, while in supine position. (Angels in Snow posture)
	Unit 8:	Tempo set by teacher and verbal instructions	Unit 8: Tap each hand twice, alternating hands while maintaining rhythm and tapping pattern
Level C	Unit 1:	Verbal instructions	Unit 1: Stand balanced on one foot for 8 seconds; then balance on the other foot
	Unit 2:	Verbal instructions	Unit 2: Hop forward on one foot, a distance of 8 feet; then on the other foot
	Unit 3:	Verbal instructions	Unit 3: Skip, maintaining synchronous pattern for at least 15 feet
	Unit 4:	Verbal instructions	Unit 4: Move tongue and eyes in same direction at same time, upon verbal direction
	Unit 5:	A string and verbal instructions	Unit 5: Tie a bow
	Unit 6:	Verbal instructions	Unit 6: Name designated body parts (touched but not seen)
	Unit 7:	Verbal instructions	Unit 7: Move arm and leg on same side simultaneously while in a supine position; then the other arm and leg (Angels in Snow posture). Move both hands sumultaneously in the same direction to draw a horizontal line; then move both in opposite direction
	Unit 8:	Tempo set by teacher and verbal instructions	Unit 8: Hop twice, alternating feet while maintaining rhythm and hopping pattern

Note. Adopted from "Adaptive Education for Young Children: The Primary Education Project" by L.B. Resnick, M.C. Wang, and J. Rosner. In *Preschool in Action: Exploring Early Childhood Programs* (2nd ed.), edited by M.C. Day and R.K. Parker (Boston: Allyn & Bacon, 1976).

References

Beck, I. L., & Bolvin, J. A model for non-gradedness: The reading program for individually prescribed instruction. Elementary English, 1967, 46(2), 130-135. Also LRDC Publication Series R44.

Champagne, D. The Educational Specialist role: A short description. Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1971.

Cooley, W. W., & Leinhardt, G. The application of a model for investigating classroom processes (LRDC Publication 1975/24). Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1975.

Cox, R. C., & Boston, M. E. Diagnosis of pupil achievement in the individually prescribed instruction project. Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1967.

Durost, W. N., Bixler, H. H., Wrightson, J. W., Prescott, G. A., & Balow, I. H. Metropolitan Achievement Tests. New York, NY: Harcourt, Brace, Jovanovich, 1971.

Eichelberger, R. R., & Boston, M. E. Follow Through Program final sponsor report school year 1973-74 (Vol. I & II). Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1976. (a)

Eichelberger, R. T., & Boston, M. E. The LRDC Follow Through individualized early learning proram. Paper submitted to Follow Through for final evaluation report, 1976. (b)

Gagne, R. M. The acquisition of knowledge. Psychological Review, 1962, 69, 355-365.

Gagne, R. M. Learning hierarchies. Educational Psychologist, 1968, 6, 1-9.

General Accounting Office. Follow Through: Lessons learned from its evaluation and need to improve its administration. Report to the Congress by the Comptroller General of the United States, Washington, D. C., October, 1975.

Glaser, R. Individuals and learning: The new aptitudes. Educational Researcher, 1972, 1, 5-13.

Jastak, J. F., Bijou, S., W., & Jastak, S. R. Wide Range Achievement Test. Wilmington, DE: Guidance Associates, 1965.

Leinhardt, G. The boojum of evaluation: Implementation, some measures. Unpublished doctoral dissertation, University of Pittsburgh, 1972.

Leinhardt, G. Observation as a tool for evaluation of implementation. Instructional Science, 1976, 5, 343-364.

Leinhardt, G. Evaluating an adaptive education program: Implementation to replication. Instructional Science, 1977, 6, 223-257. (a)

Leinhardt, G. Program evaluation: An empirical study of individualized instruction. American Educational Research Journal, Summer 1977, 14 (3), 277-293. (b)

Leinhardt, G. Applying a classroom process model to instructional evaluation. Curriculum Inquiry, 1978, 8 (2), 155-176.

Lindvall, C. M., & Bolvin, J. O. The project for individually prescribed instruction (The Oakleaf Project). Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1966. (LRDC Working Paper 8; ERIC Document Reproduction Service No. ED-010 522)

Piaget, J. Psychology of intelligence. New Jersey: Littlefield, Adams (Rep. by arrangement with Humanities Press), 1963.

Raven, J. C. Coloured progressive matrices. London: H. K. Lewis and Co., Ltd., 1956.

Resnick, L. B. Design of an early learning curriculum. Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1967. (LRDC Working Paper 16)

Resnick, L. B., Wang, M. C., & Kaplan, J. Behavior analysis in curriculum design: A hierarchically sequenced introductory mathematics curriculum. Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1970. (LRDC Publication Series, Monograph 2, 1970).

Rosner, J. The development and validation of an individualized perceptual skills curriculum (LRDC Publication, 1972/7). Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1972. Also, ERIC Reproduction Service ED 062 731.

Skinner, B. F. Beyond freedom and dignity. New York, NY: A. A. Knopf, 1971.

Thorndike, R., Hagan, E., & Lorge, I. Cognitive Abilities Test (Primary I/Form I). Boston, MA: Houghton Mifflin, 1968.

Wang, M. C. The PEP testing program. Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1969.

Wang, M. C. Learning activities and tutoring lessons for the classification and communication curriculum. Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1972.

Wang, M. C. Psychometric studies in the validation of an early learning curriculum. Child Development, 1973, 44, 54-60. (a)

Wang, M. C. Teacher's manual for the exploratory learning component of the classification and communication skills curriculum: Unit games (Vol. 1); Commercially-produced games (Vol. 2), Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1973. (b)

Wang, M. C. Teacher's manual for the exploratory learning component of the LRDC individualized instruction program for the early learning grades: Learning center (Vol. 1); Special projects (Vol. 2). Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1973. (c)

Wang, M. C. The accuracy of teachers' prediction on children's learning performance. The Journal of Educational Research, 1973, 66 (10) 462-465. (d)

Wang, M. C. The rationale and design of the Self-Schedule System (LRDC Publication, 1974/5). Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1974.

Wang, M. C. (Ed.) The use of direct observation to study instructional learning behaviors in school settings. Instructional Science, 1976, 5 365-389. (a) Also, LRDC Publication, 1974/9.

Wang, M. C., (Ed.) The self-schedule system for instructional-learning management in adaptive school learning environments (LRDC Publication, 1976/9). Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1976. (b)

Wang, M. C., & Brictson, P. An observational investigation of classroom instructional-learning behaviors under two different classroom management systems. Unpublished manuscript, University of Pittsburgh, Learning Research and Development Center, 1973.

Wang, M. C., Mazza, M., Haines, J., & Johnson, M. Some measured effects of a classroom management model designed for an individualized early learning curriculum. Paper presented at the annual meeting of the American Educational Research Association, Chicago, April, 1972.

Wang, M. C., & Resnick, L. B. The primary education program (PEP). Johnstown, PA: Mafex Associates, Inc., 1978.

Wang, M. C., Resnick, L. B., & Boozer, R. F. The sequence of development of some early mathematics behaviors (LRDC Publication, 1971/6). Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1971.

Wang, M. C., Resnick, L. B., & Schuetz, P. A. PEP in the Frick elementary school: Interim evaluation report of the primary education project 1968-69. Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1970. (LRDC Working Paper 57).

Wang, M. C., Resnick, L. B., & Schuetz, P. R. PEP in the Frick

elementary school: Interim evaluation reports 1969-70 (LRDC Publication, 1974/13). Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1974.

Wang, M. C., & Siegel, A. W. The rationale and design of an adaptive beginning school learning environment: Curriculum objectives (LRDC Publication, 1975/1). Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center, 1975.

Wang, M. C., & Stiles, B. An investigation of children's concept of self-responsibility for their school learning. American Educational Research Journal, 1976, 13(3), 159-179. Also, (LRDC Publication 1975/11).

Footnotes

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(3) LRDC was established in 1963 with the overall goal of carrying out a program of research and development that would lead toward a better understanding and improvement of educational practices in the nation's elementary schools. Within LRDC's scope of work are projects committed to research and development in learning and cognition as they relate to instruction, the design of improved instructional practices and classroom processes, the development of evaluation and implementation methodology, and the assessment of the effectiveness of school programs. For over a decade, LRDC has been concerned with designing school programs that meet the individual needs of students. A basic aim of the individualized instructional model developed at LRDC is to provide quality education for all children. The main task has been to design programs that are flexible and adaptive to a wide range of individual differences in children. A number of individualized instructional programs have been developed and tested by the LRDC staff and teachers in the collaborating schools. Among these is the Individualized Early Learning Program, the program being implemented in the LRDC Follow Through sites. LRDC has participated in the National Follow Through Program since 1968, and is working with seven Follow Through project sites to implement the Individualized Early Learning Program. The program is currently being used in 23 Follow Through elementary schools.

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