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THE EFFECT OF INDIVIDUALIZED LEARNING ACTIVITY PACKAGES
IN MATHEMATICS ON THE ACADEMIC ACHIEVEMENT
OF SEVENTH- AND EIGHTH-GRADE STUDENTS
IN THE DEMOPOLIS CITY SCHOOLS

by

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A DISSERTATION

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TABLE OF CONTENTS

LIST OF TABLES	iv
LIST OF FIGURES	vi
ACKNOWLEDGMENTS	vii
Chapter	
I. INTRODUCTION	1
Statement of the Problem	4
Statement of the Purpose	6
Significance of the Study	6
Methodology	7
Sources of Data	7
Analytical Criteria for Evaluation	7
Procedures	8
Definition of Terms	8
Delimitations	10
Organization of the Study	12
II. REVIEW OF RELATED LITERATURE	13
Definition of Individualization	13
Contrasting Views of Individualization	18
Self-Paced Unit Plans	19
Learning Activity Packages	22
Demopolis LAP	27
Learning Activity Packages and Student Achievement	32
Summary	35

III.	METHODS AND PROCEDURES	37
	The School	37
	Participants in the Study	39
	Treatment	40
	Collection of Data	46
	Treatment of Data	49
IV.	ANALYSIS OF THE DATA	52
	Design	52
	Treatments	53
	Levels	54
	Statistical Computations	55
	Statistical Procedures	55
	One-Way Analysis of Variance	57
	Two-Way Analysis of Variance	60
	Grade Seven	61
	Grade Eight	65
	Summary	70
V.	SUMMARY, CONCLUSIONS, RECOMMENDATIONS, AND IMPLICATIONS	72
	Summary of Findings	74
	Conclusions	76
	Recommendations	77
	Implications for Educational Practice	78
APPENDIX A	MATH INVENTORY	80
APPENDIX B	DATA ON MATCHED PAIRS	90
BIBLIOGRAPHY	93

LIST OF TABLES

1.	Enrollment by Grade Levels of Demopolis Junior High School, 1972-1973 School Year	30
2.	Enrollment by Homogeneous Sections of Demopolis Junior High School, 1972-1973 School Year	38
3.	Enrollment by Race of Demopolis Junior High School, 1972-1973 School Year	40
4.	A Comparison of Mathematics Sections of the California Achievement Tests, Level 3, Form A, and Level 4, Form A . . .	48
5.	Enrollment by Instructional Practices in Mathematics of Demopolis Junior High School, 1972-1973 School Year	50
6.	Analysis of Variance Summary for Grade Seven Sample	58
7.	Analysis of Variance Summary for Grade Eight Sample	59
8.	Analysis of the Total Sum of Squares in the Treatments x Levels Design	60
9.	Analysis of Variance Summary by Sex for Grade Seven	62
10.	Analysis of Variance Summary by Race for Grade Seven	63
11.	Analysis of Variance Summary by Intelligence Quotient for Grade Seven . .	64

12.	Analysis of Variance Summary by Sex for Grade Eight	66
13.	Analysis of Variance Summary by Race for Grade Eight	68
14.	Analysis of Variance Summary by Intelligence Quotient for Grade Eight . .	69

LIST OF FIGURES

1.	Gibbons' Classification of Individualized Instructional Programs Through Individual Practices	20
2.	Ubben's Model of Options of Individualization Available in Use of LAP	26
3.	Scope and Sequence for LAP Mathematics Program, Demopolis Junior High School . . .	41

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CHAPTER I

INTRODUCTION

While the importance of the individual has been proclaimed throughout the history of American education and the desirability of individualized instruction has been espoused for a considerable time, only recently have developments permitted creation of effective programs for individualization. These developments include:

1. An awareness of and skill in specifying educational objectives.
2. Acceptance of the notion of self-instruction, self-initiation, and self-direction in learning.
3. Refinement of testing techniques that permit assessment in terms of specific goals.
4. Acceptance of differentiated responsibilities that permit instructional roles other than that of teacher.
5. Development of improved management skills that allow for proper record keeping and classroom management.
6. Awareness of the use of feedback data about the student as a contingency for motivation.¹

¹Robert G. Scanlon, Foreword to An Educator's Guide to the New Design, by Richard P. Manatt and E. Truce Meeks (Dubuque, Iowa: Kendall/Hunt Publishing Co., 1971), p. vii.

The definitional problem with the term individualization is seen as a major obstacle in any consideration of the instructional process.² Individualized instruction is descriptive of diverse approaches to teaching with various foci of concern and theoretical bases. Essential prior questions pertain to instruction as well as individualization; understanding of the concept of instruction is claimed to be the "most significant thing in understanding individualized instruction."³ These concerns must be considered and stipulative definitions stated.

Among current programs of individualization are the following: the Learning Activity Package (LAP) of the Nova School District in Fort Lauderdale, Florida;⁴ the Individual Study Unit (ISU) of the Wyandanch Public Schools of Wyandanch, Long Island, New York;⁵ Individually

²James E. Eisele, "Individualized Instruction," Contemporary Education 43, no. 1 (October 1971):16.

³James E. McClellan, "Individualized Instruction: A Projection," Philosophical Redirection of Educational Research, ed. Lawrence G. Thomas, in The Seventy-first Yearbook of the National Society for the Study of Education, pt. I (Chicago: University of Chicago Press, 1972), p. 173.

⁴James Lewis, Jr., Administering the Individualized Program (West Nyack, N.Y.: Parker Publishing Co., 1971), pp. 12, 13.

⁵Ibid., p. 13.

Prescribed Instruction (IPI) developed by the University of Pittsburgh;⁶ the Program for Learning in Accordance with Needs (PLAN) developed jointly by the American Institute for Research and Westinghouse Learning Corporation;⁷ and Continuous Progress Lessons (CPL's) created by teachers in Phoenix, Arizona.⁸

While there were numerous programs of individualization appearing under as many acronyms, there was a scarcity of published evaluative research. Having reviewed the research related to individualized instruction, Malan and Merrill concluded that there was "a great dearth of valid, published research studies which attempt directly to evaluate individualized instruction."⁹

Providing for individual needs and desires in an individualized program of instruction must necessarily

⁶Ibid.

⁷Individualization in Schools: The Challenge and the Options (Washington, D.C.: National School Public Relations Association, 1971), p. 20.

⁸"More Projects on Individualized Instruction," Arithmetic Teacher 18, no. 7 (November 1971):474.

⁹Ronald F. Malan and M. David Merrill, "Acronyms Anonymous: Toward a Framework for the Empirical Validation of Methods of Individualizing Instruction," Educational Technology 19, no. 12 (December 1971):32.

include consideration of the professional staff and the students in the context of a particular school. Dwight W.

Allen stated:

When educational offerings are individualized for students' needs and desires and when the program is designed in the light of the abilities and desires of the professional staff administering the program, the curriculum in its entirety must reflect a plan peculiar to that school.¹⁰

Statement of the Problem

Demopolis Project LAP, funded under the Elementary and Secondary Education Act (ESEA), Title III, located in the Demopolis City Schools, Demopolis, Alabama, was an effort to utilize the developments listed above and to employ the position delineated by Allen.

By means of Learning Activity Packages (LAPs), individualized instruction was provided in the areas of science and mathematics, grades seven and eight, in the Demopolis Junior High School. The 1972-1973 academic year was the first year of implementation of the program in mathematics, with the implementation of science to follow in the 1973-1974 school year.

¹⁰ Dwight W. Allen, Foreword to Individualizing Learning Through Modular-Flexible Programming, by Gaynor Petrequin (New York: McGraw-Hill Book Co., 1968), p. ix.

Of the various methods of individualization, the learning package or instructional packet was probably the most controversial.¹¹ It was through the use of such an approach that the Demopolis LAP program was designed to provide for a wide range of student interest, abilities, and achievement levels.¹²

The evaluation design for the 1972-1973 academic year provided a means for determining an expansion of the range of student interest and activities beyond the limits commonly associated with math and science programs in the junior high school. The design also included a comparison of the range of academic achievement by students in LAP classes with individual performance in the context of group oriented programs conventionally found in school.¹³

While group norms and individual comparisons were called for in the design, it was considered desirable to examine in depth the relative significance of several

¹¹Arthur A. Herd, "Successful Practices in Individualized Instruction," NASSP Bulletin 55, no. 359 (December 1971):76.

¹²"Demopolis City Schools, ESEA, Title III, Initial Application, Project L.A.P.," n.d., p. 29.

¹³Sam Leles, "Project L.A.P. Evaluation Design, 1972-1973, Demopolis City Public Schools, Demopolis, Alabama," n.d.

variables upon academic achievement in mathematics and to explore the questions of reliability and practicality.

Statement of the Purpose

The purpose of this study was to determine the effect of individualized Learning Activity Packages in mathematics on the academic achievement of seventh- and eighth-grade students in the Demopolis City Schools during the 1972-1973 academic year. Effectiveness was established by academic growth as measured by standardized pre- and post-tests.

The statistical and substantive significance of each of three variables were determined by grade level as they related to academic achievement. These variables were: (1) race, (2) sex, and (3) intelligence quotient.

Significance of the Study

The study provided information useful to the Demopolis City Board of Education in determining the advisability of continuing the LAP program when federal funding terminated in June, 1974. Findings could also be utilized to determine the necessity of refinements in the program.

Of more general significance, the study provided data of value in establishing the importance of race, sex, and intelligence quotient by grade level upon the academic achievement of students in mathematics who received instruction by means of the LAP program. Conversely, findings provided insight as to the suitability of the LAP program for students of a particular race or sex, of a certain age group, and/or of various levels of intelligence as measured by an intelligence quotient.

Methodology

Sources of Data

Pre- and post-testing using the math section of the California Achievement Tests (CAT) provided data for a determination of the range of academic growth as herein defined. The intelligence quotient was determined by use of the Otis-Lennon Test of Mental Ability. Chronological age, race, and sex were identified by local school records.

Analytical Criteria for Evaluation

The Lindquist treatments x levels design was employed to "increase the precision of the treatment comparisons by 'matching' the treatment groups with reference

to a 'control' variable related to the criterion variable."¹⁴ Analysis of variance and correlation techniques were used to determine reliability and practicality of the statistical findings.

Procedures

Test data were used to match pairs by grade level on the basis of four variables: (1) chronological age, (2) race, (3) sex, and (4) intelligence quotient. An in-depth review was made of the literature which related to individualized instruction, self-paced unit plans, learning activity packages, and pertinent research. Conclusions, recommendations, and implications were based on the analysis of data and literature applicable to the Demopolis Project LAP program of instruction.

Definition of Terms

Academic achievement--the scores of students on the mathematics portion of the California Achievement Tests, 1970 revision. Pre- and post-test data were

¹⁴E. F. Lindquist, Design and Analysis of Experiments in Psychology and Education (Boston: Houghton Mifflin Co., 1973), p. 121.

obtained by use of Level 3 Form A for seventh-grade students and by use of Level 4 Form A for eighth-grade students.

Academic growth--the improvement of student performance on the California Achievement Tests as reflected in a comparison of pre- and post-test scores.

Behavioral objective--a statement which "communicates to the teacher and learner the intent of the activity to be achieved at the conclusion of a learning experience, the conditions necessary for the attainment of the learning experience, and the level of performance."¹⁵

Evaluation design--a document systematically providing for data collection, interpretation, and dissemination related to the attainment of the ESEA, Title III project objectives.

Individualized instruction--"a phylum rather than a species of approaches to teaching" which has as its

¹⁵James V. McCullouch, "The Effects of Using a Behavioral-Objectives Curriculum in Mathematics on the Academic Achievement of Ninth-Grade Pupils in the Meridian Separate School District" (Ed.D. dissertation, University of Alabama, 1970).

theoretical ideal the provision of separate, unique, appropriate instruction for each student.¹⁶

Learning Activity Package (LAP)--highly structured printed material which serves the dual purpose of providing learning activities and specifying the location of study material for a concept or skill which is behaviorally stated. The crucial component of a LAP is the behavioral objective.

Self-paced unit plans--a means by which an effort is made to provide "individualized instruction" by allowing each student to begin his learning at a level of difficulty at which he is able to successfully perform, to proceed at his own pace, and to assume responsibility for his own learning.

Delimitations

Generalizations from the study are necessarily limited in that the sample was taken from the seventh- and eighth-grade students enrolled in the Demopolis Junior High School, Demopolis, Alabama. Utilization of the treatments x levels design with matched pairs further

¹⁶Maurice Gibbons, "What Is Individualized Instruction?" Interchange 1, no. 2 (February 1970):28.

limited the sample to students in LAP classes with those in conventional classes who matched on the predictor variables of chronological age, sex, race, and intelligence quotient.

While conditions under which students were expected to learn included inadequate heating, an obsolete physical plant, a first-year exposure to a program of individualized instruction, and a first or second year of a highly racially integrated school environment, the effects of such variables were equally applicable to students in both the LAP and the non-LAP groups.

The study was restricted to one year of instruction. Pre-test scores were derived from testing in May, 1972, while post-test scores were obtained from testing conducted the latter part of April, 1973. Only the scores of students either in LAP classes or non-LAP classes in mathematics throughout the entire 1972-1973 school year were included.

The limitations and assumptions implicit in the use of a standardized test to measure achievement in a locally-prepared teacher-developed individualized program and in local conventional instruction in mathematics are recognized.

Organization of the Study

Chapter I provided an introduction to the study and included a statement of the problem, a statement of the purpose, the significance of the study, methodology, definition of terms, and delimitations of the study.

Review of literature related to individualized instruction, and specifically to the Demopolis LAP program of individualization, was summarized in Chapter II.

Chapter III described, in detail, the methodology of the study. Included in Chapter III are descriptions of the school in which the study took place, the participants in the study, the treatment, the collection of data, and the treatment of data.

Test results and analysis of data collected in the study are contained in Chapter IV. Summarization of findings, recommendations, and implications for educational practice comprise Chapter V.

CHAPTER II

REVIEW OF RELATED LITERATURE

The review of literature included material which was related to (1) the definition of individualization, (2) the contrasting views of individualization, (3) self-paced unit plans, (4) learning activity packages, (5) Demopolis LAP, and (6) learning activity packages and student achievement.

Definition of Individualization

McClellan has claimed that of utmost importance to an understanding of individualized instruction is an understanding of the concept of instruction. He defined the latter as "that sort of intervention in another's life which provides him some purpose in acting a certain way or some reason for believing something he might not otherwise have believed."¹

¹James E. McClellan, "Individualized Instruction: A Projection," Philosophical Redirection of Educational Research, ed. Lawrence G. Thomas, in The Seventy-first Yearbook of the National Society for the Study of Education, pt. I (Chicago: University of Chicago Press, 1972), p. 189.

While this change in students is "the fundamental purpose of individualization" it is, according to Gibbons, inadequate as a basis for categorization of individualized programs.² Rather, the "nature of the conditions for learning provided by the teacher, from whatever source of inspiration or authority, seems the most reliable basis for describing a program."³

After reviewing various programs referred to as individualized, noting the varying degrees of individualization and examining elements of individualized programs, Gibbons concluded that such programs "constitute a widely diverse family, . . . are based on different interpretations of individualization, . . . are inspired by different philosophies and theories, . . . and confounded by the ambiguity of their label."⁴

Current use of the term "individualization" makes no distinction between "general and specific goals of

²Maurice Gibbons, "What Is Individualized Instruction?" Interchange 1, no. 2 (February 1970):34.

³Ibid.

⁴Ibid., p. 28.

education and between group and individual instruction."⁵ Various definitions have called for elements different in degree if not in kind. A definition offered by Herd emphasized a high degree of flexibility which allowed a student to learn at his own pace, included some assumption of responsibility by the student for his own learning, and provided for "multiple materials, media, and procedures."⁶

White defined individualized instruction as the matching of a student to an instructional system "such that he is working at his own speed, learning style, and ability level of appropriate materials in keeping with his goals, supported by adequate assistance in a suitable learning environment."⁷ The instructional system includes educational objectives, exit criteria, strategies and methods for goal attainment, physical spaces in which to learn, appropriate group sizes ("group" meaning one or

⁵Eugene D. Nichols, "Is Individualization the Answer?" Educational Technology 12, no. 8 (March 1972):57.

⁶Arthur A. Herd, "Successful Practices in Individualized Instruction," NASSP Bulletin 55, no. 359 (December 1971):76.

⁷Virginia T. White, "A Profile of Individualized Instruction," Mathematics Teacher 65, no. 5 (May 1972): 394.

more), supportive personnel, and media.⁸ The educational system, of which the instructional system is a subsystem has, as components, both formative and summative evaluation.⁹

Indelicato presented a definition of individualized instruction which called for diagnosis of pupil needs and prescription of appropriate materials, provided for self-pacing, and allowed the student to "achieve a certain mastery of the content."¹⁰

Among feasible strategies for mastery learning, Bloom, Hastings, and Madaus included those "permitting students to go at their own pace."¹¹ The problem of developing a strategy for mastery learning was seen by Bloom, Hastings, and Madaus as basically "one of

⁸ Ibid., pp. 394-95.

⁹ Ibid., p. 448.

¹⁰ Arthur Indelicato, "Individualizing Mathematics in a Modular-Scheduling Program," Mathematics Teacher 65, no. 5 (May 1972):459.

¹¹ Benjamin S. Bloom, J. Thomas Hastings, and George F. Madaus, Handbook on Formative and Summative Evaluation of Student Learning (New York: McGraw-Hill Book Co., 1971), p. 51.

determining how individual differences in learners can be related to the learning and teaching process."¹²

Howes spoke of individualization as:

. . . a way of thinking about the teaching-learning process. It is an attitude toward the function of the school, a broader way of thinking about class organization, materials, and the approach to the individual child. It demands a new conception of the curriculum.¹³

If the basis for describing a program of individualization as advocated by Gibbons above is accepted, the five components of an individualized classroom outlined by Dell serve as a concrete, specific description of individualized instruction. They are:

- A. Components dealing with curriculum materials
 - 1. A unit of achievement--terminal objectives and instructional objectives
 - 2. Learning activities in a prewritten learning guide
 - 3. Evaluation of student achievement
- B. Components dealing with classroom involvement
 - 4. Teacher involvement
 - 5. Student responsibilities¹⁴

¹²Ibid., p. 44.

¹³Virgil M. Howes, ed., Individualization of Instruction: A Teaching Strategy (New York: Macmillan Co., 1970), pp. v-vi.

¹⁴Helen Davis Dell, Individualizing Instruction: Materials and Classroom Procedures (Chicago: Science Research Associates, 1972), p. 5.

Contrasting Views of Individualization

McClellan indicated basic differences in the manner in which the term individualized instruction had been used by educators writing in professional publications. Both the Sixty-first Yearbook of the National Society for the Study of Education (NSSE), Part I,¹⁵ published in 1962, and the 1964 Yearbook of the Association for Supervision and Curriculum Development (ASCD)¹⁶ bore the exact title, Individualizing Instruction. McClellan maintained that not only was there otherwise little connection between the two yearbooks, there was "a profound disagreement on what it means to individualize."¹⁷

The NSSE sense of individualizing

focuses on the problem of preventing variance (among the individual members of an instructional group) from interfering with the effectiveness of instruction. The . . . ASCD sense

¹⁵ Individualizing Instruction, in Sixty-first Yearbook of the National Society for the Study of Education, Fred T. Tyler, Chairman, pt. I (Chicago: University of Chicago Press, 1962).

¹⁶ Ronald C. Doll, ed., Individualizing Instruction, in 1964 Yearbook of the Association for Supervision and Curriculum Development (Washington, D.C.: The Association, 1964).

¹⁷ McClellan, p. 173.

is concerned with helping each individual to release his unique potential as a human being.¹⁸

The problem of individualization, in the NSSE sense, was to increase "the effectiveness of instruction by adapting it to the traits of the learner--his present repertoire of knowledge, the rate at which he can learn new material, and so on."¹⁹ In the ASCD sense, the problem was to release "the full potential in each learner."²⁰

Gibbons divided theorists into two groups, one searching for "the perfect input to yield predicted outputs; and the other advocating the development of independence, freedom, and responsibility in students."²¹ The word individualized can describe a complete or a relative state, depending upon the degree to which separate instruction has been accomplished.

Self-Paced Unit Plans

Figure 1 portrays the taxonomic scheme developed

¹⁸Ibid., p. 183.

¹⁹Ibid., p. 178.

²⁰Ibid.

²¹Gibbons, p. 49.

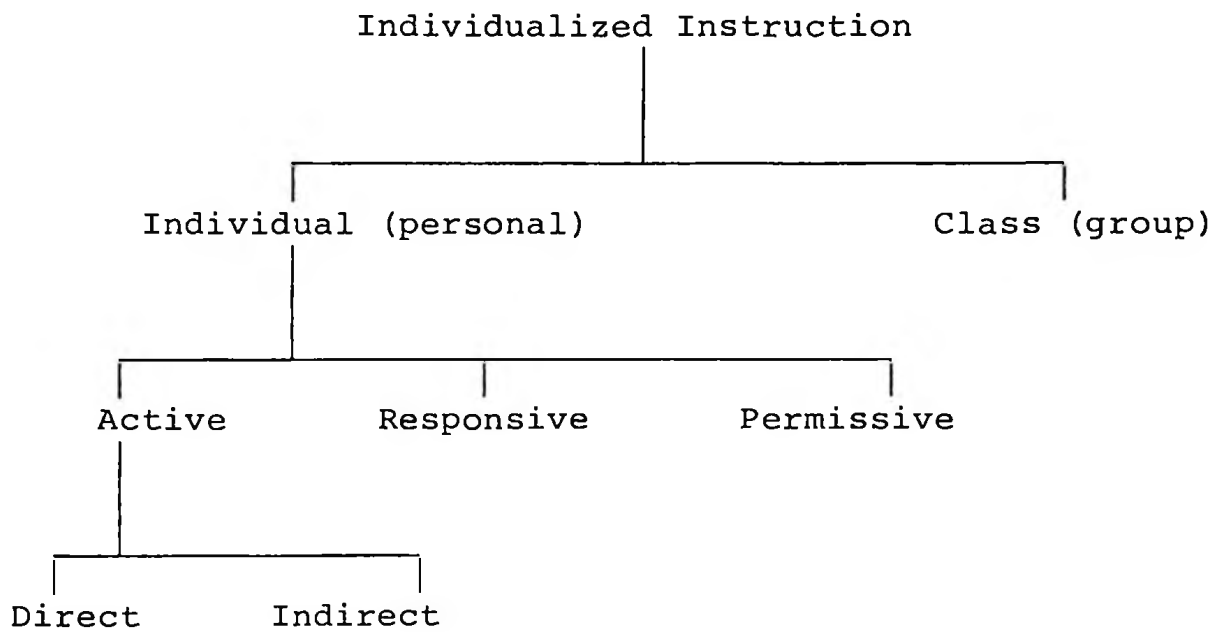


Fig. 1. Gibbons' Classification of Individualized Instructional Programs Through Individual Practices

SOURCE: Maurice Gibbons, "What Is Individualized Instruction?" Interchange 1, no. 2 (February 1970):35.

by Gibbons²² in which individualized instruction represented a phylum of curriculum programs with two families of programs, personal (individual) and group (class). Family had to do with how the teacher addressed his students. The next sub-classification had to do with the decision-making pattern established by the teacher in the classroom. The teacher was categorized as (1) actively in control, (2) permissive, or (3) responsive.

In active forms of individualization, instruction may be modified for each student but still include any of the constraints on individual freedom typical of the traditional classroom.²³

In the third order of classification, the basic means by which the teacher instructed was the criterion for separating "individual" programs. The two means of instruction were: "directly by confrontation with the student or indirectly through such mediating devices as teaching machines, general equipment, study materials, activities, games, simulation."²⁴

Gibbons indicated his belief that:

²²Ibid., pp. 33-38.

²³Ibid., p. 35.

²⁴Ibid., p. 37.

The most common form of individual program involves active though indirect teacher control of student decision-making. Most of the programs in that category offer the student control over only the pace at which he works. This is a minimal form of individualization. . . .²⁵

Categorized as self-paced unit plans were such programs as Individually Prescribed Instruction (IPI), Program for Learning in Accordance with Needs (PLAN), and the self-paced Learning Activity Packages (LAP's) referred to in Chapter I.

Learning Activity Packages

The Learning Activity Package (LAP) was developed at the Nova Schools in Fort Lauderdale, Florida, as "an off-shoot of the UNIPAC idea disseminated by the Kettering Foundation."²⁶

As a package, a lesson plan, a systems approach, or the material for individualizing instruction, the UNIPAC is not readily distinguished by its format from other packages. It contains the classic package elements and its power lies in its utilization.²⁷

²⁵ Ibid.

²⁶ John H. Hansen and Arthur C. Hearn, The Middle School Program (Chicago: Rand McNally & Co., 1971), p. 110.

²⁷ William B. Field and Gardner Swenson, "The

Nova's LAP was defined as "a private learning plan for each student, with readings, study guides, suggested resources, and self-evaluation section."²⁸ The LAP is

. . . a broadly programmed set of materials that provide each student with alternatives of how, what, when and where to learn while using efficiently a wide range of learning resources. The student literally works his way through a series of learning activities that are most relevant to him at any given time and at a pace and level unique to him. The package is organized around behavioral objectives. Students are provided opportunities for self-assessment as well as teacher evaluations. The package contains required and optional in-depth learning opportunities utilizing a multi media, mode, content and activity approach. The Learning Activity Package is the curricular vehicle to help facilitate the individualization of instruction.²⁹

The Learning Activity Package is based upon the scope and sequence of the curriculum and consists of seven basic components: (1) pre-test, (2) rationale,

UNIPAC: A Form and Process of Individualizing," Educational Technology 12, no. 9 (September 1972):12.

²⁸Arthur B. Wolfe and James E. Smith, "At Nova, Education Comes in Small Packages," Nations Schools 81, no. 6 (June 1968):48.

²⁹Jan McNeil and James E. Smith, "The Multi's at Nova," Educational Screen and Audiovisual Guide 47, no. 1 (January 1968):16-17.

(3) behavioral objectives, (4) activities, (5) self-evaluation, (6) post-test, and (7) in-depth opportunities.³⁰

The key ingredient of the LAP is the behavioral objective(s). While the behavioral objectives must relate to the topic or concept, the remainder of the ingredients of the LAP relate to the objectives. It was the behavioral objective that determined what the student was to do, the various learning activities to prepare him to do it, the assessment of his readiness and accomplishment, the conditions under which he was to do it, and the level of performance expected of him in doing it.³¹

Cardarelli identified four assumptions regarding learning that were applicable to the use of individualized Learning Activity Packages.

1. Each student is an individual who has a right to receive instruction geared to his needs, his interests, and his capabilities.

³⁰Hansen and Hearn, p. 110.

³¹Ray L. Talbert, "A Learning Activity Package: What Is It?" Educational Screen and Audiovisual Guide 47, no. 1 (January 1968):20.

2. The teacher's role is that of diagnostician, prescriber, motivator, and facilitator of learning.
3. The student's role is that of an independent person capable of making decisions, accepting responsibility for his own education, and getting along with others.
4. The atmosphere of the LAP program classroom or school must reflect an open structure where initiative, creativity, exploration, meaningful interaction, and awareness of the needs of others could flourish.³²

Using an idea presented by Jack V. Edling in Individualizing Instruction: A Manual for Administrators,³³ Ubben illustrated the options of individualization available by use of Learning Activity Packages. Such options were present when there existed a combination of availability of (1) multiple packages or objectives and (2) multiple resources within each package. Figure 2 graphically portrays the options of selection of resources

³²Sally M. Cardarelli, "The LAP--A Feasible Vehicle of Individualization," Educational Technology 12, no. 3 (March 1972):27.

³³Jack V. Edling, Individualizing Instruction: A Manual for Administrators (Corvallis, Oreg.: Continuing Education Publications, 1970).

		OBJECTIVES	
		Teacher Selected	Student Selected
RESOURCES	Teacher Selected	A	C
	Student Selected	B	D

Option A. The teacher retains all decision control over the child by prescribing both the package to be studied and the resources within that package to be completed.

Option B. The teacher prescribes to the student a particular learning package but then allows the student freedom in choosing the resources most appealing to him. Under this option, the student needs to complete only enough resources to adequately prepare him for the behavioral performance called for in the objective.

Option C. Assuming there exist within the package system numerous packages, the student is allowed to select a package of his own choosing. After he has determined the package he is going to work, the teacher assigns the resources for the child within that package.

Option D. The student not only selects his own package from those available but also has freedom to choose his resources within that package. . . . Additional freedom on the part of the learner in the design of his instructional program could be obtained only with a learner designed package.

Fig. 2. Ubben's Model of Options of Individualization Available in Use of LAP

SOURCE: Gerald C. Ubben, "The Role of the Learning Package in an Individualized Instruction Program," in Individualized Instruction--Programs and Materials (Englewood Cliffs, N.J.: Educational Technology Publications, 1973), pp. 19-20.

and objectives possible utilizing LAPs and the resulting degree of individualization as explained by Ubben.³⁴

Demopolis LAP

Kapfer maintained that, "If a strategy for individualizing instruction is to be effective, it should begin with the currently existing program as perceived by teachers and pupils."³⁵

Smith stated his opinion that, ". . . up to this point, a standardized LAP (that is, a LAP that can be used by teachers throughout the country or even in two neighboring school districts) has not been developed" and suggested that "the staff within a school or district write their own LAPs."³⁶

The Demopolis LAP program was an attempt to

³⁴Gerald C. Ubben, "The Role of the Learning Package in an Individualized Instruction Program," in Individualized Instruction--Programs and Materials (Englewood Cliffs, N.J.: Educational Technology Publications, 1973), pp. 19-20.

³⁵Philip G. Kapfer, "An Instructional Management Strategy for Individualized Learning," in Schools for the Middle Years: Readings, ed. George C. Stoumbis and Alvin W. Howard (Scranton, Pa.: International Textbook Co., 1969), p. 370.

³⁶James E. Smith, "The Learning Activity Package (LAP)," Educational Technology 12, no. 9 (September 1972): 17.

implement the positions of Kapfer and Smith above, as well as the position taken by Allen noted in Chapter I, as to the curriculum reflecting a plan peculiar to a particular school.

The purpose of the Demopolis project was "to provide a sequential program of individualized instruction through the preparation and application of teacher made Learning Activity Packages."³⁷ The Demopolis LAPs met the criteria of Learning Activity Packages as described by Jelden in that they were designed so as "to provide for the learner a self-pacing, individualized, multi-media system of education."³⁸

The conventional program of instruction in the Demopolis (Alabama) City School System was considered inadequate in the seventh and eighth grades by teachers and school administrators, due to (1) the wide range of ability and achievement of the student population and (2) the different ethnic backgrounds of the students.³⁹

³⁷"Demopolis City Schools, ESEA, Title III, Initial Application, Project L.A.P.," n.d., p. 1.

³⁸D. L. Jelden, "Learning Activity Packets for Individualized Instruction," Man/Society/Technology 31, no. 5 (February 1972):140.

³⁹"Demopolis City Schools," p. 26.

In a city with a population of 7,396, the Demopolis City School System consisted of four schools: Eastside Elementary School, Westside Elementary School, Demopolis Junior High School, and Demopolis High School. With a total enrollment of 1,954 students, there were 935 whites and 1,019 blacks in the school system.

The Demopolis Junior High School, in the year of this study, had an enrollment of 341 students in grades seven and eight. Table 1 shows the composition of the student population by grade, sex, and race. Having come from an elementary school that was either predominantly white or predominantly black in student population and teaching staff, the vast majority of junior high students experienced either their first or second year of instruction in a highly racially integrated setting, which included a ratio of about 50:50 in student and faculty composition.

The Demopolis LAP program of individualized instruction was patterned after Nova's LAP and was funded under ESEA Title III. The three-year funding period was from June 15, 1971, through June 14, 1974, at a total cost of \$147,025. In addition to providing the necessary equipment, supplies, and consultive assistance, the funds

also made possible the full-time assistance of a project director and four paraprofessionals to supplement the existing professional staff of the school. The latter consisted of thirteen classroom teachers, one reading teacher, one part-time counselor, one librarian, two teacher aides, one school secretary, and the school principal.

TABLE 1

ENROLLMENT BY GRADE LEVELS OF DEMOPOLIS JUNIOR
HIGH SCHOOL, 1972-1973 SCHOOL YEAR

	Seventh Grade	Eighth Grade	School Totals
Boys	108	74	182
Girls	86	73	159

Grade Totals	194	147	341

Blacks	102	66	168
Whites	92	81	173

The entire project staff was located in the Demopolis Junior High School which was housed in a building constructed in 1914 as a twelve-grade school. One

classroom in the building was designated as the math LAP lab. Conventional school furnishings were supplemented with individual study carrels. Supplies and equipment frequently used by students were located in the LAP lab for easy access. A paraprofessional was assigned to the lab to give individual assistance to students, to coordinate the use of instructional materials, and to improve communication between the teacher and students.

Learning Activity Package materials were obtained by students at the LAP dissemination center located near the math LAP lab. It was here, also, that tests were scored, additional supplies distributed, and LAP materials produced.

Prior to implementing the LAP instructional program in the 1972-1973 school year, more than one calendar year was required for enabling activities. The activities included in-service workshops of varying size and duration to familiarize teachers with the LAP concept of individualization, the writing and use of behavioral objectives, and the preparation of packages.

During the year of planning, existing course offerings in mathematics were analyzed, a scope and

sequence was prepared, packages were written, and field testing was conducted.

Learning Activity Packages and
Student Achievement

The Encyclopedia of Educational Research reported a considerable interest in individualization of instruction in mathematics but also indicated a lack of significant published findings on individualized programs of instruction. No reference was made to individualized programs in mathematics undergoing study, except three which included the use of an electronic computer.⁴⁰

As reported in Chapter I, Malan and Merrill conducted an extensive review of research related to individualization and concluded the latter part of 1972 that there was a scarcity of such studies.⁴¹ Only two studies were identified as reporting empirical research of individualized programs. Besvinick and Crittenden reported on the effectiveness of non-gradedness at Melbourne

⁴⁰ Robert L. Ebel, ed., Encyclopedia of Educational Research, 4th ed. (New York: Macmillan Co., 1969), p. 772.

⁴¹ Ronald F. Malan and M. David Merrill, "Acronyms Anonymous: Toward a Framework for the Empirical Validation of Methods of Individualizing Instruction," Educational Technology 19, no. 12 (December 1971):32.

(Florida) High School.⁴² Webb studied the effects of students transferring from a continuous progress, individualized school to a typical, traditional school.⁴³

The former resulted in a reexamination of the program and the latter concluded that the transferred students felt more ignored and neglected in the traditional setting than in the individualized one.

Graham reported that an individualized program in mathematics in grades five and six resulted in heightened student interest in mathematics and more heterogeneity in student achievement.⁴⁴ Anderson reported that, based upon test scores, increased learning resulted from Individually

⁴²Sidney L. Besvinick and John Crittenden, "The Effects of a Nongraded School," School and Society 96, no. 2305 (March 1968):181-84.

⁴³Leonard Leon Webb, "Selected Transitional Effects for Students Transferring from a Continuous Progress Program to a Non-Continuous Progress Program" (Ed.D. dissertation, Brigham Young University, Provo, Utah, 1969).

⁴⁴William A. Graham, "Individualized Teaching of Fifth- and Sixth-Grade Arithmetic," in Individualizing Instruction in Science and Mathematics, ed. Virgil M. Howes (New York: Macmillan Co., 1970), pp. 103-6.

Prescribed Instruction in mathematics (K-12) at Bethel Park, Pennsylvania.⁴⁵

Sinks analyzed the effects of changing the learning environment to achieve an individually prescribed curriculum for seventh-grade students in social studies, writing, science, and mathematics in the Skiles Junior High School in Evanston, Illinois, from May, 1967, through May, 1968. Learning packages which were developed by teachers in the school provided the means for individualization.⁴⁶ Grouping of students into control and experimental classrooms was done on the basis of attitude, sex, and race. Results suggested that the treatment accounted for increased gains in achievement scores on the Sequential Tests of Educational Progress (STEP) in each of the four subject areas.⁴⁷

⁴⁵Donald E. Anderson, "Using IPI in Math Makes Progress in Bethel Park," Nations Schools 83, no. 4 (April 1969):82.

⁴⁶Thomas A. Sinks, "Individual Progress: A Study of Seventh Graders," The Clearing House 44, no. 8 (April 1970):457-60.

⁴⁷Thomas Alonzo Sinks, "How Individualized Instruction in Junior High School Science, Mathematics, Language Arts, and Social Studies Affects Student Achievement" (Ph.D. dissertation, University of Illinois, 1968).

Studer reported on Individually Prescribed Instruction (IPI) in mathematics in grades five and six in an elementary school with an almost equal number of white and black students. A comparison of students using IPI with students in conventional classrooms, using Stanford Achievement Test scores, indicated the individualized classes "lead by an average of 5-1/2 months over the building norms."⁴⁸ It was noted, however, that the students in the treatment groups were chosen solely on the basis of the desire of their teachers to participate in IPI.

Studer concluded from the data that IPI may be:

. . . an ideal technique to use in integrated schools for there seems to be a positive self-concept development in this kind of program. It also meets the wide range of demands of the integrated classroom.⁴⁹

Summary

Review of related literature made evident the need for definitional clarity in the use of the term

⁴⁸Harold R. Studer, "Individualizing Mathematics in an Integrated School," Pennsylvania School Journal 118, no. 2 (December 1969):110.

⁴⁹Ibid.

individualization. Contrasting views of individualization, categorization of individualized instructional programs, and characteristics of learning activity packages were considered. The specific LAP program of individualization which was the object of this study was examined in relation to these prior considerations.

Research findings related to similar individualized instructional programs were examined and summarized. Such a review revealed the scarcity of research related to individualized junior high school mathematics programs.

CHAPTER III

METHODS AND PROCEDURES

The following methods and procedures were utilized in the analysis of the effect of individualized learning activity packages in mathematics on the academic achievement of seventh- and eighth-grade students. Consideration was given the conditions present during the study as well as the methodology employed. Included were descriptions of the instructional program, the participants in the program, the school in which the program was implemented, and the methodological details related to the collection and treatment of the data.

The School

The Demopolis Junior High School, the school in which the LAP program was implemented, was constructed as a twelve-grade school building in 1914. The structure was deficient in heating, lighting, and ventilation.

With an enrollment of 341, the school consisted of the seventh and eighth grades. During the year of the

study, most students experienced their first or second year of instruction in a highly racially integrated setting. The period of the study was the first year of implementation of the LAP mathematics program.

The Demopolis Junior High School students were assigned to sections which were alleged to be homogeneous. Such grouping was made primarily upon the basis of reading scores on standardized tests and past academic achievement as reflected in teacher-assigned grades. Table 2 shows the sections which were classified as high, average, or low.

TABLE 2
ENROLLMENT BY HOMOGENEOUS SECTIONS OF DEMOPOLIS JUNIOR
HIGH SCHOOL, 1972-1973 SCHOOL YEAR

Grade	Section	Achievement Level	Students
7	C	High	30
7	D	High Average	27
7	E	Average	26
7	G	Average	28
7	H	Low	26
7	A	Low	30
7	B	Low	27

8	C	High	29
8	D	High Average	33
8	E	Average	28
8	A	Low	29
8	B	Low	28

Participants in the Study

Selection of sections of students to participate in the LAP instructional program was made on the basis of the following criteria:

1. Only one LAP math class could be scheduled each class period in order to:
 - a. conduct activities in the one classroom available for use as a LAP math lab,
 - b. have one paraprofessional available in the lab at all times.
2. Sections would be representative of the wide range of student achievement in the entire school student population.
3. Teachers participating in the LAP instructional program would also teach in the conventional classes relying primarily upon large group instruction.
4. With a rotating class schedule of five seventy-minute periods per day, providing twenty-five class periods per week, the math LAP lab would be used by students twenty periods.
5. Sections would be representative of the racial composition of Demopolis Junior High School. Table 3

shows the school enrollment by race for each class section.

Sufficient numbers of students did not participate in the LAP instructional program due to the above considerations so as to allow a comparison of students in LAP with students in conventional classes.

TABLE 3

ENROLLMENT BY RACE OF DEMOPOLIS JUNIOR HIGH SCHOOL,
1972-1973 SCHOOL YEAR

Grade/Section	Blacks	Whites	Total
7 C	6	24	30
7 D	6	21	27
7 E	5	21	26
7 G	15	13	28
7 H	13	13	26
7 A	30	0	30
7 B	27	0	27

8 C	7	22	29
8 D	10	23	33
8 E	10	18	28
8 A	11	18	29
8 B	28	0	28

Treatment

The scope and sequence for the mathematics program depicted in Figure 3 was designed by the instructional

Name _____ Section _____ Teacher _____

I. Fundamental Math		*	&	\$
A. Cardinal Number				
B. Ordinal Number				
C. Even & Odd Numbers				
D. Signs & Symbols				
1. Signs				
2. Numbers				
E. Sets				
F. Number Patterns				
G. Whole Numbers				
1. Addition				
2. Subtraction				
3. Comparing Add. & Sub.				
4. Multiplication				
5. Division				

II. Time			
*	&		\$

III. Money			
*	&		\$

IV. Fractions		*	&	\$
A. Introduction				
B. Addition				
C. Subtraction				
D. Multiplication				
E. Division				

V. Decimals		*	&	\$
A. Addition				
B. Subtraction				
C. Multiplication				
D. Division				

VI. Percent			
*	&		\$

VII. Factoring & Factors			
*	&		\$

VIII. Scientific Notation		*	&	\$
A. Place Value				
B. Exponents				

IX. Bases			
*	&		\$

X. Measurement	*	&	\$
A. Graphs			
B. Measures			

XI. Business Math	*	&	\$
A. Taxes			
B. Insurance			
C. Banking			
D. Percent in Business			

XII. Pos. & Neg. Numbers	*	&	\$

XIII. Ratio	*	&	\$

XIV. Algebra	*	&	\$

XV. Geometry	*	&	\$

*: Minimum Level
 &: Intermediate Level
 \$: Maximum Level

Fig. 3. Scope and Sequence for LAP Mathematics Program,
 Demopolis Junior High School

staff as a continuous progress, non-graded approach to individualization. Both seventh- and eighth-grade students in the Demopolis Junior High School had learning activity packages available for each sub-category appearing in Figure 3. Each student was provided a folder which contained the packages being used and a copy of the form shown as Figure 3. By use of this instrument, each student maintained a cumulative summary of his progress, showing both the LAP covered and its level of difficulty.

Each sub-category in Figure 3 indicated LAPs of the three levels of difficulty. The levels were indicated in Figure 3 as follows: * = minimum level; & = intermediate level; and \$ = maximum level.

The intermediate level LAPs were intended to provide activities and evoke skills accepted locally as equivalent to average seventh- and eighth-grade expectations in regard to academic performance. Likewise, the minimum level was considered approximately equivalent to average second- through sixth-grade achievements. Maximum level LAPs called for academic performance in excess of average seventh- and eighth-grade performance and provided experiences conventionally reserved for senior-high-grade levels.

A degree of individualization was achieved by the provision of the thirty-eight LAP categories, each in the form of three levels of difficulty, for a total of 114 LAPs. Further individualizing occurred by assigning specific activities in a LAP to a particular student rather than requiring all students assigned a LAP to complete the same activities. Conditions and performance of LAP objectives were established by the teacher and the particular learner.

Upon entry into the LAP program of instruction, each student was tested to determine his individual needs. This diagnosis was made, using the appropriate level of a standardized test battery (the California Achievement Tests), and a locally prepared Mathematics Inventory, Appendix A. The latter was designed to determine a student's mastery of the content at the different levels of difficulty of the LAP program. The use of the former evaluative instrument is described below.

Once placed into the LAP program, each student received additional diagnosis by the provision of pre-tests for each LAP sub-category in order to determine (1) if the student had a need to perform the LAP and, if

so, (2) on what level of difficulty of material he should begin his instruction. Post-tests designed for each difficulty level on each LAP sub-category provided the means for determining satisfactory completion of a specific learning activity package.

The professional instructional staff consisted of three teachers certified in the area of mathematics. The eight-grade mathematics teacher taught the LAP students as well as all non-LAP eighth-grade students. Each of the two seventh-grade mathematics teachers taught both LAP and non-LAP classes.

Non-LAP instruction in mathematics consisted of the conventional lecture-discussion method with the provision of textbook exercises. The scope of the conventional instruction in mathematics in grades seven and eight was equivalent to the LAP program as set forth in Figure 3.

The fact that the same teachers were involved in both the control (non-LAP) and experimental (LAP) classes placed the variable of individual teacher characteristics under some degree of control.

Paraprofessionals not only assisted teachers in

the distribution of materials and equipment, but they rendered individual instructional assistance to students. The aide, a black, assigned to the math LAP lab as a member of the instructional team facilitated communication between the three white teachers and the black students. Two additional aides provided student and teacher assistance from the LAP dissemination center.

The instructional staff developed, refined, and implemented the LAP program. Two of the three teachers, the eighth-grade teacher and one of the seventh-grade teachers, with the assistance of the paraprofessionals and the project director, prepared the Learning Activity Packages and related items which were used in this study. The third teacher was not a member of the Demopolis Junior High School faculty during the period the packages were developed but was involved in material refinement.

Collection of Data

The instrument used to measure the academic growth of students in LAP and non-LAP instruction in mathematics was the California Achievement Tests, 1970 edition. Level 3, Form A, was administered to students in grade seven. Eighth-grade students were administered Level 4,

Form A. Academic growth was determined by administering pre- and post-tests, using the appropriate levels of the California Achievement Tests. Pre-testing was conducted prior to implementation of the LAP program in May, 1972, and post-testing occurred in April, 1973.

The mathematics section of both levels measured (1) computation, (2) concepts, and (3) word problems. Table 4 summarizes the content of Level 3, Form A, and Level 4, Form A, of the mathematics section of the California Achievement Tests.

The mathematics section of the California Achievement Tests was accepted as valid in relation to the cognitive objectives of both the LAP instructional program and the conventional classroom instruction in mathematics in the Demopolis Junior High School.

The instrument used to determine the intelligence quotient (IQ) of all students composing the population was the Otis-Lennon Mental Ability Test, Intermediate Level, 1967 edition, with 1967 norms. The Otis-Lennon Deviation IQ (DIQ) is a normalized standard score with a mean of 100 and a standard deviation of 16 points. The Otis-Lennon Mental Ability Test was administered in October, 1972.

TABLE 4

A COMPARISON OF MATHEMATICS SECTIONS OF THE CALIFORNIA
ACHIEVEMENT TESTS, LEVEL 3, FORM A,
AND LEVEL 4, FORM A

Measurement	Level 3, Form A items	Level 4, Form A items
Computation: ability to do basic mathematics operations	48	48
Concepts: understanding of some mathematics concepts	25	35
Problems: ability to work mathematics word problems	15	15
Fractions: ability to add, subtract, multiply, and divide fractions and mixed numbers	20	0

Data regarding (1) chronological age, (2) race, and (3) sex were gathered from school records and confirmed by local school staff personnel.

Treatment of Data

The research design included experimental (LAP) and control (non-LAP) treatments of students in mathematics in grades seven and eight in the Demopolis Junior High School. Table 5 indicates the division of students by sections as to instructional practice. Of twelve sections, five received LAP instruction and seven were taught in conventional classrooms, utilizing primarily large group instruction, lecture/discussion, and considerable reliance on a textbook for each grade level. Of the 341 students, 142 were in the LAP program and 199 were in traditional classrooms.

The Lindquist treatment x levels design was used since (1) the major purpose of the study was to determine if the treatments would have different average effects on members of the population, and (2) the secondary purpose was to determine if the treatments had the same relative effect at all levels.

Four "control" variables were considered:

(1) chronological age, (2) race, (3) sex, and (4) intelligence quotient. Academic growth, the difference in pre- and post-test scores on the California Achievement Tests,

was the criterion variable. Considering the latter as a dependent variable, an analysis of variance was made to determine if a statistically significant change had occurred. Correlation techniques were employed to determine substantive significance of the findings.

TABLE 5

ENROLLMENT BY INSTRUCTIONAL PRACTICES IN MATHEMATICS
OF DEMOPOLIS JUNIOR HIGH SCHOOL,
1972-1973 SCHOOL YEAR

Grade/Section	LAP Math	Conventional Math
7 C	. .	30
7 D	27	. .
7 E	. .	26
7 G	. .	28
7 H	. .	26
7 A	30	. .
7 B	27	. .
8 C	29	. .
8 D	. .	33
8 E	. .	28
8 A	29	. .
8 B	. .	28
Totals	142	199

Seventh-grade students in LAP classes were matched with seventh-grade students in non-LAP classes. Eighth-grade students in LAP classes were matched with eighth-grade students in non-LAP classes. The Individual students were matched, using four variables: (1) chronological age, (2) race, (3) sex, and (4) intelligence quotient.

The resulting matched pairs were: (1) within five months in chronological age, (2) of the same race (either white or black), (3) of the same sex, and (4) not different by more than five points in Otis-Lennon DIQ. The DIQ range extended from a score of 73 to one of 119.

Appendix B contains the data, by pairs, of the twenty-nine matched pairs used in the study. Only students enrolled for the entire school year in either a LAP or non-LAP class were considered for matching on the four control variables. The age, expressed in months, was the chronological age of the students at the time they were administered the Otis-Lennon Mental Ability Test in October, 1972.

CHAPTER IV

ANALYSIS OF THE DATA

The total seventh- and eighth-grade enrollment in the Demopolis Junior High School, 341 students, was involved in providing the initial data from which students receiving control or experimental treatments were matched by pairs. The four control variables used in matching students were: (1) chronological age, (2) sex, (3) race, and (4) intelligence quotient. On this basis, fifty-eight students were matched so as to provide twenty-nine pairs. Twelve pairs ($n = 24$) comprised the seventh-grade sample and seventeen pairs ($n = 34$) made up the eighth-grade sample.

Design

The Lindquist treatments x levels design was used to increase the precision of the treatment comparisons by providing for direct control of inter-subject variations (Type S errors). The design also permitted a study of simple effects as well as main effects of the treatments.

Simple effect refers to the treatment effect for a given level of the control variable; the main effect of the treatments is the weighted average of the simple effects for all levels of the control variable.¹

Treatments

The study compared the effects of two treatments. The control treatment consisted of conventional classroom instruction which was generally large group instruction utilizing lecture and discussion methods. Students were selected from seventh- or eighth-grade classes in mathematics.

The experimental treatment consisted of the use of Learning Activity Packages as a means of individualizing instruction. Students in grades seven and eight were administered LAPs without regard to the students' grade level.

Designations for the two treatments are indicated as follows:

A_1 = LAP (Learning Activity Package)

A_2 = CCI (Conventional Classroom Instruction)

¹E. F. Lindquist, Design and Analysis of Experiments in Psychology and Education (Boston: Houghton Mifflin Co., 1973), p. 15.

Levels

While students within a given grade were matched on the variable of age, no analysis was made of the age variable within grades. Rather, three control variables, (1) sex, (2) race, and (3) intelligence quotient, underwent analysis of variance.

Levels were established for the two discrete variables of race and sex. The non-ordered categories or levels for the variable of race were:

Level₁ = black (Negroid)

Level₂ = white (Caucasoid)

The levels of sex were designated as follows:

Level₁ = female

Level₂ = male

Levels for intelligence quotient as determined by the Otis-Lennon Mental Ability Test correspond to scale intervals for that continuous variable. Since the instrument has a mean score of 100 and a standard deviation of ± 16 , the following levels were established:

Level₁ = above average ($\bar{>}$ 100 DIQ)

Level₂ = below average ($<$ 100 DIQ)

Statistical Computations

The statistical computations were made on an electronic computer. Both one-way and two-way analysis of variance were accomplished by computer programs developed by Dr. Arthur Cromer, Chairman, Department of Computer Science, University of Louisville, Louisville, Kentucky.

Additional correlational techniques were applied by use of a mini-computer utilizing recognized procedure as described below for a determination of the substantive significance of research findings in relation to the one-way analysis of variance.

Statistical Procedures

Analysis of variance was utilized in looking for significant differences in academic achievement between the two treatments at each of the two grade levels.

The total variability in a system ($\sum x_T^2$) consists of the variability between groups ($\sum x_b^2$) and the variability within groups ($\sum x_w^2$) where \sum stands for "sum of" and x represents the deviations squared. The deviation from the raw score (X) and the mean of the system (M) is equal to x , or $(X - M = x)$.

Sources of variability in the system are identified as treatment (Σx_b^2), error (Σx_w^2), and total (Σx_T^2). Sum of squares (Σx^2) as described above are given for each source. The degrees of freedom (df) are calculated for the sources. Where k = number of groups, the df for Σx_b^2 (treatment) = $(k - 1)$. The df for Σx_w^2 (error) = $(n - k)$ where n = number of subjects in sample and df for Σx_T^2 (total) = $(n - 1)$.

The mean square was computed by dividing the sum of squares by their appropriate degrees of freedom. The Fisher F value of reliability was calculated by dividing the treatment mean square by the error mean square. By use of the F value and the degrees of freedom, the confidence level was established.

In addition to a determination of reliability by the F ratio, the percentage of the total variability of the system that could be accounted for by group membership (treatment) was determined by the correlational Eta squared (θ^2). The formula for θ^2 is treatment variability (Σx_b^2) divided by the total variability (Σx_T^2).

One-Way Analysis of Variance

The one-way analysis of variance of the matched pairs in grade seven examined the difference in means in each of the treatment groups. Raw scores consisted of the difference in pre- and post-test scores of students on the California Achievement Tests. Students were matched by grade on the four variables of age, sex, race, and intelligence quotient.

Where treatment A_1 = LAP and treatment A_2 = conventional classroom instruction, \bar{X} = cell mean, and SS = sum of squares, the model may be depicted as:

TREATMENTS

A_1 = LAP

A_2 = CCI

\bar{X} = 11.25	\bar{X} = 7.33
SS = 1078.25	SS = 676.67

The grand sum of raw scores (ΣX) was 223 and the number of observations was (n) 24, resulting in a system mean (M) of 9.29. Table 6 depicts a summary of the analysis of variance for grade seven.

TABLE 6

ANALYSIS OF VARIANCE SUMMARY FOR GRADE SEVEN SAMPLE

Source	Sum of Squares	Degrees of Freedom	Mean Squares
Treatment	92.04	1	92.04
Error	1754.92	22	79.77
Total	1846.96	23	

The F value of 1.154 had an exact probability of being caused by chance .295. Thus, the difference obtained between the treatments could have been caused by chance alone more than twenty-nine times out of one hundred. Statistically, the results were not significant. Eta squared indicates the percentage of variability that could be accounted for at only 5 percent.

One-way analysis of variance of the eighth-grade sample was made, utilizing the procedure detailed above. The model may be portrayed as:

TREATMENTS

$$A_1 = \text{LAP}$$

$$A_2 = \text{CCI}$$

$\bar{X} = 6.0$	$\bar{X} = 7.18$
SS = 1276.0	SS = 722.47

The grand sum of raw scores (ΣX) was 224 and the number of observations (n) was 34, resulting in a system mean (M) of 6.588. Table 7 contains a summary of the analysis of variance in the eighth-grade sample when the differences in academic achievement in the two treatments were examined. All eighth-grade students in the sample were matched on the four variables of age, sex, race, and intelligence quotient.

TABLE 7
ANALYSIS OF VARIANCE SUMMARY FOR GRADE EIGHT SAMPLE

Source	Sum of Squares	Degrees of Freedom	Mean Squares
Treatment	11.76	1	11.76
Error	1998.47	32	62.45
Total	2010.24	33	

$F = .188$; the exact probability of obtaining such an F value with 1 and 32 degrees of freedom is .671. The results were not statistically significant. $\eta^2 = .01$; only 1 percent of the total variability in the system could be accounted for.

Two-Way Analysis of Variance

The analysis of the total sum of squares in the treatments x levels design is exactly like that for all double-entry tables. The analysis of variance as summarized by Lindquist is shown in Table 8.²

TABLE 8

ANALYSIS OF THE TOTAL SUM OF SQUARES
IN THE TREATMENTS X LEVELS DESIGN

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares
Treatments (A)	$a - 1$	$SS_A = \sum \frac{T^2}{n} - \frac{T^2}{N}$	$SS_A / (a-1)$
Levels (L)	$l - 1$	$SS_L = \sum \frac{T^2}{n} - \frac{T^2}{N}$	$SS_L / (l-1)$
(Cells)	$(al - 1)$	$SS_{\text{cells}} = \sum \sum \frac{T^2}{n} - \frac{T^2}{N}$	
Treatments x Levels (AL)	$(a-1) \times (l-1)$	$SS_W = SS_{\text{cells}} - SS_A - SS_L$	$SS_{AL} / ((a-1)(l-1))$
Within Subgroups (w)	$N - al$	$SS_W = SS_T - SS_{\text{cells}}$	$SS_W / (N-al)$
Total (T)	$N - 1$	$SS_T = \sum \sum \sum X^2 - \frac{T^2}{N}$	

²Ibid., p. 123.

The computer program utilized for the two-way analysis of variance employed a harmonic n (number of observations) in arriving at computations for each analysis of variance summary. This procedure weights the raw data in such a manner as to give an equal n size to each of the four cells. The assumption is made that the same number of observations (n) would occur in each of the cells in the population of which the sample is representative.

Below are models illustrative of the analysis of variance by grade level for the three variables of sex, race, and intelligence quotient. Each model shows cell, level, and treatment means and is followed by a statement of probability.

Grade Seven

Variable: Sex

LEVELS

TREATMENTS

$A_1 = \text{LAP}$

$A_2 = \text{CCI}$

$L_1 = \text{female}$

$\bar{X}_{11} = 12.25$	$\bar{X}_{12} = 7.38$
$\bar{X}_{21} = 9.25$	$\bar{X}_{22} = 7.25$

$\bar{X}_{L_1} = 19.63$

$L_2 = \text{male}$

$\bar{X}_{L_2} = 16.50$

$\bar{X}_{A_1} = 21.50$

$\bar{X}_{A_2} = 14.63$

A summary of the analysis of variance by sex is contained in Table 9. No statistical significance is indicated by the F values at .05.

TABLE 9
ANALYSIS OF VARIANCE SUMMARY BY SEX FOR GRADE SEVEN

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio	Probability of $F >$
Levels	13.02	1	13.02	.150	.702
Treatments	63.02	1	63.02	.728	.404
Treatments x Levels	11.02	1	11.02	.127	.725
Within Subgroups	1730.87	20	86.54		
Total	1817.93	23	79.04		

Variable: Race

LEVELS

TREATMENTS

$A_1 = \text{LAP}$

$A_2 = \text{CCI}$

$L_1 = \text{black}$
(Negroid)
 $L_2 = \text{white}$
(Caucasoid)

$\bar{X}_{11} = 9.50$	$\bar{X}_{12} = 6.50$
$\bar{X}_{21} = 12.13$	$\bar{X}_{22} = 7.75$

$\bar{X}_{L_1} = 16.00$

$\bar{X}_{L_2} = 19.88$

$\bar{X}_{A_1} = 21.63$

$\bar{X}_{A_2} = 14.25$

The analysis of variance summary by race comprises Table 10. F values were not significant at the .05 confidence level.

TABLE 10
ANALYSIS OF VARIANCE SUMMARY BY RACE FOR GRADE SEVEN

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio	Probability of F $\bar{>}$
Levels	20.02	1	20.02	.231	.636
Treatments	72.52	1	72.52	.837	.371
Treatments x Levels	2.52	1	2.52	.029	.866
Within Subgroups	1732.37	20	86.62		
Total	1827.43	23	79.45		

Variable: Intelligence Quotient

LEVELS

TREATMENTS

A₁ = LAP

A₂ = CCI

L₁ = above average
($\bar{>}$ 100 DIQ)

L₂ = below average
($<$ 100 DIQ)

\bar{X}_{11} = 12.13	\bar{X}_{12} = 7.75
\bar{X}_{21} = 9.50	\bar{X}_{22} = 6.50

\bar{X}_{L_1} = 19.88

\bar{X}_{L_2} = 16.00

\bar{X}_{A_1} = 21.63

\bar{X}_{A_2} = 14.25

The analysis of variance summary by intelligence quotient is contained in Table 11. No F values were statistically significant at .05. It is to be noted that the sample was derived by matching students on the four variables of age, sex, race, and intelligence quotient. The procedure resulted in identical seventh-grade students comprising levels as established for race and intelligence quotient. Race, level 1, was comparable to intelligence quotient, level 2. Level 2, race, was comparable to level 1, intelligence quotient.

TABLE 11

ANALYSIS OF VARIANCE SUMMARY BY INTELLIGENCE
QUOTIENT FOR GRADE SEVEN

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio	Probability of F >
Levels	20.02	1	20.02	.231	.636
Treatments	72.52	1	72.52	.837	.371
Treatments x Levels	2.52	1	2.52	.029	.866
Within Subgroups	1732.37	20	86.62		
Total	1827.43	23	79.45		

Grade Eight

Variable: Sex

LEVELS

TREATMENTS

 $A_1 = \text{LAP}$ $A_2 = \text{CCI}$

$L_1 = \text{female}$	$\bar{X}_{11} = .17$	$\bar{X}_{12} = 9.83$	$\bar{X}_{L_1} = 10.00$
$L_2 = \text{male}$	$\bar{X}_{21} = 9.18$	$\bar{X}_{22} = 5.73$	$\bar{X}_{L_2} = 14.91$
	$\bar{X}_{A_1} = 9.35$	$\bar{X}_{A_2} = 15.56$	

A summary of the analysis of variance by sex in grade eight constitutes Table 12. F values for treatment and levels were not significant at .05. However, the F value of 6.199 for interaction (treatments x levels) was statistically significant at .05. The exact probability of $F > 6.199$ with 1 and 30 degrees of freedom is .019.

The observed interaction "is measured by the difference between the differences between treatment means for the two levels."³

$$d = (\bar{X}_{11} - \bar{X}_{12}) - (\bar{X}_{21} - \bar{X}_{22})$$

Applying the F test of significance of the interaction results in an F value of 6.199. This significance,

³Ibid., p. 124.

however, cannot justify the conclusion that the difference necessarily resulted from differences in the relative effects of the treatments at the two levels.

TABLE 12

ANALYSIS OF VARIANCE SUMMARY BY SEX FOR GRADE EIGHT

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio	Probability of $F >$
Levels	46.78	1	46.78	.868	.359
Treatments	74.91	1	74.91	1.389	.248
Treatments x Levels	334.21	1	334.21	6.199	.019
Within Subgroups	1617.48	30	53.92		
Total	2073.38	33	62.83		

Lindquist identified three possible components of the observed treatments x levels interaction.⁴ The components are classified as to cause:

1. one component due to Type S error--that due solely to the assignment of subjects to treatment groups,
2. one component due to Type G error (extrinsic

⁴Ibid.

interaction)--that due to extraneous factors which tend to have the same effect on all members of a given treatment group, but different effects on different treatment groups in any single replication, and

3. one component due to the treatments alone (intrinsic interaction).

Statistical significance indicates that something besides Type S error is present or that, in fact, there is interaction in the population. This interaction may be intrinsic or extrinsic. It is not possible to separate the intrinsic and extrinsic interactions in a single experiment of the treatments x levels type.

However, "the more carefully controlled the experiment, the more surely does a significant F imply an interaction."⁵ The treatments in the study were simultaneously administered on a group basis to subjects from all levels. Therefore, many, but not necessarily all, of the extraneous factors had the same effect at all levels.

⁵Ibid., p. 140.

Variable: Race

LEVELS	TREATMENTS		
	$A_1 = \text{LAP}$	$A_2 = \text{CCI}$	
$L_1 = \text{black}$ (Negroid)	$\bar{X}_{11} = 5.50$	$\bar{X}_{12} = 7.00$	$\bar{X}_{L_1} = 12.50$
$L_2 = \text{white}$ (Caucasoid)	$\bar{X}_{21} = 6.89$	$\bar{X}_{22} = 7.33$	$\bar{X}_{L_2} = 26.72$
	$\bar{X}_{A_1} = 12.39$	$\bar{X}_{A_2} = 14.33$	

The analysis of variance by race is summarized in Table 13. F values were not significant at .05.

TABLE 13

ANALYSIS OF VARIANCE SUMMARY BY RACE FOR GRADE EIGHT

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio	Probability of $F > \bar{F}$
Levels	6.28	1	6.28	.097	.758
Treatments	8.01	1	8.01	.124	.728
Treatments x Levels	2.36	1	2.36	.037	.850
Within Subgroups	1940.89	30	64.70		
Total	1957.54	33	59.32		

Variable: Intelligence Quotient

LEVELS	TREATMENTS		
	A ₁ = LAP	A ₂ = CCI	
L ₁ = above average (> 100 DIQ)	$\bar{X}_{11} = 5.78$	$\bar{X}_{12} = 6.11$	$\bar{X}_{L_1} = 11.89$
L ₂ = below average (< 100 DIQ)	$\bar{X}_{21} = 6.25$	$\bar{X}_{22} = 8.38$	$\bar{X}_{L_2} = 14.63$
	$\bar{X}_{A_1} = 12.03$	$\bar{X}_{A_2} = 14.49$	

The summary of the analysis of variance by intelligence quotient in grade eight comprises Table 14. F values were not statistically significant at .05.

TABLE 14
ANALYSIS OF VARIANCE SUMMARY BY INTELLIGENCE
QUOTIENT FOR GRADE EIGHT

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio	Probability of F $\bar{>}$
Levels	15.85	1	15.85	.241	.627
Treatments	12.80	1	12.80	.194	.663
Treatments x Levels	6.80	1	6.80	.103	.750
Within Subgroups	1975.82	30	65.86		
Total	2011.27	33	60.95		

Summary

Analysis of the data revealed one significant F ratio at the .05 confidence level. This significance was found in regard to interaction (treatments x levels) in an examination of the variable of sex in grade eight. No determination as to whether such interaction was intrinsic or extrinsic could be made in the treatments x levels design utilized in the study. Control was exercised through procedures applying different treatments simultaneously to all levels in a given group. This would tend to distribute equally any extraneous factors effecting the differences in subgroup means.

An examination of treatment means revealed that in grade eight students undergoing conventional classroom instruction consistently had a mean greater than those utilizing Learning Activity Packages. In no case was such a difference statistically significant at .05.

By levels in grade eight, there were no statistically significant differences at .05.

Treatment means in grade seven indicated that students achieved greater academic growth in LAP than in

conventional classroom instruction. At no time, however, were differences significant at .05.

No F values were significant at .05 in relation to levels nor to interaction (treatments x levels) in grade seven.

CHAPTER V

SUMMARY, CONCLUSIONS, RECOMMENDATIONS, AND IMPLICATIONS

The purpose of this study was to determine the effect of individualized Learning Activity Packages in mathematics on the academic achievement of seventh- and eighth-grade students in the Demopolis City Schools during the 1972-1973 academic year.

To make such a determination, students from LAP math classes were matched with those from classes utilizing conventional classroom instruction (CCI). The matching was done on the basis of four variables:

(1) age, (2) sex, (3) race, and (4) intelligence quotient.

The intelligence quotients were derived by use of the Otis-Lennon Test of Mental Ability.

Effectiveness of instruction was established by academic growth as measured by pre- and post-tests. The instruments used were the mathematics sections of the appropriate levels of the California Achievement Tests (CAT).

The Lindquist treatments x levels design was used to increase the precision of the treatment comparisons. One-way analysis of variance was made of both grade seven and grade eight. Two-way analysis of variance was used to examine the effects of the two treatments in relation to three of the matching variables: (1) sex, (2) race, and (3) intelligence quotient. The latter analysis was performed by grade level.

The LAP treatment was a non-graded, continuous progress, locally prepared, individualized instructional program in mathematics. Content included traditional seventh- and eighth-grade subject matter. Packages were available on three levels of difficulty, ranging from skills approximately equivalent to second-grade level to those conventionally reserved for senior-high-grade levels.

Initial data for the study were provided by 341 seventh- and eighth-grade students in the Demopolis Junior High School, Demopolis, Alabama. From this population, fifty-eight students in LAP and CCI were matched on the variables of (1) age, (2) sex, (3) race, and (4) intelligence quotient. Twelve pairs (n = 24)

constituted the seventh-grade sample and seventeen pairs (n = 34) comprised the eighth-grade sample.

Summary of Findings

Treatment means indicated that students in grade eight performed better in conventional classroom instruction than in classes using Learning Activity Packages. Students in grade seven achieved greater academic growth through Learning Activity Packages than through conventional classroom instruction. The differences, however, were not statistically significant at the .05 confidence level in either grade level.

No F values were sufficiently large to establish statistical significance at .05 for any of the levels considered in the study.

Analysis of interaction revealed no significance at .05 in grade seven. F values for interaction relating to race and intelligence quotient for grade eight were not significant at .05.

Statistically significant interaction between treatments and sex was found. The F value of 6.199 for interaction (treatments x levels) was significant at .05.

The exact probability of $F > 6.199$ with 1 and 30 degrees of freedom is .019.

However, such significance could not justify the conclusion that the differences necessarily were attributable to differences in the relative effects of the two treatments at the two levels (female and male). Statistical significance did indicate the presence of something besides Type S error or interaction in the population.

It was not possible to determine if such interaction was intrinsic or extrinsic in a single study utilizing the treatments x levels design. An intrinsic interaction was quite possible in this study since the treatments were simultaneously administered on a group basis to subjects from both levels. Thereby, many, but not necessarily all, extraneous factors had the same effect at both levels.

A model of the treatments x levels design relating to the variable of sex in grade eight illustrates the increased precision in comparison of treatments afforded by the design.

LEVELS	TREATMENTS		
	$A_1 = \text{LAP}$	$A_2 = \text{CCI}$	
$L_1 = \text{female}$	$\bar{X}_{11} = .17$	$\bar{X}_{12} = 9.83$	$\bar{X}_{L_1} = 10.00$
$L_2 = \text{male}$	$\bar{X}_{21} = 9.18$	$\bar{X}_{22} = 5.73$	$\bar{X}_{L_2} = 14.91$
	$\bar{X}_{A_1} = 9.35$	$\bar{X}_{A_2} = 15.56$	

An examination of subgroup means (\bar{X}) indicated that the academic growth of boys in grade eight was greater in LAP than in CCI. The academic growth of girls in grade eight was markedly greater in CCI than in LAP.

Conclusions

The following conclusions were reached:

1. Students in the study in grade seven experienced greater academic growth in mathematics in instruction using Learning Activity Packages than in conventional classroom instruction.
2. The differences in academic growth in mathematics in grade seven of students using Learning Activity Packages and students in conventional classroom instruction were not statistically significant at .05 confidence level.

3. Students in the study in grade eight experienced greater academic growth in mathematics in conventional classroom instruction than in instruction using Learning Activity Packages.
4. The differences in academic growth in mathematics in grade eight of students in conventional classroom instruction and students using Learning Activity Packages were not statistically significant at .05 confidence level.
5. The observed interaction of treatments and sex of students in the study in grade eight was statistically significant at .05 confidence level.

Recommendations

The study should be replicated with an equivalent sample of subjects under the same conditions. A uniformity trial could be conducted in the repetition of the study by administering only the LAP treatment to all treatment groups. Any observed interaction would be attributable entirely to extraneous factors. If the interaction obtained in this study was much larger than

in the uniformity trial, the presence of an intrinsic interaction in this study would be suggested.¹

Replication of the study with a greater number of observations is recommended. This might be accomplished by use of a different design in a study of a school population comparable in size and characteristics to that of this study. A replication utilizing the treatments x levels design should be done in the context of a considerably larger population from which to draw matched pairs.

Evaluative measures other than standardized tests should be considered for assessing the effect of an individualized instructional program. Indicators of individual achievement would provide data unobtainable in conventional evaluative instruments. Achievement might be examined in relation to individual assumption of responsibility for learning, interest, and effort.

Implications for Educational Practice

The comparison of academic growth by students in LAP and in conventional classroom instruction indicated

¹E. F. Lindquist, Design and Analysis of Experiments in Psychology and Education (Boston: Houghton Mifflin Co., 1973), p. 127.

that as a group the achievement of students is comparable. Therefore, individualization of instruction by use of Learning Activity Packages provides for greater heterogeneity of interests, activities, and achievement levels while allowing comparable academic growth.

Decisions regarding instructional approaches in the junior high or middle school grades should consider the maturation of students. Individualization of instruction by use of Learning Activity Packages appears to effect academic growth most positively among seventh-grade students and upon eighth-grade male students.

The maturation factor appears most evident in grade eight. Findings tend to indicate that, in mathematics, conventional classroom instruction is preferable for eighth-grade girls. Individualized instruction in mathematics by use of Learning Activity Packages seems to be more appropriate for eighth-grade boys.

The common emphasis placed upon ability grouping in mathematics appears to be justifiably open to question. In fact, heterogeneous groupings are considered advantageous in an individualized instructional program in mathematics utilizing Learning Activity Packages.

APPENDIX A

MATH INVENTORY

MATH INVENTORY

NAME _____ SECTION _____

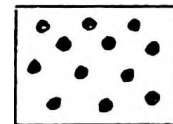
1. How many circles are found inside the box? _____



2. If we were to put all the stars in Box A into Box B, how many stars would we have in Box B? _____

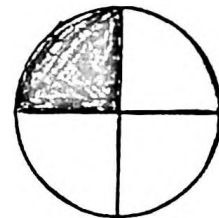


3. If this box of marbles were divided equally among two boys, how many marbles would each boy have? _____



4. Circle the largest number: 3 4 30 003

5. What part of the circle is colored?
A. $\frac{1}{4}$ B. $\frac{1}{2}$ C. $\frac{3}{4}$ D. $\frac{4}{4}$



- What part of the circle is not colored?
A. $\frac{1}{4}$ B. $\frac{1}{2}$ C. $\frac{3}{4}$ D. $\frac{4}{4}$

6. Which answer will be the largest? _____

A. $12 + 12 + 12 + 12 =$ _____

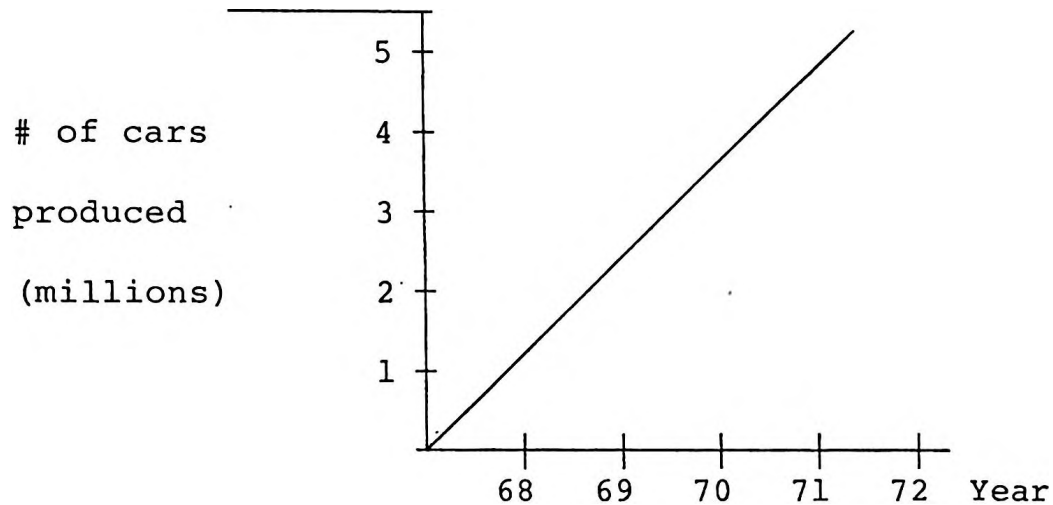
B. $12 \times 5 =$ _____

7. If I have two dimes, three quarters, a nickel and four pennies in my hand, how much money do I have?

8. $468 +$ _____ hundreds _____ tens _____ ones

$1,346 +$ _____ thousands _____ hundreds _____ tens _____ ones

9. Round off 6,471 to the nearest ten. _____
10. What is the difference in temperature between an oven which is 325°F. and one which is 450°F.? _____
- 11.



According to the above graph, 5 million cars were produced in what year? _____

12. Is the following statement true or false?
 $7 + (46 - 32) - 20 = (15 + 3) - 17$ _____
13. In 1,789,432 how many ten thousands are there? _____
14. Locate the number which is halfway between 38 and 52. _____
15. Is 13 a prime or composite number? _____
16. Which number is greater? 46 or 36 _____
17. What is the absolute value of -15? _____

18. Identify the following figures as a square, as a rectangle, or triangle.

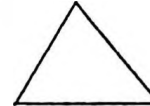
A.



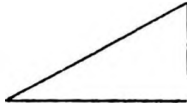
B.



C.



D.



A. _____ B. _____ C. _____

D. _____

19. Which digit of the following number represents the thousandths place?

17.019234 _____

20. Add the following numbers:

$$\begin{array}{r} 12 \\ +26 \\ \hline \end{array} \quad \begin{array}{r} 15 \\ +87 \\ \hline \end{array} \quad \begin{array}{r} 74 \\ +20 \\ \hline \end{array} \quad \begin{array}{r} 106 \\ +294 \\ \hline \end{array} \quad \begin{array}{r} 362 \\ +205 \\ \hline \end{array} \quad \begin{array}{r} 1369 \\ +4942 \\ \hline \end{array}$$

21. Add the following:
- $$191 + 36 + 4 = \underline{\hspace{2cm}}$$
- $$\begin{array}{r} 4,169 \\ 3,280 \\ 6,139 \\ \hline 5,642 \end{array}$$

22. Add: $16.02 + 0.42 + 3.1 = \underline{\hspace{2cm}}$

$$.001 + 4.62 + 962 = \underline{\hspace{2cm}}$$

23. Subtract the following:

$$\begin{array}{r} 9 \\ -4 \\ \hline \end{array} \quad \begin{array}{r} 3 \\ -2 \\ \hline \end{array} \quad \begin{array}{r} 38 \\ -17 \\ \hline \end{array} \quad \begin{array}{r} 24 \\ -15 \\ \hline \end{array} \quad \begin{array}{r} 220 \\ -41 \\ \hline \end{array} \quad \begin{array}{r} 506 \\ -97 \\ \hline \end{array} \quad \begin{array}{r} 9.006 \\ - .779 \\ \hline \end{array}$$

24. Subtract: $\$1.04 - 0.97 = \underline{\hspace{2cm}}$ $20 - .8 = \underline{\hspace{2cm}}$

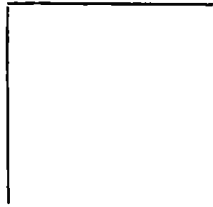
$$13.00 - 1.76 = \underline{\hspace{2cm}}$$

25. Divide the following: $3/\overline{12}$ $4/\overline{284}$
26. Divide: $3/\overline{620}$ $30/\overline{24000}$
27. Multiply the following: $\begin{array}{r} 9 \\ \times 5 \\ \hline \end{array}$ $\begin{array}{r} 8 \\ \times 7 \\ \hline \end{array}$ $\begin{array}{r} 13 \\ \times 4 \\ \hline \end{array}$ $\begin{array}{r} 1006 \\ \times 12 \\ \hline \end{array}$
28. Multiply: $\begin{array}{r} 468 \\ \times 10 \\ \hline \end{array}$ $\begin{array}{r} 29 \\ \times 100 \\ \hline \end{array}$ $\begin{array}{r} 63 \\ \times 92 \\ \hline \end{array}$ $\begin{array}{r} 797 \\ \times 289 \\ \hline \end{array}$
29. Multiply the following: $4\frac{4}{5} \times 2 = \underline{\hspace{2cm}}$
 $\frac{1}{2} \times 1\frac{3}{4} = \underline{\hspace{2cm}}$ $3\frac{1}{3} \times 2\frac{1}{2} = \underline{\hspace{2cm}}$
30. Find the quotient: $2.4 \div 0.6 = \underline{\hspace{2cm}}$
 $36.0 \div .12 = \underline{\hspace{2cm}}$ $25.6 \div 16 = \underline{\hspace{2cm}}$
31. Solve for X in the following equations:
 a) $X + 3X = 36$
 b) $\frac{6}{9} = \frac{4}{X}$
32. List the odd numbers from 1 through 25.

33. Of the following numbers, circle the largest.
 45 54 450 504
34. Express 21.49 in word form.

35. Write the following equation in words: $31 + 19 = 50$

36. Complete the following diagram of a square:

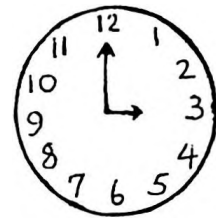


37. Fill in the blanks with the missing numbers.

$$36 + \underline{\quad} = 46$$

$$92 - \underline{\quad} = 46$$

38. According to this clock, what time is it?



39. Place one of the following symbols between the pairs of numbers to make each statement true.

<, =, >

$$(11 + 11) \underline{\quad} (9 + 13)$$

$$45 \underline{\quad} 37$$

$$25 \underline{\quad} 168 - 41$$

$$15 + 6 - 9 \underline{\quad} 32 - 20$$

40. Construct a graph which includes all of the following data: In 1969, 4 million cars were sold. In 1970, 4-1/2 million cars were sold, and in 1971, 5 million cars were sold.

41. Color 3/4 of this square.



42. Which of the following is the largest?

IX, XXI, VIII, XIX

43. Write the number which is equal to the following Roman numerals.

A. III _____ B. XIX _____

C. LX _____ D. MCMLXXI _____

44. Circle the largest number in each of the following pairs:

A. $\frac{1}{2}$ or .5001 B. 5.0 or $\frac{5}{10}$

C. 3.0 or $\frac{19}{6}$ D. 1.941 or 19.41

45. Express the following fractions in their lowest terms.

A. $\frac{4}{6} =$ B. $\frac{9}{12} =$ C. $\frac{6}{8} =$ D. $\frac{75}{100} =$

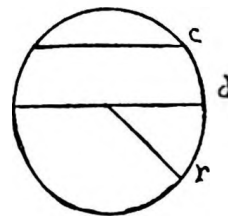
46. Convert $\frac{14}{5}$ to the smallest whole number and fractional part.

47. Using the rules of exponential notation, express 64 as a notation of two.

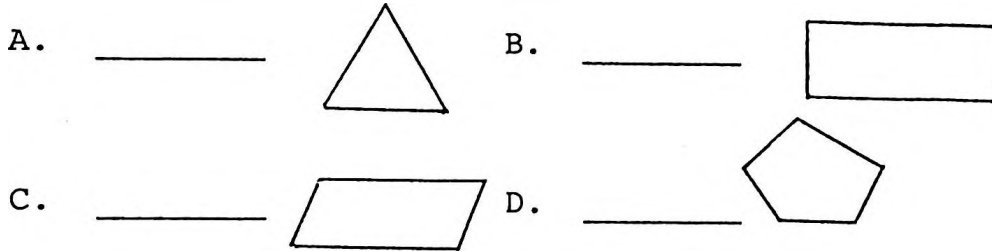
48. Convert 24 to the base 4 system. _____

49. Identify the following parts of the circle:

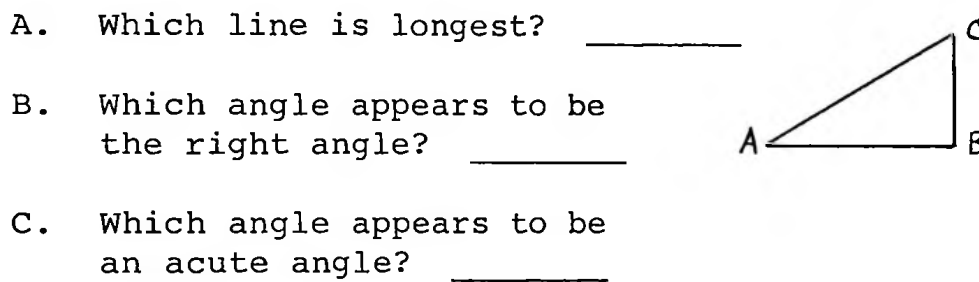
c _____ d _____ r _____



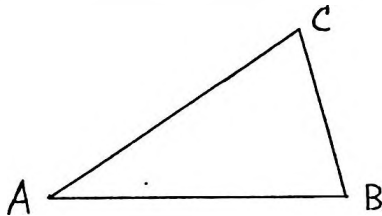
50. Name the following diagrams:



51. If the figure is a right triangle, answer the following questions:



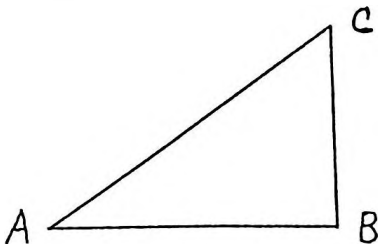
52. How large is $\angle ABC$ if $\angle CAB$ is 40° and $\angle ACB$ is 75° ?



53. A bicycle is coasting down a street at 15 miles an hour. How long would it take to go 5 miles?

54. Ruby bought 2 lbs. of salted nuts at \$1.49 a pound, and paid for them with a \$5.00 bill. How much money would she receive in change? _____

55. Given a right triangle, how long is the hypotenuse AC, if $AB = 3$ inches and $CB = 2$ inches? _____



56.
$$\begin{array}{r} 3 \text{ ft. } 10 \text{ in.} \\ + 11 \text{ ft. } 9 \text{ in.} \\ \hline \end{array} \quad \begin{array}{r} 16 \text{ ft.} \\ - 5 \text{ ft. } 8 \text{ in.} \\ \hline \end{array}$$

57. Solve for n:

a) $\frac{n}{9} = \frac{4}{12}$

b) $\frac{15}{7} = \frac{30}{n}$

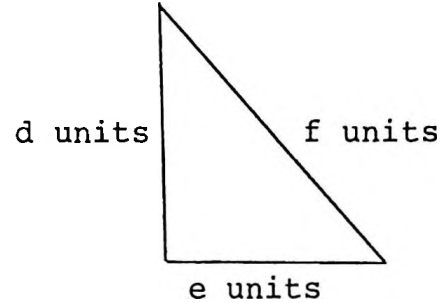
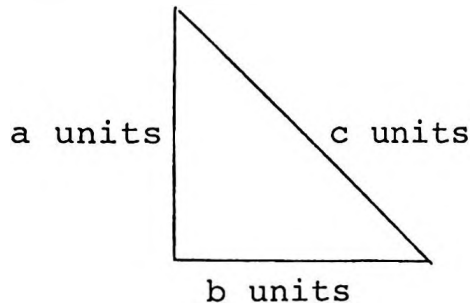
c) $\frac{9}{10} = \frac{n}{50}$

58. Solve each equation:

a) $5a + a = 36 + 6$

b) $4d - 5 = d + 10$

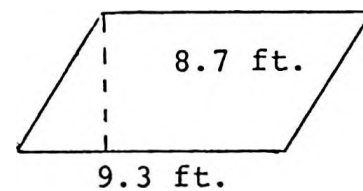
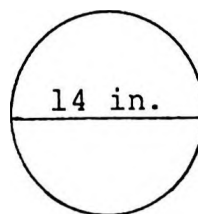
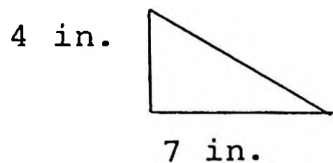
59. Use the similar triangles below to help you complete the following:



$$\frac{a}{d} = \frac{b}{e} = \frac{c}{f}$$

If $a = 6$, $b = 8$, $d = 9$, and $e =$ _____

60. Find the area of each figure below. Use 3.14 for π .



61. Complete the table for each cone described below.
Use 3.14 for π .

diameter	radius	height	volume
_____ ft.	2 ft.	3 ft.	____ cu. ft.

Solve the following:

62. 8 is _____% of 20
63. 65 is 20% of _____
64. _____ is 75% of 60

Find the interest:

65. \$500 at 7% for 2 years _____

APPENDIX B

DATA ON MATCHED PAIRS

DATA ON MATCHED PAIRS

Student Identification #	Sex	Race	DIQ	Age	CAT Pre	CAT Post	Academic Growth
E 7 CC 162	F	C	110	152	69	83	14
D 7 ML 049	F	C	111	150	72	80	8
E 7 CC 159	F	C	108	148	86	86	0
D 7 ML 055	F	C	110	145	81	86	5
E 7 CC 156	F	C	105	154	97	104	7
D 7 ML 051	F	C	107	155	85	99	14
E 7 CC 167	F	C	104	146	70	91	21
D 7 ML 054	F	C	102	145	56	88	32
E 7 CC 172	M	N	92	152	52	73	21
A 7 ML 012	M	N	94	151	48	51	3
H 7 CC 179	M	N	83	152	80	81	1
A 7 ML 005	M	N	81	149	44	71	27
C 7 CC 099	F	C	118	148	96	98	11
D 7 ML 058	F	C	119	145	81	98	17
C 7 CC 093	M	C	117	156	89	91	2
D 7 ML 033	M	C	118	156	91	95	4
C 7 CC 110	F	C	116	146	94	96	2
D 7 ML 048	F	C	116	144	81	95	14
C 7 CC 092	M	C	112	155	95	100	5
D 7 ML 032	M	C	111	153	100	103	3
G 7 CC 080	F	N	93	145	76	74	-2
D 7 ML 056	F	N	93	145	74	80	6
G 7 CC 073	F	N	83	163	81	87	6
A 7 ML 022	F	N	84	167	29	31	2
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E 8 CC 328	M	C	106	155	34	46	12
A 8 ML 270	M	C	105	158	39	41	2
E 8 CC 327	M	C	98	165	37	46	9
A 8 ML 274	M	C	93	162	28	33	5

DATA ON MATCHED PAIRS--Continued

Student Identification #	Sex	Race	DIQ	Age	CAT Pre	CAT Post	Academic Growth
E 8 CC 321	M	C	96	164	29	45	16
A 8 ML 271	M	C	93	167	28	39	11
E 8 CC 341	F	N	92	161	38	46	8
A 8 ML 287	F	N	93	164	33	29	-4
E 8 CC 068	F	N	91	166	44	59	15
A 8 ML 288	F	N	91	166	54	63	9
B 8 CC 303	M	N	88	166	37	37	0
A 8 ML 275	M	N	89	169	42	39	-3
B 8 CC 297	M	N	85	158	25	34	9
A 8 ML 266	M	N	86	159	40	55	15
E 8 CC 319	M	N	80	175	29	36	7
A 8 ML 260	M	N	80	173	36	51	15
E 8 CC 323	M	N	101	158	44	55	11
C 8 ML 238	M	N	102	157	73	89	16
E 8 CC 331	F	N	101	154	52	55	3
C 8 ML 245	F	N	101	154	56	50	-6
D 8 CC 217	F	C	116	154	50	62	12
C 8 ML 255	F	C	118	156	78	82	4
D 8 CC 228	F	C	113	167	54	60	6
C 8 ML 252	F	C	114	165	66	61	-5
D 8 CC 197	M	C	114	160	50	59	8
C 8 ML 241	M	C	111	159	75	73	-2
D 8 CC 219	F	C	106	169	41	56	15
C 8 ML 253	F	C	107	166	63	66	3
D 8 CC 199	M	C	108	168	58	55	-3
C 8 ML 234	M	C	107	166	55	71	16
D 8 CC 205	M	C	103	157	67	58	-9
C 8 ML 239	M	C	106	155	46	70	24
D 8 CC 207	M	N	99	167	50	53	3
C 8 ML 231	M	N	97	166	59	61	2

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