A STUDY OF THE RELATIONSHIP BETWEEN SOCIOCULTURAL VARIABLES AND GEOMETRIC PROBLEM SOLVING PERFORMANCES OF DISADVANTAGED CHILDREN

STEVEN NEWSTAT
PH. D.

This is to certify that the

thesis entitled

A Study of the Relationship Between Sociocultural
Variables and Geometric Problem Solving
Performances of Disadvantaged Children

presented by

Steven Newstat

has been accepted towards fulfillment
of the requirements for

Ph. D. degree in Curriculum

Chas T. Schuller
Major professor

Date 10/31/72

O-7639

G—673

Z—302

Z—68

ABSTRACT

A STUDY OF THE RELATIONSHIP
BETWEEN SOCIOCULTURAL VARIABLES
AND GEOMETRIC PROBLEM SOLVING
PERFORMANCES OF DISADVANTAGED
CHILDREN

BY

STEVEN NEWSTAT

The purpose of this research study was to determine if sociocultural variables of socioeconomic status, "father" present in the home, and crowding in the home influenced the learning of geometric constructions by culturally impoverished junior high school students.

A geometry workbook was designed to minimize the influence of reading by presenting each geometry lesson via an audio tape. Each taped lesson was approximately fifteen minutes in length and contained all of the necessary information for learning specific types of geometric constructions illustrated in the workbook.

In th

to the cognit

theories were

general, the

developmental

learning patt

capability fo

Pedago

matical conce

theories disc

the purpose o

individual di

differential m

these modes to

discussed. Re

by the various

essential for t

methodology fo

The dat

achievement te

certain cultura

ment of the tea

In this

between social

In this study a review of the literature pertaining to the cognitive theories of psychology was presented. These theories were based upon Piaget, Bruner and Ausubel. In general, the cognitive theorists attempted to explain the developmental learning patterns of the organism. These learning patterns were descriptions of the organism's capability for operational thinking.

Pedagogical implications for learning mathematical concepts are prevalent throughout the cognitive theories discussed in this investigation. Although the purpose of this investigation was not to study individual differences, some generalizations as to differential modes of intellectual growth for applying these modes to solving mathematical problems has been discussed. Recognition of the capabilities suggested by the various phases of intellectual growth are essential for the development of an adequate teaching methodology for the culturally impoverished learner.

The data analyzed in this research study included achievement test scores, course grades assigned by teachers, certain cultural variables, and scores on the test instrument of the teaching method being evaluated by this study.

In this study the predicted non-correlation between social and familial variables and student achievement

correlation

for correla

significance

The

familial cha

a "father" i

systematic e

on the teach

It wo

cultural vari

performance o

deficiencies

When the disa

teaching metho

skills.

Furthe

mental variabl

characteristic

data, and any

between infanc

and effect rel

child and his

achievement were found. The non-significance of these correlations were determined by a two-tailed t test for correlated means and the t ratio for testing the significance of a correlation coefficient.

The results of this study indicated that familial characteristics, the presence or absence of a "father" in the home, and crowding produced no systematic effect upon the performance of students on the teaching method in question.

It would appear, from this study, that socio-cultural variables are not correlated with students performance on the test instrument; and vocabulary deficiencies are not a barrier to successful learning when the disadvantaged child is presented with a teaching methodology that does not emphasize reading skills.

Further research should be focused on environmental variables and their relationships to physical characteristics, personality development, achievement data, and any changes in the socioeconomic status between infancy and adulthood. This chain like cause and effect relationship, between the disadvantaged child and his environment, should provide further understanding t

that would over

social deprivat

understanding toward the development of a curriculum that would overcome the multilateral influence of social deprivations on learning.

THE

TECH

A STUDY OF THE RELATIONSHIPS BETWEEN SOCIOCULTURAL VARIABLES AND GEOMETRIC PROBLEM SOLVING PERFORMANCES OF DISADVANTAGED CHILDREN

A DISSERTATION SUBMITTED TO
THE FACULTY OF INSTRUCTIONAL DEVELOPMENT AND
TECHNOLOGY OF THE COLLEGE OF EDUCATION OF
MICHIGAN STATE UNIVERSITY

IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE
OF DOCTOR OF PHILOSOPHY

BY

STEVEN NEWSTAT

OCTOBER, 1972

I would

Charles F. S

of my resear

doctoral co

studies in

program.

I would

encourageme

possible th

years. Bot

which has

ACKNOWLEDGEMENTS

I would like to express my appreciation to Professor Charles F. Schuller for assisting me in the completion of my research study. I am indebted, as well, to my doctoral committee who aided and guided me in my studies in educational theory during my doctoral program.

I would also like to thank my parents for their encouragement and timeless cooperation which made possible the completion of my studies over the past years. Both they and my wife have provided a model which has been a constant source of inspiration.

TABLE OF CONTENTS

Table

1 Analy
in Ge
Stude

2. Analy

3. Analy

4. Corre
Instr

5. Corre
Test

6. Corre
Test

7. Corre
by Gr
ment.

8. Corre
ment
Grade

LIST OF TABLES

9. Corr
ment

10. Corr
ment

Purpose of t

The

student is a

tude, persev

gence. It a

ing major ps

findings that

conditions of

Other

to learn, an

environmental

Gould,[2] and J

vironment as

educational b

social demand

pirations for

peer group in

tended to inf

disadvantaged

Chapter 1

INTRODUCTION

Purpose of the Study

The educational achievement of the disadvantaged student is a product of a variety of factors such as aptitude, perserverance, experience, motivation, and intelligence. It appears from a review of studies concerning major psychological theories and related research findings that most of these factors are influenced by the conditions of the disadvantaged child's environment.

Other factors such as motivation, the ability to learn, and maturation were also affected by certain environmental conditions. The research studies by Irwin,[1] Gould,[2] and Jordan[3] demonstrated the influence of the environment as it applied to the achievement motivation and educational behavior of the disadvantaged child. The social demands for educational achievement, parental aspirations for the educational accomplishments of the child, peer group influences, and other environmental conditions tended to influence the educational achievement of the disadvantaged child.

The

child, which

also influen

Piaget obser

consisting o

tions that r

environment.

that the ear

influence hi

The r

Newton,[8] Brun

ment produce

achievement

influenced h

determining

ences. At t

taged child'

his motivati

mental and

portant to

ence of the

The intellectual development of the disadvantaged child, which contributes to his educational progress, is also influenced by the characteristics of his environment. Piaget observed that "intelligence can be conceived as consisting of a series of attempts, inspired by implications that resulted from them but selected by the external environment."[4] Hebb concurred with Piaget when he observed that the early experiences of the disadvantaged child may influence his basic learning abilities.[5]

The research findings of Deutsch,[6] Coleman,[7] Newton,[8] Bruner[9] and others demonstrated that the environment produced a multilateral influence on the educational achievement of the disadvantaged child. The environment influenced his potential academic achievement directly by determining the kind and quality of educational experiences. At the same time, it also influenced the disadvantaged child's academic growth indirectly by conditioning his motivation for learning and by stimulating his developmental and maturation processes. It is, therefore, important to ascertain information concerning the influence of the environment upon the academic achievement of the disadvant

his education

Socioeconomic

the type of e

this study, w

In or

of social de

include both

The environme

criteria were

comprised the

SES score.

study and the

in a later ch

The p

was to explor

specific ongo

to the educat

investigation

measurement o

the disadvantaged child in order to better understand his educational behavior. In this study an Index of Socioeconomic Status (SES) will be utilized to determine the type of environment in which the population, used in this study, was raised.

In order to study the multilateral influences of social deprivation on learning one would have to include both cognitive and psychomotor experiences. The environmental conditions which met these dual criteria were then viewed as social deprivations and comprised the variables which were combined into a composite SES score. The particular variables selected for this study and their mode of combination will be discussed in a later chapter.

The purpose of the present investigation was to explore the educational environment in terms of specific ongoing processes and forces that may be related to the educational achievement of the population under investigation. It involved the identification and measurement of environmental factors in terms of general status chara

occupation a

instrument.

Need for the

This

of environme

achievement

was studied

learning and

The

of reference

mainstream, t

the dominant

taged learner

disadvantaged

ized measurin

foreign to hi

Gordo

is to concern

status characteristics such as social class, and father's occupation as they are related to performance on the test instrument.

Need for the Study

This research study concerned itself with aspects of environmental factors that influence the academic achievement of disadvantaged children. The environment was studied in relationship to its influence on verbal learning and intellectual achievement.

The more constricted an individual's social frame of reference and the greater his distance from the cultural mainstream, the less meaningful and the less effective are the dominant cultural values that impinge on the disadvantaged learner in the schools. Thus, the behavior of a disadvantaged child becomes less interpretable by standardized measuring techniques, as these techiques are more foreign to his social frame of reference.

Gordon[10] stressed that if psychological appraisal is to concern itself with the problems of educational planning for

should conce

instruments

al planners

learning, st

disabilities

would make t

analyses rat

advanced the

appraisal th

tion for ame

by disadvant

It m

and educatic

exclusive, b

manner. Thu

usually a cu

Kenneth Clar

planning for the socially disadvantaged, researchers should concentrate on the development of new teaching instruments and techniques. They would provide educational planners with the means to evaluate potential for learning, styles of learning, and patterns of learning disabilities. Such a procedure, according to Gordon, would make the appraisal process one of qualitative analyses rather than of quantitative assessment. He advanced the position that it is through qualitative appraisal that the educator will gain prescriptive direction for ameliorating the learning difficulties encountered by disadvantaged children as they progress through school.

It must be recognized that cultural deprivation and educational deprivation are not necessarily mutually exclusive, but may reinforce one another in a negative manner. Thus, the result for disadvantaged children is usually a cumulative deficit in learning. According to Kenneth Clark,

. .
abandons
meaningf
sufferin
problems
retardat
children
they fal

The

student has

credence to

Ausubel,

his
invariat
continui
environn
child's
a reflec
that is
confider

Deu

. .
his env
is made
has the
that hi

Fur

that the lo

> . . . low-status minority children [are] literally abandoned by our public schools, in terms of any meaningful definition of the term education, are suffering from a pattern of unresolved educational problems. But the data support the fact that the retardation is cumulative; that the longer the children remain in school, the further behind they fall in the basic subjects. [11]

The learning environment of the disadvantaged student has been described by Ausubel as one that lends credence to the cumulative deficit theory. According to Ausubel,

> His cumulative intellectual deficit is almost invariably, in part, the cumulative impact of a continuing and consistently deficient learning environment. . .Thus, most of the lower-class child's alienation from school is in great measure a reflection of cumulative deficits of a curriculum that is too demanding of him, and impaired self-confidence that he must bear.[12]

Deutsch concurred with Ausubel when he observed,

> . . .that when a disadvantaged student broadens his environmental contacts by going to school, he is made aware of his inferior class status and this has the same depressing effect on his performance that his inferior class status had all along.[13]

Furthermore, it has been shown, statistically, that the longer a disadvantaged student remained in school, the

The

tive learnin

that the edu

mental and c

culturally d

. . .
years o
plus mi
who are
intelle

In

class life

Bernstein

restricte

of an ext

at a low

language

not as

class c

school, the lower their tested reading ability becomes.[14]

The theories advanced to account for this cumulative learning deficit are usually based on the concept that the educational materials require greater environmental and cultural experience than is possessed by the culturally disadvantaged student. Deutsch stated that,,

> . . .it would appear that when one adds four years of school experience to a poor environment, plus minority status what emerged are children who are apparently less capable of handling standard intellectual and linguistic tasks.[15]

In a study by Milner it was found that a lower-class life results in a restrictive use of language.[16] Bernstein has described this language as following a restricted linguistic pattern that hinders the development of an extensive functional vocabulary which keeps thought at a low level of conceptualization.[17]

The importance of these different orientations to language was that the culturally disadvantaged student was not as equally suited to school instruction as his middle-class counterpart. Almy and Chittenden have determined that the co

is markedly

It would se

advantaged

resources i

ence unless

designed to

In a

there was r

background

expected ra

with this

that

> Ch
> cognit
> metho
> used a
> disad
> envir

Unless th

deprived

from the

that the cognitive performance of disadvantaged children is markedly inferior to that of a middle-class student.[18] It would seem reasonable, therefore, to assume that a disadvantaged youth upon entering school with these limited resources is going to find learning a frustrating experience unless the schools develop educational materials designed to overcome these deficits.

In a study by Coleman et. al. it was shown that there was reasonable convincing evidence that the home background of students was a major determinant of their expected rate of progress.[19] Deutsch tended to agree with this finding when he concluded from his study that

> Children with deficits in learning and cognitive skills should be approached with methods to learn skills that would have been used at an earlier time had they not been disadvantaged in either their home or school environment.[20]

Unless these differences are realized, the culturally deprived student will derive little of educational value from the years spent in public schools.

The

Beilin and

bei
class c
much le
sentati
the mid
symbolic
continu

Whi

when he obs

The
on the
cogniti
underly
self-co
abiliti
dimini
achiev

These defi

make it mo

to compreh

which pre

experienc

T

socially

The disadvantaged child was characterized by Beilin and Gotkin as

> being enactive and less able than the middle-class child to deal with concrete materials, and much less with their pictorial or schematic representation. . . the disparities become greater as the middle-class child acquires competence in the symbolic reasoning while the lower-class youngster continues to struggle with concrete materials. . .[21]

Whiteman tended to agree with this point of view when he observed that,

> The lower achievement level may even feed back on the slower development of the originally lowered cognitive skills. A series of interactions between underlying abilities, overt achievement and inward self-confidence may take place resulting in lower abilities producing lower achievements, and inducing diminished self-confidence, which in turn feeds upon achievement and so on.[22]

These deficiencies in cognitive and psychomotor experiences make it more difficult for the disadvantaged student to comprehend and successfully compete in a curriculum which presupposes a variety of cognitive and verbal experiences which disadvantaged students often do not possess.

The learning difficulties encountered by the socially disadvantaged student are often characterized as being somewh

are in some

impoverishe

are intellec

the disadvan

An i

has labeled

This would

of his exper

by verbal m

greater lan

this for le

fact that m

tated by ver

or even to

verbal tasks

non-verbal

mediation.

Huma

the develop

being somewhat universal in nature. That is, all individuals are in some manner intellectually, socially and culturally impoverished. This viewpoint does not recognize that there are intellectual and social characteristics unique to the disadvantaged youth.

An impoverished environment resulted in what Jensen has labeled a "higher threshold" for verbal mediation.[23] This would mean that the disadvantaged youth, as a result of his experiental background, is less able to solve problems by verbal mediation than would be true of a student with greater language experience. The potential importance of this for learning cannot be overestimated, in view of the fact that mathematical problems whose solutions were facilitated by verbal mediation were not limited to verbal problems, or even to problems verbally stated. In many so-called non-verbal tasks verbalization plays an integal role and many non-verbal problems are solved with the use of verbal mediation.

Human learning is sufficiently complex to justify the development of alternate teaching strategies for no single appro

to accommoda

by students

educational

curr
of exper
cannot b
as much
disabili
child.
fic skil
backgrou
should b
which wi
of the c
directed
deficit.

Bloo

what we have

tion to find

master the s

meet this ob

curriculum d

tion specify

single approach is likely to have sufficient sophistication to accommodate all the varied cognitive patterns employed by students and their teachers. In general, compensatory educational programs involved

> curricula which simply present a cafeteria of experience which do not include some direction, cannot be expected to succeed - or to accomplish as much in ameliorating the school learning disabilities manifested by the disadvantaged child. Therefore, the evaluation of the specific skills and deficits of children from varying backgrounds should continue, and the attempt should be made to devise curricula and experience which will be consistent with the current skills of the child and which will be effectively directed toward his growth in the areas of deficit.[24]

Bloom maintained that "most students can master what we have to teach them, and it is the task of instruction to find the means which will enable our students to master the subject under consideration."[25] In order to meet this objective, Bruner believed that the format for curriculum designs should begin with a theory of instruction specifying

should
readily
merit c
for si
new pro
manipul
A theor
effecti
materia

One

knowledge

tional res

that inclu

upon the t

Tyler, the

least eval

1
backg

2
the s
disco

3
pria
ditio

> . . . the ways in which a body of knowledge should be structured so that it can be most readily grasped by the learner. . .since the merit of a structure depends upon its power for _simplifying information_, _for generating new propositions_, _and for increasing the manipulability of a body of knowledge_. . . A theory of instruction should specify the most effective sequences in which to present the materials to be learned.[26]

One difficulty in determining this body of knowledge was the failure, for the most part, of educational researchers to plan and conduct empirical studies that included parameters which had a significant influence upon the type of learning being appraised. According to Tyler, the most important of these parameters, and the least evaluated were:

> 1. the abilities, interests, and relevant background of the students;
>
> 2. the extent to which the environment of the school, home and neighborhood encourage or discourage school learning...;
>
> 3. the extent to which...program appropriately fits in with the total pattern of conditions required for effective learning.[27]

Bro

observation

variance oc

homogeneous,

inv
the ide
lower-c
cogniti
identif
present
ance cr

Whe

have been

can be dev

tially, th

educationa

of learnin

in
his at
to pra
guidan
gains
and co
part c
learni
aid in
but no

Brown and Deutsch tended to agree with Tyler's observations when they noted that a sizeable error variance occurred when racial groups were treated as homogeneous entities.[28] Moreover,

> investigators have largely failed to pursue the identification of specific features of the lower-class environment which are associated with cognitive and verbal development. . .We must identify environmental factors which, when present or absent, can be related to performance on these abilities.[29]

When the parameters of these environmental factors have been identified viable compensatory education programs can be developed for socially disadvantaged students. Essentially, this would involve the writing and filling of educational prescriptions concerning the total process of learning. Such a process

> involves a sequence in which the student turns his attention to the learning situation, seeks to practice the things he is to learn, obtains guidance as needed in making his efforts successful, gains satisfaction from successful performance and continues the practice until the things become part of his available repertoire. Typically, a learning procedure or device is developed to aid in some part or parts of the learning process but not all of it.[30]

[illegible]

pa

re

Th

ab

di

Th

Al

st

ar

ap

Rosner points out that the "areas of intellectual performance which show the least difference in level of performance are those associated with mathematical reasoning."[31] Beilin has demonstrated that

> disadvantaged children are more likely to succeed initially with subjects that are not too culturally laden. . . such as mathematics which is relatively more cultural-free than others.[32]

Thus, one reference point from which to begin the abatement of intellectual impoverishment of the disadvantaged youth is in the area of mathematics.

> Mathematics, however, is both an organized body of knowledge and a set of methods of critiquing and extending that knowledge. Both aspects are equally important. Either aspect, or both, may hold transient attention for solving the mathematical problem-at-hand. The mathematics curriculum planner therefore, cannot, select a particular psychologically-based strategy of instruction. He must first identify the terminal characteristics of the subject-matter to be learned.[33]

These terminal characteristics become the course objectives. Also, the mathematics curriculum designer must specify the student population taking these mathematical courses. Only after this is determined, can the curriculum designer make an appropriate selection of a teaching strategy to be employed.

a

s
t

f
o
p

a
J

The purpose of the present research study was as follows:

1. To determine whether the relationship between specific environmental factors and performance on the test instrument were independent of socioeconomic status.

2. To explore whether some specific environmental factors interact jointly with the socioeconomic status of the disadvantaged child and do thereby affect his performances on the test instrument used in this study.

To accomplish the above, a population of disadvantaged children in Philadelphia were selected from a Junior High School in a racially encapsulated area.

Chapter 1

REFERENCES CITED

1. C. Orvis Irwin, "Language and Communications," Handbook of Research Methods in Child Development, Edited by Paul H. Mussen, New York: John Wiley and Sons, 1960, Chapter 12.

2. Rosalind Gould, "Some Sociological Determinants of Goal Strivings," Journal of Social Psychology, 13: 461-73, May, 1941.

3. Thomas E. Jordan, "Early Developmental Adversity and Classroom Learning: A Prospective Inquiry," American Journal of Mental Deficiency, 69: 360-71, November, 1964.

4. Jean Piaget, The Origins of Intelligence in Children, translated by Margaret Cook, New York: International Universities Press, Inc., 1952, p. 358.

5. D.O. Hebb, Organization of Behavior, New York: Science Edition, Inc., 1961.

6. Martin Deutsch, Minority Group and Class Status as Related to Social and Personality Factors in Scholastic Achievement, Society for Applied Anthropology, Monographs No. 2, Ithaca, N.Y., Cornell University, 1960.

7. J. Coleman, et. al., Equality of Educational Opportunity, United States Office of Education, Washington, D.C., 1966.

8. Eunice Shaed Newton, "Planning for the Language Development of Disadvantaged Children and Youth," Journal of Negro Education, 33: 264-74, Summer, 1964.

9. Jerome Bruner, "The Cognitive Consequences of Early Deprivation," Sensory Deprivation, edited by Philip Solomon and others, Cambridge, Mass.: Harvard University Press, 1961, Chapter 13, pp. 195-207.

Chi
Me
Pre

Me
19

Not
for
1:

Lan
of

Mal
Lec

p.

Rea
Pat
22:

Bri

Thi
Pap
for
196

Chi
U.S

10. Edmund W. Gordon, "Counseling Socially Disadvantaged Children," in Mental Health of the Poor, edited by Frank Riessman, Jerome Cohen, and Arthur Pearl, New York: Free Press of Glencoe, 1964, pp. 275-82.

11. Kenneth B. Clark, "Unstructuring Education," in New Relationships in ITV, Educational Media Council, Inc., 1967.

12. David Ausubel, "How Reversible are the Cognitive and Motivational Effects of Cultural Deprivation? Implications for Teaching the Culturally Deprived," Urban Education, 1: 18, Summer, 1964.

13. Martin Deutsch, "The Role of Social Class in Language Development and Cognition," American Journal of Orthopsychiatry, 35: 85, January, 1965.

14. Martin Deutsch, "Social Intervention and the Malleability of the Child," Annual School of Education Lecture, Cornell University, Ithaca, New York, 1965, p.24.

15. Deutsch, "The Role of Social Class," Op. Cit., p. 86.

16. Esther Milner, "A Study of the Relationship Between Reading and Readiness in Grade I School Children and Patterns of Pattern-Child Interference," Child Development, 22: 95-112, 1951.

17. Basil Bernstein, "Language and Social Class," British Journal of Sociology, 11: 275, September, 1960.

18. M. Almy and E. Chittenden, "Young Children's Thinking: Understanding of the Principle of Conservation," Paper Presented at the Biennial Meeting of the Society for Research in Child Development, Berkley, California, 1963.(Mimeo)

19. James Coleman and others, Equality of Educational Opportunity, United States Office of Education, Washington, D.C., 1966.

20. Deutsch, "Social Intervention," Op. Cit., p. 13.

Iss
Soc
Con
Ach
Chi

Enr
Enr
Univ

al
1966

Camb

Corn
May,

W.W.

Eval
John
New

in N
Soci

Ment
Teach

the

Educ
of Na
Give

21. Harry Beilin and Lassar G. Gotkin, "Psychological Issues in the Development of Mathematics Curricula for Socially Disadvantaged Children," Paper Presented to the Conference on Mathematics Education for Below Average Achievers held by the School Mathematics Study Group in Chicago, April 10-11, 1964, p. 15. (Mimeo)

22. Martin Whiteman, "Developmental Theory and Enrichment Programs," in Environmental Deprivation and Enrichment, New York, Ferkhauff Graduate School, Yeshiva University, 1965, p. 56.

23. A.R. Jensen, "Verbal Mediation and Educational Potential," Psychology in the Schools, 3: 99-109, 1966.

24. Jerome S. Bruner, The Process of Education, Cambridge, Harvard University Press, 1960, pp. 203-204.

25. Benjamin Bloom, "Learning for Mastery,"Evaluation Comment, University of California, Los Angeles, California, May, 1968, p. 1.

26. Jerome S. Bruner, Toward a Theory of Instruction, W.W. Norton Publisher, 1968, p. 41.

27. Ralph W. Tyler, "The Possibilities of Educational Evaluation," in School and the Challenge of Innovation, John Burns (Chairman), Committee for Economic Development, New York, p. 81.

28. Martin Deutsch and Bert Brown, "Social Influence in Negro-White Intelligence Differences," Journal of Social Issues, 20: 28, April, 1964.

29. Ibid., p. 30.

30. Ralph W. Tyler, Op. Cit., p. 83.

31. B. Rosner, Community Socioeconomic Status in Mental Organization, Unpublished Doctoral Dissertation, Teachers College, Columbia University, 1955, p. 71.

32. R. Kelson, New Curriculum and the Teaching of the Disadvantaged, McGraw-Hill, New York, p. 16.

33. Lee S. Schulman, "Psychology and Mathematics Education," Mathematics Education, Sixty-Ninth Yearbook of National Society for the Study of Education, Part I, University of Chicago Press, Chicago, 1970, p. 71.

of

ope

pre

ide

stu

of

and

dev

app

rel

chi

for

Chapter 2

BASIS FOR THE STUDY

Factors associated with learning disabilities of disadvantaged children are identifiable but they operate neither independently nor with a clearly predictable pattern. Future efforts to characterize, identify, and select the socially disadvantaged student must be directed toward the identification of their learning disabilities. This is basic to, and a pre-requisite for, implementing new curriculum developments and experimentation with different approaches to teaching the disadvantaged.

This chapter is concerned with specific research relative to the study as follows:

1. The learning disabilities of disadvantaged children which affect their academic achievement.

2. Sociocultural variables that may account for differences in achievement and learning capabilities

within disadvantaged groups.

Additional purposes of this chapter are (1) to provide some historical perspective of the test instrument; (2) to present a background of cognitive psychology associated with learning mathematical concepts.

The Disadvantaged Child

There are different types of disadvantaged children. The group or subgroup in question may be easily identifiable, as ethnic groups, or relatively difficult to distinguish as in groups of individuals with common interests, such as an athletic team. Culturally influenced behavior may be formal and deliberate or incidental and subtle.

A review of the literature shows that a variety of different terms are used interchangeably when identifying a population as being disadvantaged. Anastasi referred to culturally deprived children as "persons exposed to inconsistent and often incompatible mores, goals, and social pressures."[1] Kerber and

S

in

cu

co

fo

g

ne

th

pe

wh

li

as

ha

cu

eq

di

pa

ha

Smith used the term culturally deprived children but in reference to those who "do not know enough of our cultural heritage, do not have the possession, rewards, competences, or knowledge which are too much taken for granted as given everybody in the American Society."[2]

Deutsch and his associates used the term minority-group children to apply to the absence of the "home, neighborhood, and school environment that might enable them [the disadvantaged] to utilize their ability and personality potentials fully."[3]

Passow[4] has used the term culturally disadvantaged when referring to the economic state in which they live. He also described culturally disadvantaged children, as being synonymous with the following terms: socially handicapped children; culturally different children; culturally impoverished children; children with inferior educational background; children of low social origin; the diverse, low income groups; children of depressed parents; and children of depressed areas.[5] Deutsch has observed that the home of a disadvantaged youth is ch

the

in

mod

be

tio

a s

chi

abs

part

and

characterized by

> . . . A scarcity . . . of books, toys, puzzles, pencils and scribbling paper. It is not that the mere presence of such materials would necessarily result in their productive use, but it would increase the child's familiarity with the tools he'll be confronted with in school. Actually, for the most effective utilization of these tools, guidance and explanations are necessary from the earliest time of exposure. Such guidance requires not only the presence of aware and educated adults, but also time - a rare commodity in these marginal circumstances.[6]

In a study by Ausubel, it was shown that a delay in the acquisition of certain formal language forms resulted in difficulty in the transition from concrete to abstract modes of thought.[7] Deutsch found lower-class children to be inferior in abstract conceptualization and categorization of visual stimuli.[8] A similar result was found in a study by Bean, who had discovered that lower-class children tended to be relatively poor in visual imagery, abstraction and verbalization.[9]

The research of Spain[10] states, that for the most part, the major difference between the culturally deprived and non-culturally deprived child was the slower increase in the functional use of language by the culturally deprived children.

Gordon[11] held that all organized patterned behaviors are reflections or interactions between the organism and its environment. Deutsch and Brown,[12] found a similar interaction position, and suggested making an analysis of social factors, of social class components, and of the interaction of the two. Hunt[13] focuses more directly on the developmental dimension and he emphasizes the hierarchical and sequential arrangement in developing intellectual capacities. Chilman[14] pursued the dimensions of development still further by suggesting that disadvantaged children have a pragmatic, concrete and personal style, that is, the style of an immature person.

Reissman[15] defines a series of euphemisms such as culturally deprived, educationally deprived, deprived, underprivileged, disadvantaged, lower-class, lower socioeconomic group as interchangeable.

He stated that

> While lower socioeconomic groups lack many of the advantages (and disadvantages of middle-class culture), we do not think it is appropriate to describe them as "culturally deprived" . . .
>
> The term "culturally deprived" refers to those aspects of middle-class culture - such as education, books, formal language - from which these groups have benefited.
>
> However, because it is the term in current usage, we will use "culturally deprived" interchangeably with "educationally deprived" to refer to the members of lower socioeconomic groups who have had limited access to education.[16]

Throughout this study, the term culturally disadvantaged is used according to the definition set forth by Reissman in the preceding paragraph.

Euclidean Geometry as a Basis for Research Materials Used in this Study

Euclid composed the Elements, in which he collected many of the geometric discoveries of Hermotimus, Pathagoras, Eudoxus, completed many of the theorems developed by Theatetus, and supplied then irrefutable mathematical proofs of geometric concepts which had not been mathematically proven by his predecessors.[1]

The logical structure of Euclid's Elements fulfilled Aristotle's desire to develop a science based up

ax

ne

in

of

fi

ac

an

by

th

Eu

(B

in

ga

Bi

fo

th

ha

upon the "primitive elements, on definitions and axioms."[2] Each of Euclid's thirteen books began with newly introduced concepts. The first book was divided into the following areas: (1) the primitive notions of geometry (point, line, surface, angle, boundary, and figure), and (2) the basic geometric figures (right angle, acute and obtuse angles, triangle, circle, quadrilaterals, and parallel lines). These explanations were followed by the postulates, and then by the axioms. Together, they comprised the mathematical foundation upon which Euclid developed a theory of geometry. This foundation (Book I) served as a base for the material utilized in the test instrument employed in the present investigation.

Birkhoff and Beatley's Geometry

Generally, the format of a geometry course has followed the pattern established by Euclid over two-thousand years ago. Throughout history mathematicians have sought to modify and clarify Euclid's geometry in an attempt to make its mathematical basis more rigorous. The past century has seen considerable improvement upon Euclid's treatment of geometry with the emergence of alternative systems.

Perhaps the most significant attempt to structure demonstrative geometry was undertaken by George Birkhoff and Ralph Beatley.[1] Beginning with an article in 1930 in the Fifth Yearbook of the National Council for the Teachers of Mathematics entitled "A New Approach To Elementary Geometry" and culminating with the publication in 1940 of the textbook Basic Geometry, they presented a logically sound elementary system of geometry which provided an alternative approach to the teaching of traditional Euclidean Geometry.[2] This approach was the basis for the workbook containing the geometric constructions used in this investigation.

Theories of Cognitive Psychology Relative to Teaching Mathematics

The purpose of this section of the study is to review the literature pertaining to cognitive psychology as it a

disac

theor

c
i
p

i
o
s

curri

tive

behav

is as

Accor

mo
sy
pr
mo

The Ge

His th

matica

it applies to the teaching of mathematical concepts to disadvantaged students. The importance of psychological theory, as it is related to learning geometry, is that it

> 1. Can provide information as to the nature of each act of learning and the conditions affecting it. Each act of learning contains . . . the whole problem of learning.
>
> 2. Can formulate an economics of learning, that is to say, a theory and a practical art for selecting optimal rates and order of presentation when there are several or a large number of items to be learned.[1]

Beilin and Gotkin[2] suggested that the mathematics curriculum for disadvantaged pupils be subjected to a cognitive analysis in order to know what is to be taught and what behaviors and cognitive processes the disadvantaged learner is assumed to have in order to cope with mathematical problems. According to them,

> . . . the disadvantaged child who is lacking in most cases the relevant cognitive structures or the symbolic means of representing his experience, may profit from being provided with appropriate logical models or problem solving strategies.[3]

The Geneva School

The Geneva School was represented by Jean Piaget. His theory was closely associated with the study of mathematical learning. Piaget's theory of cognition supported by th

can b

metat

depen

relev

theory

human

of the

provid

of a l

as an

their

area c

solvin

in thi

above

by the works of Flavell,[4] Furth,[5] Sigel and Hooper,[6] can be interpreted as a group of three theories: a metatheory, a stage-independent theory, and a stage dependent theory.[7] The stage-dependent theory is relevant to the mathematical concepts used in this study.

Stage-Dependent Theory. As a stage-dependent theory, Piaget's[8] work embraced the nature of the human learner, the nature of knowledge, and the nature of the general development of the learner. This theory provided the human learner with inborn structures, capable of a limited number of perceptions. This was considered as an operational mode common to all living organisms in their interaction with reality.

This operational mode can be interpolated to the area of geometry. To assist the disadvantaged child in solving the construction problems in the workbook used in this research the psychological principles discussed above were incorporated in the design of the material.

The
mov
ana
to

and
par
dev
or
In
the
gra
add
in
inc
per

att
wi

These materials were designed to encourage the student to move from the stage-dependent theory to combinatorial analysis which resulted in his ability to seek solutions to geometric constructions by deductive reasoning.

Formal Stage Theory. Research by Inhelder and Piaget[9] on the reasoning capacity of children of particular ages has led them to the conclusion that development of the capacity for hypothetical reasoning or formal aspects of logic began at about age eleven. In a study by Hill[10] it was shown that children between the ages of six and eight had a considerable intuitive grasp of many principles of logical inferences. In addition, these children demonstrated their understanding in reasoning from hypothetical premises. Her results also indicated that simple demonstrations improved children's performance in recognition of valid inferences.

A study by Yudin and Kates[11] investigated concept attainment of adolescents. Their findings were consistent with Inhelder and Piaget's assertion that the age of twelve is the beginning of formal operations. The educationally disadvantaged individuals did not begin to fully employ formal operations until the ages of fourteen to sixteen but did show significant gains during these two years though equilibrium was not yet attained.

Factors of culture, socioeconomic status, and formal education, are recognized as variables which can promote or deter educational development and specifically the development of the capacity for hypothetical reasoning.

The Harvard School

The Process of Education, a report by Jerome Bruner[12] became the focal point for the learning by discovery approach. Although Bruner's theory was not original, he managed to embody the letter and spirit of the reform movement to renovate mathematics education during the decade of the 1950's. These talents have enabled Bruner to present educational theories in a manner which have had a pervasive influence on the contemporary educational scene. While recognizing that these theories were not new, it is still important to realize that they are significant and challenging to the teaching of mathematical concepts.

Bruner's concept of knowledge structure was related to the writings of Alfred North Whitehead.[13] His educational psychology about learning by discovery was based upon Piaget[14] and included ideas from the writings of Dewey,[15] and Scott.[16]

Bruner classified the modes of representation as enactive, iconic, and symbolic. These three learning sequences designated ways in which the learner made discoveries which were necessary for the teaching of transferrable principles and processes.

The deficits in symbolic representation and language development are reflected in studies of concept development in disadvantaged children. Concept formation in disadvantaged students has been found, by Reissman, as being content-centered rather than form-centered and whose reasoning has been described as more inductive than ded

Gor

gen

tra

or

depr

gene

prec

effe

chil

the

taug

by Br

which

the p

to le

deductive.[17] This conceptual style was reported by Gordon[18] to limit the child's ability to make accurate generalizations from the specific to the general and to transfer knowledge utilizing previously learned concepts.

Although Bruner did not concede the necessity or the possibility of linking specific age limits or deprivation levels to these representational modes, he generally compared his levels to Piaget's stages of preoperational, concrete, and formal intelligence.

According to Bruner, any subject can be taught effectively in some intellectually honest form to any child at any stage of development.[19]

Bruner emphasized the kind of processes learned by the student, in contrast to the specific subject matter taught, that is, "knowing is a process, not a product."[20]

Peel[21] discussed the learning strategies reported by Bruner, Goodnow and Austin. He recommended instruction which recognized individual differences and suggested the possibility of developing a new strategy appropriate to learning formal mathematical operations.

David Ausubel

The Theory. Ausubel[22] recognized the careful sequencing of instructional experience so that the teaching of any mathematics unit was clearly and logically related to the units that precede it. His theory of learning concentrated on meaningful learning requiring that the learner utilized a meaningful set and that the material learned have potential relevance for the learner. The characteristics of a meaningful learning set included the ability to relate new material to corresponding features of existing cognitive structures and the capacity for incorporating the various relationships of the new material into present cognitive structure. For new material to be learned, a more general concept must already have been incorporated into the cognitive structure. These principles were some of integral features of the test instrument used in this study.

Ausubel[23] conceived of the cognitive organization of meaningful learning by the learner as a hierarchical system. Rote learning resulted from materials not inherently meaning-

I

p

t

b

t

l

g

as

Au

ea

th

ge

th

the

Tea

D/s

ori

ful, or at least not meaningful to the learner, or with potentially meaningful materials not approached with the proper learning set. This notion was similar to Hunt's theory of learning. He proposed that learning tasks can be divided into those which require complete information transmission (rote learning), information reduction (concept learning), and information production (probabilistic learning).[24]

The arrangement of curricular materials can be governed by Ausubel's subsumption theory, a theory which assumed a hierarchical organization of knowledge.[25] Ausubel suggested the use of advance organizers prior to each unit and subunit. These organizers would contain the particular unit which they preceded; they would be general in nature and formulated in terms familiar to the student. These principles were incorporated into the teaching methodology employed in this study.

Teaching Mathematics to Disadvantaged Children

A theory of developing cognitive structure was oriented toward providing the disadvantaged learner with

a logical structure which he may apply to a variety of mathematical relations. These relations would be developed in a logically ordered fashion so that the disadvantaged student acquires fundamental logical principles in a sequential order gradually developing more complex and sophisticated mathematical skills. Such a procedure would allow the disadvantaged child to "bypass the often arduous and frustrating task of attempting to discover mathematical principles which come more easily to middle-class children (who have considerably broader referential systems)."[1] To overcome the disadvantaged student's achievement deficit on tests measuring cognitive ability, the school, being the primary method of socializing and teaching the disadvantaged youth, must also accept its own failures whenever any such child fails. To ignore this fact means that the school will only tend to increase the achievement deficit and further impoverish the intellectual talents of the disadvantaged youth.

Martin Deutsch,[2] in his study concerning the social milieu of the disadvantaged child and its effects upon the

lear
ente
what
inev
rath

self
defi
decr
disa

that
skil
Bald

learning process, concluded that the lower-class child enters the school situation so poorly prepared to produce what the school demands that initial failures are almost inevitable and the school experience becomes negatively rather than positively reinforcing.

Educators must not allow themselves to believe as self-evident and self-fulfilling the cumulative-deficit theory. Instead the schools must undertake to decrease this intellectual impoverishment of the culturally disadvantaged.

According to Cynthia Deutsch,

> Environmental background factors can be very important in the training of problem solving abilities and that these underlying skills are most crucial in the learning process in school.[3]

It has been shown by Piaget, Baldwin, and others that conceptual thinking and fundamental problem solving skills begin to develop during the early preschool period. Baldwin summarizes Piaget's findings as follows:

thre

lear

of t

Thes

and

to d

to g

home

to t

thes

in t

chil

shown

> After infancy the cognitive development of the child consists largely of the development of conceptual schemata. At the end of infancy he can exhibit the behavior that follows the simple logical rule. . .The course of the development of this conceptual schemata is from the specific to the general. The child first recognizes relationship in the one situation, then gradually generalizes until finally it becomes an abstract schema.[4]

Nelson observed that "children as young as three years have the ability to use a simple form of rational learning, and they can discover the rational organization of the learning problems with which they are confronted."[5] These evidences suggest that the higher cognitive processes and mental skills which are very important to learning begin to develop at a very early age, much before the child begins to go to school. Consequently, the intellectuality in the home, the kind of complex and challenging environment provided to the child in the home contribute to the development of these abilities and skills. The influence of the home in this respect can continue even after the disadvantaged child begins formal schooling.

Bruner,[6] Sigel and McBane,[7] and Bernstein[8] have shown that the home environment plays a very important role f

a part

school

the ki

at the

is not

nesses

experi

nature

partic

specia

genera

notion

ch
ch
la
sl
r
i
d

These

later

role in the development of the child's verbal facility as a part of the socialization process much before he enters school. The quality of his language usage depends upon the kind of language models available to him in the home at the initial stages of his language development.

The cognitive development of disadvantaged children is not as adequate as that of their advantaged peers. Weaknesses in language, limited range of cognitive and verbal experiences, and restricted stimulation of an intellectual nature all produce certain cognitive deficiencies. In particular, culturally deprived children seem to have special difficulty in developing concepts of an abstract generalizing nature. Empirical evidence supported the notion that

> school achievement of disadvantaged [children] is characterized by a cumulative-deficit phenomenon. The children begin school with certain inadequacies in language development, perceptual skills, attentional skills, and motivation. Under the usual school curriculum, the achievement pattern of deprived children is such that they fall increasingly behind their non-deprived peers in school subjects.[9]

These cognitive deficiencies become most evident in the later elementary and junior high school grades when the subje

arith

stude

Deuts

than

child

with

child

arithr

entia

and l

advan

impor

mathe

that

lower

statu

Dunk

subject matter typically requires such abilities.

In a cross-cultural study of the acquisition of arithmetic concepts, Montague[10] found that lower-class students performed better in mathematics than in reading. Deutsch[11] also found arithmetic scores to be higher than reading scores in a population of lower-class children. Both of these researchers tended to agree with the early finding by Siller[12] that disadvantaged children are most proficient in such academic areas as arithmetic.

Davis[13] and Jensen[14] have shown that status differentiations have the effect in varying degrees of defining and limiting the intellectual environment of the disadvantaged student. They maintained that SES was an important factor in determining the development of mathematical concepts. Findlay and McGuire[15] found that children from lower status backgrounds exhibited a lower degree of problem solving capacity than higher status children.

Studies by Deutsch,[16] Newton,[17] Montague,[18] Dunkley,[19] Dutton,[20] Binkley,[21] Searle,[22] Skypek,[23] Wahl

of sc

They

envir

This

socio

direc

statu

statu

concr

obser

child

abstr

to di

term

teach

disa

Proc

Proo

Wahlstrom,[24] and Erickson[25] investigated the relationship of socioeconomic environment and mathematics achievement. They found that the lower the level of socioeconomic environment the lower the school mathematics achievement. This relationship indicated that children from low socioeconomic background had a scholastic handicap in direct proportion to the degree of their disadvantaged status.

Davis,[26] Lorge and Thorndike[27] have found that low status children tended to operate, as a group, at a more concrete level than do high status children. They observed that the early deprivation in the disadvantaged child's development resulted in a lessened ability to form abstractions and that limited verbal development is related to difficulty in learning mathematics.

Mathematics instruction should be considered in terms of matching the proper instructional module and teaching strategy to the unique characteristics of the disadvantaged learner. According to Dode, this matching process is very difficult because there " is no decisive proof that any particular teaching method . . . will guara

so fa

a mat

seque

neces

probl

is ve

knowl

seque

Heime

mathe

learn

itsel

compo

compo

there

perfo

guarantee better results than any other method or philosophy, so far as achievement is concerned."[28] Instead, it becomes a matter of determining the most effective learning sequence and combination of the instructional methods necessary for solving different types of mathematical problems. Ralph Heimer observed that such a determination is very complex because "the extent of substantive knowledge about construction of efficient instructional sequence in mathematics is at present desperately sparse."[29]

Moreover, Suppes, Hyman and Jerman concurred with Heimer when they observed that "in the cognitive domain mathematics provides one of the clearest examples of complex learning and performances, for the structure of the subject itself provides numerous constraints on any adequate theory."[30]

Kruteskie[31] has identified the two general components of mathematics learning as a visual image component and verbal-logic component. He established that there was a marked relationship between the ability to perform well in mathematics and the ability to deal with symbolic and abstract representations of problems, whether verbally or non-verbally.

Havighurst tended to agree with Kruteskie when he observed that "the difference between the socially disadvantaged and the mass majority is less on tests of certain non-verbal skills than on tests of more verbal and abstract abilities."[32] This relationship is further enhanced because disadvantaged children do not show a deficit in the conceptualization task in its performance aspect.[33] Thus curriculum materials specially designed for the disadvantaged child should prove superior to materials designed for "average" students.

Reissman observed that visual aids are "useful for eliciting the special cognitive style and creative potential of deprived children."[34] Newton tended to agree with Reissman when he observed that auto-instructional devices enhanced the learning environment of disadvantaged children because "they favor concrete, stimulus-bound cognitive processes which involve learning."[35]

Jerome Bruner, emphasizes the kinds of processes learned by the student, rather than the specific subject-matter products he may acquire. This idea was reflected in his statement that

> We teach a subject . . . to get a student to think mathematically for himself. . . to embody the process of knowledge-getting. Knowing is a process, not a product.[36]

Bruner,[37] in The Process of Education, states that the development of cognitive strategies are enhanced by providing the learner with intervening opportunities for trial and error in solving problems. This kind of exposure will increase the intellectual and social interchange between teacher and pupil.

Robert Gagne concurs with Bruner's emphasis that the process of learning was more important than its product. Gagne, however, is much more concerned with the teaching of the rules or intellectual skills that are relevant to particular instructional disciplines. He observed that when solving "a mathematical problem the individual . . . may have acquired a strategy of applying relevant subordinate rules in a certain order - but he must also have a

and Ga

the sc

learni

ar
al
co

given

time p

that

some

the p

Kelso

obser

can e

with

amour

have available the mathematical rules themselves."[38]

In contrast to the educational philosophy of Bruner and Gagne, Ausubel maintained that the primary objective of the school is the transmission of knowledge.[39] Meaningful learning, according to Ausubel, occurred

> . . . if the learning task can be related in non-arbitrary, substantive fashion to what the learner already knows, and . . . if the learner adopts a corresponding learning set to do so.[40]

Lloyd Scott concurs with Bruner's theory that given sufficient prerequisite understanding in a given time period any child can learn any subject. Scott states that "any concept may be taught a child of any age in some intellectually honest manner, if one is able to find the proper language for expressing the concept."[41] Kelson tends to reflect upon Scott's statement when he observed that "disadvantaged students, given enough time, can equal achievement levels of "suburban" children even with highly abstract content."[42]

Similarly, John Carroll views aptitude as the amount of time required by the learner to attain mastery of a

t
a
r
a
h

1

from

devel

techr

Accor

from

perce

that

in re

equi

most

to t

that

what

subs

of a learning task.[43] Benjamin Bloom observes that

> Implicit in this formulation is the assumption that, given enough time, all students can conceivably attain mastery of a learning task. If Carroll is right, then learning mastery is theoretically available to all, if we can find the means for helping each student.[44]

In order to facilitate the transition of material from one level of thinking to the next requires the development of special instructional programs and techniques to be used by the disadvantaged pupil. According to Beilin and Gotkin, these pupils will benefit from the translation of motor activity to reasoning with perceptual and audio types of presentations. They believe that the most difficult task are those in "which reasoning in relation to one form of representation is made equivalent to reasoning in another."[45]

Transfer of knowledge according to Ausubel[46] occurs most effectively if what was learned was rendered meaningful to the learner. Gagne[47] and Piaget[48] have demonstrated that a unit in mathematics should link new material and what preceded it. Once this link has been established, subsequent mastery is within the realm of accomplishment, becau

intro

resul

stabl

gener

when

embed

facts

chanc

speci

that

Gesta

recon

thei

prin

in t

because meaningfulness of the subject matter has been introduced.

If, as Ausubel suggested, meaningful learning results in positive transfer, it follows that the most stable objects of instruction are concepts, principles and general strategies, rather than isolated facts. However, when one teaches Euclidean geometry they should be embedded in a matrix of concepts and principles. When facts are related to conceptual schema, there is less chance of the student forgetting.[49] Although many of the specific associations may be forgotten, the presence of that organizing framework or matrix will, according to the Gestalt theory of learning, increase the likelihood of their reconstruction or rediscovery at a point in time when their application is needed. This matrix of concepts and principles were contained in the test instrument employed in this study.

Chapter 2

REFERENCES CITED

The Disadvantaged Child

1. Anne Anastasi, *Differential Psychology*, New York: MacMillan and Company, 1958, p. 112.

2. A. Kerber and W. R. Smith, *Educational Issues in A Changing Society*, Detroit: Wayne State University Press, 1962, p. 28.

3. Martin Deutsch and Others, "Guidelines for Testing Minority Group Children," *Journal of Social Issues*, 20: 130, April, 1964.

4. Harry A. Passow, editor, *Education In Depressed Areas*, New York: Teachers College Press, 1963, p. 333.

5. *Ibid.*, pp. 333-348.

6. Martin Deutsch, "Some Psychological Aspects of Learning in the Disadvantaged," in *The Disadvantaged Child*, Martin Deutsch and Associates, New York: Basic Books, Inc., 1967, p. 44.

7. David Ausubel, "How Reversible Are The Cognitive and Motivational Effects of Cultural Deprivation? Implications for Teaching the Culturally Deprived Child," *Urban Education*, 1: 25, Summer, 1964.

8. Martin Deutsch, *Op. Cit.*, p. 30.

9. Kenneth L. Bean, "Negro Responses to Verbal and Non-Verbal Test Material," *Journal of Psychology*, 13: 348, April, 1942.

by C
Ages
Geor

Chil
man,
coe,

of M
Soci

Rona

Rela
3: I

New
Depa
Educ
Wash

New

Evol

Math

to
Lib

10. Joseph Clarence Spain, Definition of Familar Nouns by Culturally Deprived and Non-Deprived Children of Varying Ages, Unpublished Doctoral Thesis, Nashville, Tennessee: George Peabody College for Teachers, 1962.

11. Edmund W. Gordon, "Counseling Socially Disadvantaged Children," Mental Health of the Poor, Edited by Frank Riessman, Jerome, and Arthur Pearl, New York: Free Press of Glencoe, 1964, p. 277.

12. Martin Deutsch and Bert Brown, "Social Influences of Negro-White Intelligence Differences," Journal of Social Issues, 20: 24-35, April, 1965.

13. Joseph Hunt, Intelligence and Experience, New York: Ronald Press Co., 1961, 416 pp.

14. Catherine S. Chilman, "Child-Rearing and Family Relationship Patterns of the Very Poor," Welfare in Review, 3: 15, January, 1965.

15. Frank Reissman, "The Culturally Deprived Child: A New View," Programs for Educationally Disadvantaged, U.S. Department of Health, Education, and Welfare, Office of Education, Bulletin Number 17, Government Printing Office, Washington, D.C., 1963, pp. 3-10.

16. Frank Reissman, The Culturally Deprived Child, New York: Harper and Row, 1962, p. 25.

Evolution of Euclidean Geometry

1. B. Russell, Introduction to the Philosophy of Maths, Cambridge, Mass., 1923.

2. Aristotle, Posterior Analytics in Introduction to Aristotle , ed. R. McKeon, New York: The Modern Library, 1947, pp. 9-109.

Birk

Appr
Geom
Teac
Univ

Chic

Theo

ions
by E
Educ
1960

Issu
Soci
Conf
Achi
1964

Jear

Prer

Thi
195

Birkhoff and Beatley's Geometry

1. George Birkhoff and Ralph Beatley, "A New Approach to Elementary Geometry," The Teaching of Geometry, Fifth Yearbook of the National Council of Teachers of Mathematics, Teachers College, Columbia University, Bureau of Publications, New York, 1930.

2. George Birkhoff and Ralph Beatley, Basic Geometry, Chicago: Scott, Foresman and Company, 1944.

Theories of Cognitive Psychology

1. John B. Carroll, "Analysis of Reading Instructions," in Theories of Learning and Instruction, edited by E. Hilgard, National Society for the Study of Education, University of Chicago Press, Chicago, Illinois, 1960, p. 349.

2. Harry Beilin and Lassar Gotkin, "Psychological Issues in the Development of Mathematics Curricula for Socially Disadvantaged Children," Paper read at the Conference on Mathematics Education for Below Average Achievers, School Mathematics Group, Stanford, Calif., 1964, pp. 21-22.

3. Ibid., p. 23.
4. J.H. Flavell, The Developmental Psychology of Jean Piaget, Princeton: Von Nostrand, 1963.

5. Hanes G. Furth, Piaget and Knowledge, New York: Prentice Hall, 1969.

6. I.E. Sigel and Frank H. Hooper (eds.), Logicial Thinking in Children, New York: Holt, Rinehart and Winston, 1968.

7. Flavell, Op. Cit., p. 261.

tra
Lit

Lon
lat
Inc

Abi
Sta

Ado
ogy

Har

Men

of
195

Bal

Nat

A N

adva
Fran
Pres

8. J. Piaget, The Psychology of Intelligence, translated by Malcolm Piercy and Daniel C. Berlyne, Littlefield, Adams and Co., Patterson, 1960.

9. B. Inhelder and J. Piaget, The Growth of Logical Thinking from Childhood to Adolescence, translated by Anne Parsons and Stanley Milgram, Basic Books, Inc., New York, 1961, 350 pp.

10. S.A. Hill, "A Study of the Logical Thinking Abilities of Children," Unpublished Doctoral Thesis, Stanford University, 1960.

11. L.W. Yudin and S. Kates, "Concept Attainment and Adolescent Development," Journal of Educational Psychology, 54: 177-182, August, 1963.

12. Jerome S. Bruner, The Process of Education, Harvard University Press, Cambridge, 1960.

13. Alfred North Whitehead, The Aims of Education, Mentor Books, New York, 1949.

14. John H. Flavell, The Developmental Psychology of Jean Piaget, Van Nostrand Co., Princeton, New Jersey, 1963.

15. John Dewey, The Quest for Certainty, Minton Balch and Co., New York, 1929.

16. Lloyd Scott, Trends in Elementary School Mathematics, Rand-McNally Co., Chicago, Illinois, 1966.

17. Frank Reissman, "The Culturally Deprived Child: A New View," School Life, 45:6, April, 1963.

18. Edmund W. Gordon, "Counseling Socially Disadvantaged Children," Mental Health of the Poor, Edited by Frank Riessman, Jerome Cohen, and Arthur Pearl, New York: Free Press of Glencoe, 1964, p. 277.

Cit

Ill
of
Nat
Chi

Co.

Edu

Ver

Pro

Rea

Tea

Iss
Soc
Con
Ach
193

to
Her
Cor

19. Jerome Bruner, The Process of Education, Op. Cit.

20. Jerome Bruner, "Some Theorems on Instruction Illustrated With Reference to Mathematics," in Theories of Learning and Instruction, Ernest R. Hilgard (ed.), National Society for the Study of Education, University of Chicago Press, Chicago, Illinois, 1964, p. 331.

21. E.A. Peel, The Pupil's Thinking, Oldbourne Book Co., Ltd., London, 1960, pp. 132-137.

22. David Ausubel, "In Defense of Verbal Learning," Educational Theory, 11: 18, January, 1961.

23. David P. Ausubel, The Psychology of Meaningful Verbal Learning, Grunne and Stratton, New York, 1963.

24. E.B. Hunt, Concept Learning: An Information Processing Approach, New York: Wiley and Sons, 1962.

25. David P. Ausubel, Introduction to Part I," in Readings in the Psychology of Cognition, pp. 9, 10.

Teaching Mathematics to Disadvantaged Children

1. Harry Beilin and Lassar Gotkin, "Psychological Issues in the Development of Mathematics Curricula for Socially Disadvantaged Children," Paper read at the Conference on Mathematics Education for Below Average Achievers, School Mathematics Group, Stanford, Calif., 1964, p. 24.

2. Martin Deutsch, Minority Class Status As Related to Social and Personality Factors in Scholastic Achievement, Society for Applied Anthropology, Monographs No. 2, Cornell University, Ithaca, N.Y., 1960, 32 pp.

3. Cynthia Deutsch, "The Effects of Environmental Deprivation on Basic Psychological Processes," *Art Education*, 22: 20, January, 1969.

4. A.L. Baldwin, *Behavior and Development in Childhood*, The Dryden Press, New York, 1955.

5. V.L. Nelson, "An Analytical Study of Child Learning," *Child Development*, 7: 95-114, June, 1936.

6. J.S. Bruner, "The Course of Cognitive Growth," *American Psychologist*, 20: 1007-1017, 1965.

7. I. Sigel and B. McBane, *The Relationship Between Cognitive Competence and Level of Symbolization Among Five-Year Old Children*, Merrill-Palmer Institute, Chicago, 1966.

8. Basil Bernstein, "Elaborated and Restricted Codes: Their Social Origins and Some Consequences," *American Anthropology*, II, 66: 55-69, Special Publication, J. Gomperz and D. Hymes (eds.), December, 1964.

9. M.C. Templin, *Certain Skills in Children*, University of Minneapolis Press, Minneapolis, 1957, p. 50.

10. David O. Montague, "Arithmetic Concepts of Kindergarten Children in Contrasting Socioeconomic Area," *Elementary School Journal*, 64: 388, April, 1964.

11. Martin Deutsch, *Minority Group and Class Status as Related to Social and Personality Factors in Scholastic Achievement*, Society for Applied Anthropology, Monographs No. 2, Ithaca, N.Y.: Cornell University, 1960, 32pp.

12. Jerome Siller, "Socioeconomic Status and Conceptual Thinking," *Journal of Abnormal Social Psychology*, 55: 365-71, November, 1957.

13. Allison Davis, "Society, The School, and The Culturally Deprived Student," *Improving English Skills of Culturally Different Youths*, Bulletin No. 5, U.S. Department of H. E. W., Washington, 1964, pp. 10-21.

Ave
9:

Abs
54:

spe
Lea
196

Piv
tio

Kin
Are

tar
196

Sch
18-

Var
Stu
Doc

Pos
Con
Uni

Eco
Nu
of

14. Arthur R. Jensen, "Learning Ability in Retarded, Average and Gifted Children," Merrill-Palmer Quarterly, 9: 123-40, April, 1963.

15. D. C. Findlay and C. McGuire, "Social Status and Abstract Behavior," Journal of Abnormal Social Psychology, 54: 135-137, 1957.

16. Martin Deutsch, "Social and Psychological Perspectives on the Development of the Disadvantaged Learner," Journal of Negro Education, 33: 232-44, Summer, 1964.

17. Eunice S. Newton, "Verbal Destitution: The Pivotal Barrier to Learning," Journal of Negro Education, 29: 497-99, Fall, 1960.

18. David O. Montague, "Arithmetic Concepts of Kindergarten Children in Contrasting Socioeconomic Areas," Reading Teacher, 13: 40-44, October, 1959.

19. M.E. Dunkley, "Some Number Concepts of Disadvantaged Children," Arithmetic Teacher, 12: 359-361, May, 1965.

20. Wilbur H. Dutton, "Attitudes of Junior High School Pupils Toward Arithmetic," School Review, 64: 18-22, January, 1956.

21. Marvin E. Binkley, First Grade Entrance Variables Related to Achievement and Personality, A Study of Culturally Deprived Fourth Graders, Unpublished Doctoral Dissertation, University of Tennessee, 1967.

22. Robert E. Searle, Mathematical Abilities Possessed by Kindergarten Children from Disadvantaged Communities, Unpublished Doctoral Dissertation, University of California, 1968.

23. Dora Helen Skypak, The Relationship of Socio-Economic Status to the Development of Conservation of Numbers, Unpublished Doctoral Dissertation, University of Wisconsin, 1967.

24. Ebba Wahlstrom, "The Computational Arithmetic of Social Experiences of Third Grade Children," Journal of Educational Research, 30: 124-29, October, 1936.

25. LeLand H. Erickson, "Certain Ability Factors and Their Effect on Arithmetic Achievement," Arithmetic Teacher, 5: 287-293, December, 1958.

26. A. Davis, Social Class Influences Upon Learning, Harvard University Press, Cambridge, 1948.

27. I. Lorge and R.L. Thorndike, The Lorge-Thorndike Intelligence Tests, Houghton-Mifflin, Boston, 1954.

28. T.A. Dodes, "The Science of Teaching Mathematics," Mathematics Teacher, 46: 157-66, 1953.

29. Ralph T. Heimer, "Conditions of Learning in Mathematics Sequence Theory Development," Review of Educational Research, 39: 506, October, 1967.

30. P. Suppes, L. Hyman, and M. Jerman, "Linear Structural Models for Responses and Latency Performance in Arithmetic on Computer Controlled Terminals," Psychology Series, Institute for Mathematical Studies in the Social Science Report 90, Stanford University, Stanford Calif., 1966, p. 160.

31. V.A. Kruteskie, "Some Characteristics of the Thinking of Pupils With Little Capacity for Mathematics," in B. and J. Simon (eds.), Educational Psychology in the U.S.S.R., Stanford University Press, Stanford, Calif., 1963.

32. Robert J. Havighurst,"Who Are the Socially Disadvantaged?" Journal of Negro Education, 33: 217, 1964.

33. Beilin and Gotkin, Op. Cit., p. 14.

Dis
34:

Dev
of

Bel

Har

edi

of
of
Hol

Nat
15.

Dis

Tea

Eva
the
196

34. Frank Reissman,"The Overlooked Positives of Disadvantaged Groups," Journal of Negro Education, 34: 166, Spring, 1965.

35. Eunice S. Newton, "Planning for the Language Development of Disadvantaged Children and Youth," Journal of Negro Education, 34: 175, Spring, 1965.

36. Jermone S. Bruner, Toward a Theory of Instruction, Belknap Press, Cambridge, 1966, p. 72.

37. Jerome Bruner, The Process of Education, Harvard University Press, Cambridge.

38. Robert Gagne, Conditions of Learning, 2nd edition, Holt, Rinehart and Winston, 1968, p. 38.

39. David P. Ausubel, "A Cognitive Structure View of Word and Concept Meaning," in Reading in the Psychology of Cognition, edited by Richard Anderson and David Ausubel, Holt, Rinehart and Winston, Inc., New York, 1961, p. 23.

40. David P. Ausubel, Op. Cit., p. 24.

41. Lloyd Scott, Trends in Elementary School Mathematics, Rand-McNally and Co., Chicago, 1966, pp. 15-16.

42. R. Kelson, New Curriculums and the Teaching of the Disadvantaged, McGraw Hill, New York, p. 29.

43. John Carroll, "A Model for School Learning," Teachers College Record, 64: 723-733, 1963.

44. Benjamin Bloom, "Learning for Mastery," in Evaluation Comment, Bulletin of the U.C.L.A. Center for the Study of Evaluation of Instructional Programs, May, 1968, p. 3.

45. Beilin and Gotkin, Op. Cit., p. 16.

46. David P. Ausubel, Educational Psychology: A Cognitive View, Holt, Rinehart and Winston, 1965.

47. Robert Gagne, The Conditions of Learning, Holt, Rinehart and Winston, 1965.

48. Jean Piaget, The Child's Conception of Number, Humanities Press, New York, 1952.

49. David Ausubel, Op. Cit., pp. 58-75.

Chapter 3

RESEARCH DESIGN AND SAMPLING PROCEDURES

Sample Selection

In this study 1000 culturally disadvantaged seventh and eighth grade Junior High School pupils in Philadelphia were used as subjects for the present study. Thirty class sections, equally divided between the two grades, were chosen from the Gillespie Junior High School which is located in a racially encapsulated area and has a 95 percent Negro enrollment.

Guilford[1] has maintained that there is no absolute distinction between large and small sample statistics.

> Many of the small-sample statistical tests are based upon the statistic known as the student's t. Actually t is defined as the ratio of a deviation from the mean or other parameter, in a distribution of sample statistics, to the standard error of that distribution.[2]

The distinction between large and small sample statistics becomes critical below sample size of 30.[3] Otherwise, the distribution of t approaches the standardized normal distribution as sample size increases. Furthermore,

> If really good accuracy is desired in determining interval probabilities the t distribution should be used when the sample size is around 100 cases. Beyond this number, the normal probabilities are extremely close to the exact t probabilities.[4]

It is for the reasons discussed in the preceding paragraph, that 100 subjects were randomly selected from a total population of 1000 students.[5]

The Index of Socioeconomic Status

The Index of Socioeconomic Status (SES)[6] as developed by Suzanne Keller and Estelle Cherry at the Institute for Developmental Studies was used by this researcher to assign social class ratings to the subjects involved, (See Appendix A)

> Each category for the Index was derived from an appropriately weighted composite measure of the occupational status of the main [wage earner] and education of the main [wage earner]. The weights assigned to the indicators were derived from a regression equation based on the degree of intercorrelation among these three variables.[7]

The occupational status of the Index was derived from the Empey Scale of Occupational Prestige.[8] The correlation was over .90 between the scale used in the Index of Socioeconomic Status and the Hollingshead Two Factor Index of Social Position.[9]

The educational variable of the Index was divided into eight categories ranging from one (0-4 years of school) to eight (graduate training). Each occupation was given a rating from one (lowest prestige) to ten (highest prestige), based upon the scale constructed by Empey,[10] Smith,[11] and by Hatt and North.[12] This scale had a rank order correlation of .97.[13] This treatment concurs with that used by Deutsch.

> The distribution of educational and occupational ratings were treated as if they represented parametric data, and the ratings were converted into standard scores. A social class score was obtained by adding the two derived scores.[14]

The scores were then divided into the following three levels:

> Level I. A typical family in this group has as a main wage earner a person who is unemployed, or who has an unskilled or semiskilled job. The educational level ranged from elementary schooling to completion of the Ninth grade.
>
> Level II. The typical family at this level is headed by a wage earner with a semiskilled, clerical, or sales job whose education ranged from about nine grades to high school graduation.
>
> Level III. The typical household is headed by a professional or managerial wage earner whose education would be high school graduation, college, or graduate work.[15]

Again according to Deutsch "the index shows a . . .degree of internal cohesiveness [and] has considerable construct validity."[16] Additional validity for this social class index was determined in a study by Bloom, Whiteman, and Deutsch.[17]

Based on Deutsch's SES Index, it was determined that those students participating in this study can be categorized as follows: Level I - low, 88%

Level II - middle, 9%; Level III - high, 3%. These findings compare favorably with the findings of Bloom, Whiteman, and Deutsch[18] for inner-city children in "deprived" areas.

Data Gathering Procedures

A questionnaire containing personal information items, total number of individuals living in the home and schooling of father and mother was administered to the entire population of this study. (See Appendix B) The questionnaire was developed by this researcher with the assistance of the school counselors and social workers who were desirous of ascertaining current information about the student population being tested.*

---

* Without their participation and cooperation, this study would have been very difficult to administer. They introduced the investigator to the teachers, the administrators and assisted him in the distribution and collection of the test material given to the participating classroom teachers. Also, all pertinent student information was made available to the investigator and social workers.

The principal of the school, sincere in his desire to aid the research study, did not inform any of the other teachers in the school of this project. The participating teachers received information directly from the researcher as to the nature of the study, how to administer the student questionnaire, the pre-and post-tests and the geometry lessons.

Each teacher involved in this study was instructed not to inform their students that they were participating in a research project. They were told to emphasize that the questionnaire was not a test and that the students should respond freely to the questions. All of these teachers were instructed to assist the students, where necessary, in completing the questionnaire or answering any of the items.

Attached to each questionnaire was a 4" x 5" card also to be filled out by the students. (This card would identify the questionnaire for possible follow-up by having a number identical to that of the questionnaire.)

The students completed their questionnaires in their assigned classrooms during one time period. The advantage of having all students answering the questionnaire at the same time was to standardize the experience. The time allocated for the questionnaire was 45 minutes, or one classroom period. They were collected by the investigator from each of the participating teachers during the next classroom period.

Evaluative Instrument

The evaluative instrument consisted of a workbook containing 10 separate lessons pertaining to specific types of geometric constructions, 10 fifteen minute instructional audiotapes, recorded at 3 3/4 ips, which were necessary for completing each of the 10 geometry lessons. Each lesson, along with it's corresponding audio tape, was administered to the population under investigation for the successive days. These materials were developed by Kline[19] in accordance with the following design principles:

1. The concepts to be communicated in each presentation were limited in number.

2. Practical experiences were designed to lead to intellectual discovery.

3. Correct responses were reinforced immediately to produce motive satisfaction.

4. The principle of concept generalization (knowledge transfer).

5. Each concept sequence was carefully programmed so that each geometrical principle served as a base for higher order learning, et. seq.[20]

The workbook contained the following geometry lessons:

Lesson 1

This was an introductory lesson and includes background presentation, explanation of the need and use of Geometry by todays student. Discussion of points, lines, planes, solids, etc.

Lesson 2

This lesson included a discussion of angles, an explanation of rays, the vertex of an angle, right, acute, obtuse, straight and reflex angles. Methods of labelling and referring to angles were also explained.

Lesson 3

Brief review of lessons 1 and 2. Discussion and explanation of adjacent angles, methods of adding and subtracting angles based on axioms. A simple geometric proof was included and explained.

Lesson 4

Explanations concerning pairs of angles are given. Complementary, supplementary and vertical angles are discussed and their relationship to other angles discussed in previous lesson is explained. The lesson includes work related to acute, obtuse, right and other angles. A simple formal proof is explained in an informal manner.

Lesson 5

Introduction to the compass and straight edge. Simple constructions include; constructing a line segment equal to a given line segment, bi-secting a given line and constructing an angle equal to a given angle. The last part of the lesson deals with the construction of perpendiculars.

Lesson 6

Students were instructed how to construct angles to a given size with a compass and straight edge. Practice is given in the construction of 90°, 45°, 60°, and other angles. These constructions are taught by the relationship to a circle method.

Lesson 7

This lesson included the construction of parallels to a given straight line with a complete explanation of alternate-exterior angles and corresponding angles (sometimes called exterior-interior angles). The lesson also includes the relationships and equalities of these angles formed by parallel lines cut by a transversal.

Lesson 8

This lesson included the construction of circles, triangles and quadrilaterals from given data. The latter part of the lesson includes constructing a square equal in area to a given polygon. Simple formulae are reviewed to clarify the lesson.

Lesson 9

This lesson included (1) the construction of perpendiculars to a given point; (tangent) (2) the construction of inscribed and circumscribed triangles, hexagons, squares and octagons.

Lesson 10

This lesson was concerned with the construction of triangles equal in area to given polygons.[21]

The materials, in the geometry workbook, contained the accepted geometric constructions of Euclid as presented by Birkhoff and Beatley. This approach was discussed in Chapter 3. (See Appendix C for a copy of the workbook)

Both the workbook, containing the above listed geometry lessons, along with its corresponding audio tapes were designed in such a manner that

> the student could compare his responses with correct constructions as the lesson progressed. By so doing, the correct responses by the student are progressively strenghtened by being followed immediately by motive satisfaction. . .The method used to allow the student to make this comparison was accomplished by including correct responses in the student material immediately opposite the drawing area.[22]

The workbook contained printed material to assist the student in interpreting the audio lesson, enabling him to make the basic geometric constructions as directed by the audio lesson, and answers to the supplementary material was included in the teachers' notes. The audio-tapes stressed the use of the relative pause, voice inflections and connotational emphasis. Grammatical structure normally used for written composition was considered of lesser value than the importance of "conversational" speech acceptable to the disadvantaged child.

Reliability of the Instrument

An analysis of variance technique, which was developed by Hoyt, was used to compute the estimated test reliability of the instrument used in this research.

According to Hoyt, the formulas were developed

> for estimating the reliability of a test by means of analysis of variance. . .It is essentially the method suggested by Johnson and Neyman and later used by Jackson. This particular approach does not use a new or different result for the problems of tests of significance but does possess considerable advantage in attacking problems of estimation.[23]

The residual sums of squares were used by Hoyt as a basis for estimating the discrepancy between observed variance and true variance; i.e., variance due to error in the test instrument. The residual sum of squares is obtained by subtracting the among students sum of squares and the among items sum of squares from the total sum of squares. The formula for computing the reliability coefficient r_{tt} is as follows:[24]

$$r_{tt} = \frac{V_s - V_r}{V_s}$$

where r_{tt} = The reliability coefficient of the test,

V_s = Variance among students, and

V_r = Remainder variance.

When using Hoyt's technique, for estimating test reliability by analysis of variance, the residual sum of squares serves as the means for estimating the discrepancy between the obtained variance and true variance of the student's score on a test.

> This estimate of the discrepancy is a better one than obtained by dividing the test into odd and even halves because in the latter case the particular split of the test, which is only one of many possible ways of splitting a test, may be an unlucky division and may result in either an overestimate or an underestimate of the coefficient of reliability. Furthermore, it has been shown. . . that the particular estimate of the discrepancy between the obtained and the 'true' scores is the best linear estimate where 'best' is considered in the light of the least 'squares' criterion. Hence, it is clear that this method of estimating the reliability of a test gives a better estimate than any method based upon an arbitrary division of the test into halves or into any other fractional parts.[25]

The fact that Hoyt's technique for estimating test reliability yields precisely the same result as Kuder and Richardson's split-half procedure lends strong verification to the utilization of this technique. But, the Kuder and Richardson procedure has "some of the limitations of the split-half method."[26]

Thus, Hoyt's method is an improvement over the split-half method, as well as the Kuder and Richardson procedure. This technique provides a better estimate between the obtained variance and true variance by eliminating the possibility of an unlucky odd-even split of the students' scores on a test.

The computation for the estimated reliability of the test, using Hoyt's technique, is shown in Table 1.

Table 1

ANALYSIS OF VARIANCE OF 10 ITEMS IN GEOMETRY, ADMINISTERED TO 100 STUDENTS

Source of Variation	d.f.	Sum of Squares	Variance *
Among Students	99	20.699	20.9
Among Items	9	29.789	3.30988
Residual	891	159.911	.17947
Total	999	210.399	0.2106

The coefficient of reliability of the test instrument is

$$r_{tt} = \frac{20.9 - 0.17947}{20.9}$$

$$r_{tt} = 0.9913$$

---

* Variance in this application is the same as mean squares in standard application.

An estimated test reliability of 0.9913 indicates a non-ambiguous test reliability across individual students. This test instrument, therefore, has a high degree of internal consistency and it is reliable across individual students.

Standard Error of Measurement of the Test

Though it may seem obvious to the reader that a test with such a high reliability coefficient (.9913) should have a low amount of measurement error, Hoyt's Standard Error of Measurement[27] was nonetheless computed as a further check. The Standard Error of Measurement, according to Hoyt, is obtained by taking the square root of the residual sum of squares and dividing it by the degrees of freedom for among students found in Table 1. The computation for the Standard Error of Measurement is as follows:

$$\sqrt{\frac{159.11}{99}} = 1.27$$

The Standard Error of Measurement is equal to 1.27. This measurement is a "standard deviation of an [individual's] hypothetical distribution over measured occasions."[28] It can be interpreted in the following manner:

1. The chances are two out of three that the individual's obtained score was not more than 1.27 units from his true score.

2. The chances are 95 out of 100 that the individual's obtained score was not more than 2.54 units from his true score.

3. The chances are 99 out of 100 that the individual's obtained score is not more than 3.81 units from his true score.

The small standard error of measurement indicates that the test has a low degree of measurement error and thus that a considerable of confidence can be placed in scores obtained from the test instrument.

Test Validity

Since this study did not include a previously standardized criterion measure of geometric skills it is not possible to compute a validity coefficient. However, it would seem logical to assume that a test which requires the student to demonstrate specific geometric skills is a reasure of the attainment of those skills and thus has reasonable validity for purposes of this study.

Acceptance of the above logic implies, however, that the test include a representative sampling of the broad spectrum of skills which contribute to competence in geometry. In other words, the test would be biased if it overly emphasized a few geometric skills at the expense of others. In its development, Kline incorporated the skills generally included in elementary geometry textbooks.

Statistical Procedures

The statistical methods that were used to analyze the data from this study are as follows: Product moment coefficient of linear correlation, and the "t" test for correlated means.

A product moment coefficient of linear correlation was used to estimate the degree of relationship between the variables used in this study: mathematics and verbal achievement scores, grades earned in math and English, socioeconomic factors, home crowding factor, whether or not there is a father in the home and the dependent variable which is the pre-and posttest scores.

The 10 pre-and posttest items contained the same materials that inferred a knowledge of geometric constructions and did not contain specific questions that could be directly related to the test instrument. The scores on the pre-and posttest were based upon a ten point scale. An item analysis of these scores are shown in table 2. (See Appendix D for a copy of the pre-and posttest)

The student's achievement scores in mathematics and reading were obtained from the Iowa Tests of Basic Skills that each student had taken from fourth grade through eighth grade, inclusively. The math and English course grades from fourth through eighth grade were ascertained from the cumulative records of each of the students.

A two tailed test was used to determine the significance of all differences when

TABLE 2

ANALYSIS OF TEST INSTRUMENT BY ITEM

Item	Percent Passing	Percent Failing
1	77	23
2	78	22
3	72	28
4	83	17
5	43	57
6	66	34
7	55	45
8	36	64
9	37	63
10	95	5

> No prior hypotheses about the direction of the difference between p1 and p2 is made. The test of significance should take into account both the probability of a positive difference and the probability of a negative difference.[29]

A significance level of .01 was the criterion for accepting or rejecting the research hypotheses involved.

The "t" Test

In this research study, course effectiveness was evaluated by a repeated measurements design. This design was chosen because this research study did not employ a control group.

The term repeated measurements describes a type of research design in which

> . . .two measurements are made on each element. If the order in which the treatments are administered has no effect upon the final outcome, then the difference between the two measures on the same element on a common criterion provides a measure of the relative effectiveness of the treatments. This measure is but systematic effects associated with the elements themselves. In this respect each element serves as its own control group.[30]

Moreover, "one of the primary advantages of repeated measures is the potential reduction due to experimental error."[31]

When using a repeated measurements design, the standard "t" test is not utilized because a fundamental assumption of that test is that the means being evaluated are independently derived or orthogonal. In a repeated measurements design, the fundamental assumption underlying a "t" test is violated because the same individuals appear in both sets of measurements. Therefore, in this research study it was necessary to use the "t" test for correlated means.

The "t" test for correlated means[32] is a technique which computes the correlation between the means and then uses it to correct the standard error of the difference between the means. This technique has the effect of reducing the denominator of the "t" test, which is the error term. In other words, any variation reflected in the correlation coefficient can be described to a known cause rather than being placed under unexplained experimental error.

The computation of "t", for this research design, is provided in Table 3 is further discussed in the next chapter on findings of the study.

Research Hypotheses

This study was designed to test the assumption that a teaching methodology can be developed to overcome certain sociological and environmental factors that tend to hamper the educational achievement of the disadvantaged child. To do so, the following null hypotheses, were tested:

Hypothesis 1: It is postulated that the difference between the means of the pre-and posttests will be significant.

Hypothesis 2: It is postulated that the correlation between student performance on the test instrument and SES will not be significant.

Hypothesis 3: It is postulated that the correlation between student performance on the test instrument and "father"* will not be significant.

Hypothesis 4: It is postulated that the correlation between student performance on the test instrument and crowding* will not be significant.

Hypothesis 5: It is postulated that the correlation between student performance on the test instrument and verbal achievement scores will not be significant.

Hypothesis 6: It is postulated that the correlation between student performance on the test instrument and mathematics achievement scores will not be significant.

Hypothesis 7: It is postulated that the correlation between student performance on the test instrument and grades will not be significant.

---

* "Father" refers to a home in which the father is present as opposed to one in which he is not.

* "Crowding" is the number of people in a home divided by the number of rooms in the home.

Chapter 3

REFERENCES CITED

1. J. P. Guilford, Fundamental Statistics in Psychology and Education, McGraw-Hill, 4th Edition, New York, 1965.

2. Ibid., p. 182.

3. Ibid., p. 181.

4. William L. Hays, Statistics for Psychologists, Holt, Rinehart and Winston, New York, 1966, p. 307.

5. The random table of numbers were generated by an IBM/360 Scientific Subroutine package.

6. Martin Deutsch, Alma Maliver, B. R. Brown and Estelle Cherry, Communication of Information in the Elementary School Classroom, Cooperative Research Project No. 908 of the Office of Education, U.S. Department of Health, Education and Welfare, April, 1964.

7. Ibid., p. 135.

8. LaMar T. Empey, "Social Class and Occupational Aspirations: A Comparison of Absolute and Relative Measurement," American Sociological Review, December, 1956, pp. 703-709.

9. A.B. Hollingshead and F.C. Redlich, Social Class and Mental Illness, New York: John Wiley and Sons, 1958.

10. Empey, Loc. Cit.

11. M. Smith, "An Empirical Scale of Prestige of Occupations," American Sociological Review, 8: 185-192, April, 1943.

12. P.K. Hatt and C.C. North, "Jobs and Occupations; A Popular Evaluation," in Class Status and Power, edited by R. Bendix and S.M. Lipset, The Free Press of Glencoe, 1949, pp. 411-426.

13. Ibid.

14. Deutsch, Maliver, Brown and Cherry, Op. Cit., p. 134.

15. Ibid.

16. Ibid.

17. R. Bloom, M. Whiteman and M. Deutsch, "Race and Social Class as Separate Factors Related to Social Environment," The American Journal of Sociology, 60: 471-476, January, 1965.

18. R. Bloom, M. Whiteman and M. Deutsch, Loc. Cit.

19. Robert D. Kline, "A Study to Determine If Educational Materials Designed Specifically for a Developing Nation are Equally Effective in Producing Student Achievement in a Developing Nation," Unpublished Doctoral Dissertation, Syracuse University, 1967.

20. Ibid., p. 110.

21. R.D. Kline, Workbook for Geometry, Syracuse University, Syracuse, 1967, 43 pp.

22. Kline, Op. Cit., p. 35.

23. Cyril Hoyt, "Testing Reliability Estimated By Analysis of Variance," Psychometrika, 6: p. 156.

24. Ibid., p. 155.

25. Hoyt, Op. Cit., p. 155.

26. N.M. Downie and R.W. Heath, Basic Statistical Methods, Harper and Row Publishers, New York, 1965, p. 220.

27. Hoyt, Op. Cit., p. 156.

28. William L. Hays, Op. Cit., p. 294.

29. Allan Edwards, Experimental Design in Psychological Research, Holt, Rinehart and Winston, N.Y., 1964, p. 54.

30. B.J. Winer, Statistical Principles in Experimental Design, McGraw-Hill Book Company, 1962, p. 39.

31. Ibid., p. 42.

32. J.P. Guilford, Op. Cit., p. 177.

Chapter 4

RESEARCH FINDINGS

The data gathered in this study includes achievement test scores, course grades assigned by teachers, certain familial characteristics, and scores on the test instrument of the teaching method being evaluated by this research study. Findings are presented in terms of the several hypotheses stated in Chapter 3.

The Research Hypotheses And The Findings

Hypothesis 1: It is hypothesized that the difference between the means of the pre-and posttests will be significant.

In order to evaluate this hypothesis it must be stated in the "null" form. The null hypothesis (Ho) to be evaluated is that:

> There is no significant difference between the means of the pre-and posttests. ($Ho: M_2 - M_1 = 0$)

The .01 level of significance was selected as the criterion for rejection of the null hypothesis. A "t" test for correlated means, which was discussed in the previous chapter, was used to evaluate the significance of the difference between the means of the pre-and posttest scores. The data is presented in Table 3 with the probability of "t" being based upon a two-tailed comparison.

Table 3

Analysis of Mean Scores of

Test Data

Means		Difference	SD		Computed	df	Probability
Pre	Post	(Post-Pre)	Pre	Post	"t"		of "t"
4.72	7.48	2.76	1.9	1.3	1.75	98	less than .01

Since the "t" score necessary for the rejection of the null hypothesis at the .01 level is 2.54, a computed "t" of 17.50 is clearly significant and the probability of obtaining such differences by chance is very small. Therefore, we are able to reject the null hypothesis and the alternative hypothesis (H_1) seems tenable.

The range for this study was based upon one standard deviation in both directions from the mean. As such, the range for 68 percent of the cases is equal to 7.48 ± 1.3; i.e., the range is 6.18 to 8.78.

The fact that the study did not incorporate a control group poses some questions as to the validity of the above conclusion. For example, under some circumstances, the improvement reflected in the students' performance on the posttest could be due to some maturational factor which occurred during the time between the administration of the two tests. In this case, however, the two tests were administered within the span of one-half month so maturational factors as such can be discounted.

Another counter explanation for the improvement of these students' test scores is that the pretest may have influenced their posttest scores by sensitizing them to what was expected of them or through the effect of practice.[1]

The investigator recognizes this as a legitimate criticism of the repeated measures design utilized in this study. It is quite possible that some of the improvement in the scores is due to the effect of the pretest. However, the magnitude of improvement observed was sufficient to warrante serious question that more than a minor portion could be accounted for by practice.

Statistical regression may also be a reason for the improvement in the posttest scores. However, without a control group there is no way to evaluate the extent to which statistical regression is involved in a repeated measures design. While it is true that these students were not selected because of low scores on achievement tests, their scores were still low because students of minority background tend to score low on such tests. This is an artifact of doing research involving minority subjects. It will be noted later that the relationship between performance on the test instrument and performance on standardized achievement tests was not significant. Therefore, it seems illogical that statistical regression accounts for that extent of improvement observed in this sample.

Hypothesis 2: It is postulated that the correlation between student performance on the test instrument and SES will not be statistically significant.

In order to evaluate this hypothesis it is necessary to test the assumption that the null hypothesis that the population correlation is zero is true such that

$$t = \frac{r(n-2)^{1/2}}{(1-r^2)^{1/2}}$$

which has a t distribution with n-2 degrees of freedom and can be evaluated by means of the table of t with alpha set at .01.[2] A two-tailed t test is necessary since the above hypothesis does not designate the direction of a significant departure from zero correlation.

By substitution into the above formula it can be shown that a correlation coefficient of .264 is required for significance at the .01 level.

In a repeated measurements design it is possible to generate three test performance scores: a pretest score, a posttest score and the difference between these two scores.

The results of this test are presented in Table 4.

Table 4

Corrleations Between SES

And Test Instrument

Variables	Correlation Coefficient	df	Significance
Pre vs SES	.095	98	No
Post vs SES	-.010	98	No
Gain*vs SES	-.124	98	No

Since none of the correlations in Table 4 are significant, Hypothesis 2 was confirmed in this sample. Therefore, it would seem that a student's socioeconomic status has little effect upon his capacity to respond to the method of teaching geometry under investigation.

Hypothesis 3: It is postulated that the correlation between student performance on the test instrument and "father"** will not be significant.

The null hypothesis to be tested is that the population correlation is zero. A two-tailed t test with alpha equal to .01 are the criteria for rejection of the null hypothesis.

---

* Gain represents an improvement score drived by subtracting a student's score on the pretest from his score on the posttest.

** "Father" refers to a home in which a father is present (scored as +1) as opposed to a home in which no father is present (scored as 0). In this study 78 percent of the population did not have a father present in the home; whereas 22 percent did have a father present in the home.

However, it is necessary to use the point-biserial correlation coefficient rather than the Pearson r's since "father" is a dichotomous variable. The formula[3] used in the computations reads

$$r = \frac{M_p - M_q}{\sigma_t}(pq)^{1/2}$$

where p= "father" present, q= "father" absent and t= total group.

The data is summarized in Table 5.

Table 5

Correlations Between Father

And The Test Instrument

Variables	Point-Biserial r	df	Significance
Pre vs Father	.134	98	No
Post vs Father	.080	98	No
Gain vs Father	-.097	98	No

Since all three point-biserial r's are much less than .264 Hypothesis 3 remains tenable. According to the data on this sample, the presence or absence of a father in the home produces no systematic effect upon the performance of students on the teaching method in question.

Hypothesis 4: It is postulated that the correlation between student performance on the test instrument and crowding* will not be statistically significant.

The hypothesis to be tested is that the population correlation equals zero by utilizing a two-tailed t test with alpha equal to .01 in the manner discussed previously in the analysis of Hypothesis 2. In order to reject the null hypothesis a correlation coefficient equal to or greater than .264 is required. The data is summarized in Table 6.

Table 6

Correlations Between Crowding And The Test Instrument

Variables	Correlation Coefficient	df	Significance
Pre vs Crowding	-.157	98	No
Post vs Crowding	-.134	98	No
Gain vs Crowding	.080	98	No

* Crowding is a ratio with the number of people in the home as the numerator and with the number of rooms in the home as the denominator.

Since none of the correlation coefficients listed in Table 5 are significant, Hypothesis 4 remains tenable. Therefore, the data indicates that crowding in the home does not appreciably affect a student's capacity to profit from the teaching technique being investigated.

Hypothesis 5: It is postulated that the correlation between student performance on the test instrument and verbal achievement scores* will not be significant.

In order to test this hypothesis, we will again use the null hypothesis that the population correlation equals zero as well as a two-tailed t test with alpha equal to .01. The degrees of freedom is N-2 = 100-2 = 98. In order to reject the null hypothesis in regard to any one of the computed correlations, the coefficient must equal or exceed .264.

The data is summarized in Table 7 on the following page.

---

* Scores on the verbal component of the Iowa Test of Basic Skills.

Table 7

Correlations Between Verbal Achievement

By Grade Level And The Test Instrument

		Test Instrument		
		Pre	Post	Gain
Verbal Achievement	4	-.023	.045	.066
	5	-.082	.014	.111
	6	-.150	.055	.227
	7	-.099	.040	.153
	8	-.098	.038	.150

None of the correlations are sufficient to reject the null hypothesis and Hypothesis 5 remains tenable.

It should be noted, however, that the correlation between gain and sixth grade verbal achievement (.227) would have been significant had alpha been equal to .05. (The critical r for an alpha of .05 is .205.) The data offers no explanation for this one coefficient being so much greater than the others.

In addition, it is interesting that all of the coefficients associated with the pretest are negative in sign while all the others are positive in sign. This same trend

will be observed in the next section in regard to mathematics achievement. Since this trend was not anticipated, the author is unable to evaluate its meaning with the present research design. One possible explanation is that the change in sign is due to the rather large movement (improvement) between the pre-and posttest scores on the test instrument.

In summary, the performance on the test instrument of this sample of 100 students was not significantly related to their performance on tests of verbal achievement. (Refer to Appendix E for scatterplots of Mathematics Achievement Scores for grades four through eight)

Hypothesis 6: It is postulated that the correlation between student performance on the test instrument and mathematics achievement scores* will not be significant.

The null hypothesis to be tested is that the population correlation is zero. For a two-tailed t test with 98 degrees of freedom the critical value of r for the .01 level of significance remains at .264.

The data is summarized in Table 8 on the following page.

---

* Scores on the verbal component of the Iowa Test of Basic Skills.

Table 8

Correlations Between The Test Instrument
And Mathematics Achievement By Grade Level

		Test Instrument Pre	Post	Gain
Mathematics Achievement	4	-.121	-.044	.110
	5	-.108	.011	.140
	6	-.115	.050	.188
	7	-.126	.018	.168
	8	-.084	.045	.139

None of the above coefficients are significant. Therefore, Hypothesis 6 remains tenable.

It should be noted that all of the coefficients associated with the pretest are negative in sign while all but one of the others are positive in sign. This trend was observed and discussed in the preceding discussion of Hypothesis 5 and the situation is comparably difficult to explain.

On the basis of this data it would seem that the ability of this sample of 100 students to respond to the teaching method being evaluated was not significantly related to their performance on standardized tests of mathematics achievement. (Refer to Appendix E for scatterplots of Verbal Achievement Scores for grades four through eight)

Hypothesis 7: It is postulated that the correlation between student performance on the test instrument and grades will not be significant.

The null hypothesis that the population correlation equals zero will be tested by means of a two-tailed t test with 98 degrees of freedom. The critical r for rejection at the .01 level of significance is again .264.

The correlations between the test instrument and grades received in mathematics courses are summarized in Table 9 on the following page. The correlations between the test instrument and grades received in English courses are summarized in Table 10.

Since the same trends are observed in both tables they will be discussed together.

Table 9

Correlations Between The Test Instrument

And Mathematics Grades

		Test Instrument Pre	Post	Gain
Mathematics Grades	4	-.155	-.127	.083
	5	-.018	.024	.041
	6	-.062	-.039	.043
	7	.089	.068	-.052
	8	.010	-.003	-.015

Table 10

Correlations Between The Test Instrument

And English Grades

		Test Instrument Pre	Post	Gain
English Grades	4	-.094	-.073	.053
	5	-.174	-.027	.183
	6	.014	-.044	.053
	7	-.007	-.098	.037
	8	.008	.109	.080

None of the coefficients in either table are significant. Therefore, Hypothesis 7 remains tenable. Since there is no discernible pattern to the positive and negative signs of the coefficients, no explanation can be offered. In effect, there is little relationship between the performance of this sample of 100 students on the test instrument and the grades they received in various mathematics and English courses.

Chapter 4

REFERENCES CITED

1. Anne Anastasi, Differential Psychology, 3rd edition, New York, Macmillan, 1958, pp. 190-191.

2. Allen L. Edwards, Experimental Design In Psychological Research, Holt, Rinehart and Winston, New York, 1964, p. 78.

3. J. P. Guilford, Fundamental Statistics in Psychology and Education, McGraw-Hill, New York, 1965, p. 322.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In this study the predicted non-correlation between social and familial variables and student achievement were found. The non-significance of these correlations were determined by a two-tailed t test for correlated means and the t ratio for testing the significance of a correlation coefficient.

The results of this study indicated that familial characteristics or sociocultural variables did not influence student achievement with this teaching method. This teaching method did not require reading competence in the students. This particular skill is one that the literature reviewed in this paper has shown impedes the success of disadvantaged children in learning mathematics.

According to the data of this sample, the presence or absence of a "father" in the home produces no systematic effect upon the performance of students on the teaching method in question.

In a similar manner, the null hypothesis concerned with the correlation between student performance on the test instrument and crowding in the home was rejected. Based upon the results of this study, it can be stated that it is what, rather than who, is in the learning environment of the disadvantaged child, that has the greater effect upon the student's success with the teaching methodology utilized in this study.

Although the conclusions previously stated are related to a methodology for teaching disadvantaged children, other conclusions may also be drawn from the results of this study.

These conclusions are:

1. Sociocultural variables are not significantly correlated with student performance on the test instrument.

2. Vocabulary deficiencies are not a barrier to successful learning when the disadvantaged child is presented with a teaching methodology that does not emphasize reading skills.

Recommendations

The sociocultural environment has been studied as a means of understanding the factors which influence the intellectual development of disadvantaged children. Research studies cited in this paper have shown repeatedly that this environment greatly influences the intellectual development of disadvantaged children.

The foregoing statement implies that there should be an exploration of Piaget's theory of interaction between the organism and his environment. A stimulating educational environment in the home may influence the academic growth of the child. In a similar manner, the capacity of the child to profit from such an environment may influence the parental efforts in providing a stimulating environment. A similar phenomenon may occur in the school environment. This chain-like cause and effect relationship, if studied, should provide further understanding about the interaction between the disadvantaged child and his environment. Such investigations may involve longitudinal studies as well as intensive case studies in order to obtain empirical data about the possible interaction between the disadvantaged child and his educational environment.

If a high correlation between the environmental factors and achievement scores is sustained by future research, then a wide variety of topics for studying the intellectual growth of the disadvantaged child may become evident.

One of the areas for further research would be to determine whether the relation between parallel measurements over a given amount of time is directly related to the intellectual development represented at the different stages of development. These measures could include data on physical characteristics, personality development, achievement data, home environment, and any changes in the socioeconomic status between infancy and adulthood.

A longitudinal study would also appear to be useful, especially at the elementary stage. It seems necessary to study the relationship between the measurement of the educational environment in the home at the time the disadvantaged child is first admitted to school and his educational achievement throughout school. If these relationships are found to be comparable to those found in the present study, the environment and socioeconomic measurements are likely to be very useful in making academic predictions.

Another area for further research is to study the role of social class as it affects language development and cognition. Such studies will provide further understanding about the influences of the intellectual environment in the home at different stages of development.

It would appear that the deficiencies of the sociocultural environment make it more difficult for disadvantaged children to understand a teaching methodology which presupposes a variety of experiences which they have not been afforded. The results of this study, however, indicate that a teaching methodology can be developed for this impoverished intellectual background.

If replications of this study confirm the present findings, then further research should be focused on environmental variables and their relationship with other pertinent variables. One area of research may be directed toward the development and evaluation of a curriculum that would overcome the multilateral influences of social deprivations on learning.

Chapter 5

REFERENCES CITED

1. Jerome Bruner, Toward a Theory of Instruction, Cambridge: Harvard University Press, 1966.

2. David Ausubel, Educational Psychology: A Cognitive View, New York: Holt, Rinehart and Winston, Co., 1965.

3. Jean Piaget, B. Inhelder and A. Szeminaka, The Child's Conception of Geometry, translated by E. A. Lunzer, New York: Basic Book, Inc., 1960.

4. Basil Bernstein, "Social Structure, Language, and Learning," in Harry Passow, Miriam Goldberg, Abraham J. Tannenbaus (editors) Education of the Disadvantaged, Holt, Rinehart, and Winston, Co., 1967.

5. Frank Riessman, "The Overlooked Positives of Disadvantaged Groups," Journal of Negro Education, 34: 106-66, Spring, 1965.

6. Harry Beilin, "A Cognitive Strategy for Curriculum Development," in Developing Programs for the Disadvantaged, A. H. Passow (editor), New York: Teachers College Press, 1968.

7. James Coleman and others. Equality of Educational Opportunity, United States Office of Education, Washington, D. C., 1966.

BIBLIOGRAPHY

BOOKS AND PAMPHLETS

Anastasi, Anne. <u>Differential Psychology</u>. New York: MacMillan and Company, 1958.

Anderson, Richard, Jack W. Garon, and Joseph G. Gremillion. <u>School Mathematics Geometry</u>. Boston: Houghton Mifflin Company, 1966.

Aristotle. <u>Posterior Analytics</u>. translated by Hugh Tredennick. Cambridge: Harvard University Press, 1960.

Ausubel, David P. <u>Theory and Problems of Adolescent Development</u>. New York: Grune and Stratton; 1954.

________. <u>The Psychology of Meaningful Verbal Learning</u>. New York: Grune and Stratton; 1963.

________. <u>Educational Psychology: A Cognitive View</u>. New York: Holt, Rinehart and Winston, 1965.

Baldwin, A.L. <u>Behavior and Development in Childhood</u>. New York: The Dryden Press, 1955.

Binet, Alfred, and TH. Simon. <u>The Development of Intelligence in Children</u>. translated by Elizabeth S. Kite. Baltimore: Williams and Wilkins Co., 1916.

Bloom, Benjamin S. <u>Stability and Change in Human Characteristics</u>. New York: Wiley and Sons, 1964.

Birkhoff, Garrett, and Saunders Maclane. <u>A Survey of Modern Algebra</u>. New York: The Macmillan Company, 1949.

Birkhoff, George, and Ralph Beatley. <u>Basic Geometry</u>. Chicago: Scott, Foresman and Company, 1940.

Bohr, Niels. <u>Atomic Physics and Human Knowledge</u>. New York: John Wiley and Sons, 1958.

Breslich, Ernest R. <u>Problems in Teaching Secondary-School Mathematics</u>. Chicago: The University of Chicago Press, 1931.

Bridgeman, P.W. <u>The Logic of Modern Physics</u>. New York: Macmillan, 1938.

Brown, Claude H. The Teaching of Secondary Mathematics. New York: Harper and Brothers Publishers, 1953.

Bruner, Jerome (editor). Learning About Learning. Washington, D.C.: United States Department of Health, Education, and Welfare. Cooperative Research Monograph No. 15.

________. The Process of Education. Cambridge: Harvard University Press, 1960.

________. On Knowing. Cambridge: Harvard University Press, 1962.

________. Toward A Theory of Instruction. Cambridge: Harvard University Press, 1966.

________, Jacqueline J. Goodnow, and George A. Austin. A Study of Thinking. New York: Science Editions, Inc., 1966.

Bugelski, Bergan Richard. The Psychology of Learning. New York: Holt, Rinehard and Winston, Inc., 1963.

________. The Psychology of Learning Applied to Teaching. Indianapolis: Bobbs-Merrill, 1964.

Christenhofferson, H.C. Geometry Professionalized For Teachers. Wisconsin: George Banta Publishing Co., 1933.

Clark, Kenneth B. Dark Ghetto: Dilemmas of Social Power. New York: Harper and Row, 1965.

Coleman, J., and others. Equality of Educational Opportunity. Washington, D.C.: United States Office of Education, 1966.

Coolidge, Julian Lowell. A History of Geometrical Methods. Oxford: At the Clarendon Press, 1940.

Courant, Richard, and Herbert Robbins. What Is Mathematics? New York: Oxford University Press, 1941.

Crow, L.D., and A. Crow. Child Development and Adjustment. New York: The Macmillan Company, 1962.

Davis, A. Social Class Influences Upon Learning. Cambridge: Harvard University Press, 1948.

Deutsch, Martin. Minority Class Status As Related to Social and Personality Factors in Scholastic Achievement. New York: Society for Applied Anthropology, Monographs No. 2, 1960.

________, Alma Maliver, B.R. Brown, and Estelle Cherry. Communication of Information in the Elementary School Classroom. Washington, D.C.: Cooperative Research Project No. 908 of the Office of Education, U.S. Department of Health, Education and Welfare, 1964.

Dewey, John. The Quest for Certainty. New York: Minton Balch and Co., 1929.

________. How We Think. New York: D. C. Heath, 1938.

Dienes, Zoltan P. Building Up Mathematics. London: Hutchinson Educational Ltd., 1960.

________. An Experimental Study of Mathematics-Learning. London: Hutchinson and Co., Ltd., 1964.

________. The Power of Mathematics. London: Hutchinson Educational Ltd., 1964.

________, and Malcolm A. Jeeves. Thinking in Structures (vol. 1 in Psychological Monographs on Cognitive Processes). London: Hutchinson Educational Ltd., 1965.

Dodgson, Charles L. Euclid and His Modern Rivals. London: Macmillan and Co., 1885.

Downie, N.M., and R.W. Heath. Basic Statistical Methods. New York: Harper and Row Publishers, 1965.

Edwards, Allan. Experimental Design in Psychological Research. New York: Holt, Rinehart and Winston, 1964.

Eves, Howard. An Introduction to the History of Mathematics. New York: Rinehart and Company, Inc., 1953.

________. A Survey of Geometry. Vol I. Boston: Allyn and Bacon, Inc., 1963.

Fantini, Mario D., and Gerald Weinstein. The Disadvantaged: Challenge to Education. New York: Harper and Row, 1968.

Fawcett, Harold P. The Nature of Proof. Thirteenth Yearbook of the National Council of Teachers of Mathematics. New York: Bureau of Publications, Teachers College, Columbia University, 1938.

Flavell, J.H. The Developmental Psychology of Jean Piaget. Princeton: Von Nostrand, 1963.

Forder, H.G. Geometry. London: Hutchinson's University Library, 1950.

Furth, Hanes G. Piaget and Knowledge. New York: Prentice Hall, 1969.

Gagne, Robert. Conditions of Learning. 2nd edition. New York: Holt, Rinehart and Winston, 1968.

Guilford, J.P. Fundamental Statistics in Psychology and Education. New York: McGraw-Hill, 4th edition, 1965.

Harrington, Michael. The Other America. New York: Macmillan, 1962.

Hays, William L. Statistics for Psychologists. New York: Holt, Rinehart and Winston, 1966.

Heath, Thomas L. The Thirteen Books of Euclid's Elements. Three Volumes. New York: Dover Publications, Inc., 1956.

Hebb, D.O. Organization of Behavior. New York: Science Edition, Inc., 1961.

Heisenberg, Werner. Physics and Philosophy. New York: Harper and Brothers, 1958.

Hilgard, Ernest and Gordon Bower. Theories of Learning. New York: Appleton-Century Crofts, Inc., 3rd edition, 1966.

Hill, Windfred. Learning: A Survey of Psychological Interpretations. San Francisco: Chandler Publishing Company, 1963.

Hollingshead, A.B., and F.C. Redlich. Social Class and Mental Illness. New York: John Wiley and Sons, 1958.

Hook, Sidney. Education for Modern Man. New York: Alfred A. Knopf, 1946.

Hunt, E.B. Concept Learning: An Information Processing Approach. New York: Wiley and Sons, 1962.

Hunt, Joseph. Intelligence and Experience. New York: Ronald Press Co., 1961.

Inhelder, B., and J. Piaget. The Growth of Logical Thinking from Childhood to Adolescence. translated by Anne Parsons and Stanley Milgram. New York: Basic Books, Inc., 1961.

Kelly, T.L. The Interpretation of Educational Measurements. Chicago: World Book Co., 1927.

Kelson, R. New Curriculum and the Teaching of the Disadvantaged. New York: McGraw-Hill, 1968.

Kerber, A. and W.R. Smith. Educational Issues in A Changing Society. Detroit: Wayne State University Press, 1962.

Kinney, Lucien B., and Richard C. Purdy. Teaching Mathematics in the Secondary School. New York: Rinehart and Co., Inc., 1952.

Kline, R.D. Workbook for Geometry. Syracuse: Syracuse University, 1967.

Klineberg, O. Race Differences. New York: Harper and Bros., 1935.

Koffka, K. Principles of Gestalt Psychology. New York: Harcourt, Brace and Company, 1935.

Kohler, Wolfgang. Gestalt Psychology. New York: The New American Library, 1947.

Lipsey, S.M. Political Man, The Social Bases of Politics. New York: Doubleday and Company, Inc., 1963.

Lorge, I. and R.L. Thorndike. The Lorge-Thorndike Intelligence Tests. Boston: Houghton-Mifflin, 1954.

McClelland, David, John W. Atkinson, Russell A. Clark, and Edgar L. Lowell. The Achievement Motive. New York: Appleton, Century and Crofts, 1953.

National Committee on Mathematical Requirements. The Reorganization of Mathematics in Secondary Education. Boston: Houghton Mifflin Co., 1923.

________. The Teaching of Geometry. Fifth Yearbook of the National Council of Teachers of Mathematics. New York: Bureau of Publications, Teachers College, Columbia University, 1930.

________. The Teaching of Mathematics in the Secondary School. Eighth Yearbook of the National Council of Teachers of Mathematics. New York: Bureau of Publications, Teachers College, Columbia University, 1933.

________. The Learning of Mathematics. Twenty-First Yearbook of the National Council of Teachers of Mathematics. Washington D.C.: National Council of Teachers of Mathematics, 1953.

North, C.C. Social Differentiation. Chapel Hill: University of North Carolina Press, 1926.

Ordan, H. Social Concepts and The Child Mind. New York: Kings Crown Press, 1945.

Passow, Harry A. (editor). Education In Depressed Areas. New York: Teachers College Press, 1963.

Peel, E.A. The Pupil's Thinking. London: Oldbourne Book Co., Ltd., 1960.

Piaget, Jean. The Child's Conception of Number. New York: Humanities Press, 1952.

________. The Origins of Intelligence in Children. translated by Margaret Cook. New York: International Universities Press, Inc., 1952.

________. Logic and Psychology. Manchester: University Press, 1953.

________, Barbel Inhelder, and Alina Szeminaka. The Child's Conception of Geometry. translated by E.A. Lunzer. New York: Basic Books, Inc., 1960.

________. The Psychology of Intelligence. translated by Malcolm Piercy and Daniel C. Berlyne. Patterson: Littlefield, Adams and Co., 1960.

________. Plays, Dreams and Imitations in Childhood. New York: Norton and Company, 1962.

Polya, George. Mathematical Discovery. Volume 2. New York: John Wiley and Sons, Inc., 1965.

Reissman, Frank. The Culturally Deprived Child. New York: Harper and Row, 1962.

________. Helping the Disadvantaged Pupil to Learn More Easily. New Jersey: Prentice Hall, 1966.

Russell, B. Introduction to the Philosophy of Maths. Cambridge: 1923.

Schilp, Paul A. The Philosophy of John Dewey. Evanston: Northwestern University, 1939.

Scott, Lloyd. Trends in Elementary School Mathematics. Chicago: Rand-McNally Co., 1966.

Shibli, J. Recent Developments in the Teaching of Geometry. State College, Pennsylvania: J. Shibli, Publisher, 1932.

Sigel, I.E., and Frank H. Hooper (editors). Logical Thinking in Children. New York: Holt, Rinehart and Winston, 1968.

________, and B. McBane. The Relationship Between Cognitive Competence and Level of Symbolization Among Five-Year Old Children. Chicago: Merrill-Palmer Institute, 1966.

Stamper, Alva W. A History of the Teaching of Elementary Geometry. New York: Teachers College, Columbia University, 1909.

Strang, Ruth. An Introduction to Child Study. New York: Macmillan Company, 1938.

Templin, M.C. Certain Skills in Children. Minneapolis: University of Minneapolis Press, 1957.

Terman, Lewis M., and others. The Stanford Revision and Extension of the Binet-Simon Scale for Measuring Intelligence. Baltimore: Warwick and York, Inc., 1917.

Thorndike, Edward L., and others. The Psychology of Arithmetic. New York: The Macmillan Company, 1924.

Veblen, Oswald. The Modern Approach to Elementary Geometry. The Rice Institute Pamphlet 21, 1934.

Warner, W.L., and others. Who Shall Be Educated? New York: Harper and Brothers, 1944.

Welchons, A.M., and W.R. Krickenberger. New Plane Geometry. Boston: Ginn and Company, 1956.

Wertheimer, M. Productive Thinking. New York: Harper and Brothers Publishers, 1959.

Whitehead, Alfred North. The Aims of Education. New York: Mentor Books, 1949.

Willoughby, Stephen S. Contemporary Teaching of Secondary School Mathematics. New York: John Wiley and Sons, Inc., 1967.

Winer, B.J. Statistical Principles in Experimental Design. New York: McGraw-Hill Book Company, 1962.

ARTICLES AND PERIODICALS

Adler, Irving. "Mental Growth and the Art of Teaching," The Mathematics Teacher, 59: 706-715, December, 1966.

Aebli, H. "Application of Jean Piaget's Psychology to Teaching Methods," The Developmental Psychology of Jean Piaget, J.H. Flavell, Princeton: Von Nostrand, 1963.

Arlitt, A.H. "Further Data on the Influence of Race and Social Status on the IQ," Psychology Bulletin, 18: 95-96, 1921.

Ausubel, David P. "The Use of Advanced Organizers in the Learning and Retention of Meaningful Verbal Learning," Journal of Educational Psychology, 51: 267-272, 1960.

________. "In Defense of Verbal Learning," Educational Theory, 11:15-25, January, 1961.

________. "Implications of Preadolescent and Early Adolescent Cognitive Development for Secondary-School Teaching," The High School Journal, 45: 268-275, April, 1962.

________. "Cognitive Structure and the Facilitation of Meaningful Verbal Learning," Journal of Teacher Education, 14: 217-221, June, 1963.

________. "A Teaching Strategy for Culturally Deprived Pupils: Cognitive and Motivational Considerations," School Review, 71: 454, Winter, 1963.

________. "How Reversible Are The Cognitive and Motivational Effects of Culturally Deprived Child," Urban Education, 1: 25, Summer, 1964.

________. "Introduction to Part One," in Readings in the Psychology of Cognition, pp. 3-17, edited by Richard Anderson and David Ausubel, Holt, Rinehart, and Winston, Inc., New York, 1965.

________. "Neobehaviorism and Piaget's Views on Thought and Symbolic Functioning," Child Development, 36: 1029-1032, December, 1965.

________. " A Cognitive Structure View of Word and Concept Meaning," in Readings in the Psychology of Cognition, pp. 58-75, edited by Richard Anderson and David Ausubel, Holt, Rinehart, and Winston, Inc., New York, 1965.

Baldwin, A.L., J. Kalhorn, and F.H. Breese. "Patterns of Parent Behavior," Psychological Monographs, 68, No. 3, 1945.

Bean, Kenneth L. "Negro Responses to Verbal and Non-Verbal Test Material," Journal of Psychology, 13: 348, April, 1942.

Beatley, Ralph. "Second Report of the Committee on Geometry," The Mathematics Teacher, 26: 566-71, October, 1933.

________. "Third Report of the Committee on Geometry," The Mathematics Teacher, 28: 329-79, 401-450, October, November, 1935.

Beilin, Harry. "A Cognitive Strategy for Curriculum Development," in Developing Programs for the Disadvantaged, A.H. Passow (editor), New York: Teachers College Press, 1968.

Berman, Gerald. "Boolean Algebra," in Topics in Modern Mathematics, pp. 37-48, edited by Ralph G. Stauton and Kenneth D. Fryer, Prentice Hall, Inc., Englewood Cliffs, 1964.

Bernstein, Basil. "Sociological Determinants of Perception," British Journal of Sociology, 9: 159-174, 1958.

________. "A Public Language: Some Sociological Implications of a Linguistic Form," British Journal of Sociology, 10: 318, December, 1959.

________. "Aspects of Language and Learning in the Genesis of Social Process," Journal of Child Psychology and Psychiatry, 1: 313-24, 1960.

________. "Language and Social Class," British Journal of Sociology, 11: 271-76, September, 1960.

________. "Social Class and Linguistic Development: A Theory of Social Learning," in Education, Economy and Society, edited by A.H. Halsey, Jean Floud, and C. Arnold Anderson, New York: Free Press of Glencoe, 1961, pp. 281-314.

________. "Social Structure, Language and Learning," Educational Research, 3: 163-176, June, 1961.

________. "Social Class, Linguistic Codes and Grammatical Elements," Language and Speech, 5: 221-240, October-December, 1962.

________. "Elaborated and Restricted Codes: Their Social Origins and Some Consequences," American Anthropology, II, 66: 55-69, Special Publication, J. Gompers and D. Hymes (editors), December, 1964.

________. "Social Structure, Language, and Learning," in Harry Passow, Miriam Goldberg, Abraham J. Tannenbaus (editors) Education of the Disadvantaged, Holt, Rinehart, and Winston, Co., 1967, p. 228.

Betz, William. "The Transfer of Training, With Particular Reference to Geometry," The Teaching of Geometry, Fifth Yearbook of the National Council of Teachers of Mathematics, New York: Bureau of Publications, Teachers College, Columbia University, 1930, pp. 149-99.

Birkhoff, George, and Ralph Beatly. "A New Approach to Elementary Geometry," The Teaching of Geometry, Fifth Yearbook of the National Council of Teachers of Mathematics, New York: Bureau of Publications, Teachers College, Columbia University, 1930, pp. 86-87.

Bloom, Benjamin. "Learning for Mastery," in Evaluation Comment, Bulletin of the U.C.L.A. Center for the Study of Evaluation of Instructional Programs, May, 1968.

Bloom, R., Martin Whiteman, and Martin Deutsch. "Race and Social Class as Separate Factors Related to Social Environment," The American Journal of Sociology, 60: 471-476, January, 1965.

Bruner, Jerome S., "Going Beyond the Information Given," in Contemporary Approaches to Cognition, pp. 41-67, Harvard University Press, Cambridge, 1957.

________. "Inhelder and Piaget's The Growth of Logical Thinking: A Psychologist's Viewpoint," British Journal of Psychology, 50: 363-370, November, 1959.

________. "On Learning Mathematics," The Mathematics Teacher, 53: 610-619, December, 1960.

________. "The Act of Discovery," Harvard Educational Review, 31: 21-32, Winter, 1961.

________. "The Cognitive Consequences of Early Deprivation," Sensory Deprivation, edited by Philip Solomon and others, Cambridge, Mass." Harvard University Press, 1961, pp. 195-207.

________. "The Course of Cognitive Growth," American Psychologist, 19: 1-15, January, 1964.

________. "Some Theorems on Instruction Illustrated With Reference to Mathematics," in Theories of Learning and Instruction, Ernest R. Hilgard (editor), National Society for the Study of Education, University of Chicago Press, Chicago, Illinois, 1964.

________, and Helen J. Kenney. "Representation and Mathematics Learning," in Mathematical Learning, pp. 50-59, edited by Lloyd Morrisett and John Vinsonhaler, Monograph of the Society for Research in Child Development, vol. 30, no. 1, University of Chicago Press, Chicago, 1965.

________. "On Multiple Ordering," in Studies in Cognitive Growth, pp. 154-167, edited by Jerome S. Bruner, Rose R. Olver, and Patricia M. Greenfield, John Wiley and Sons, Inc., New York, 1967.

Carroll, John B. "Analysis of Reading Instructions," in Theories of Learning and Instruction, edited by E. Hilgard, National Society for the Study of Education, University of Chicago Press, Chicago, Illinois, 1960.

________. "A Model for School Learning," Teachers College Record, 64: 723-733, 1963.

Carson, Arnold, and A.I. Rabin, "Verbal Comprehension and Communication in Negro and White Children," Journal of Educational Psychology, 51: 48, April, 1960.

Catell, R.N. "Intelligence, Fertility and Socioeconomic Factors," Eugenics Review, 29: 171-179, 1937.

Chapman, J.C., and D.M. Wiggins, "Relation of Family Size to Intelligence of Offspring and Socioeconomic Status of Family," Journal of Genetic Psychology, 32: 414-421, 1925.

Chauncey, M.R. "The Relation of the Home Factor to Achievement and Intelligence Test Score, " Journal of Educational, Research, 20: 88-90, 1929.

Chilman, Catherine S. "Child-Rearing and Family Relationship Patterns of the Very Poor," Welfare in Review, 3: 15, January, 1965.

Christofferson, H.C. "Trends for Improving Instruction in Mathematics," The Mathematics Teacher, 30: 15-20 January, 1937.

Clark, Kenneth B. "Unstructuring Education," in New Relationships in ITV, Educational Media Council, Inc., 1967.

________. "The Cult of Cultural Deprivation: A Complex Social Phenomenon," in G. Natchex (editor), Children With Reading Problems, 1968.

Coleman, J.S. "Academic Achievement and the Structure of Competition," Harvard Educational Review, 29: 330-48, 1957.

Collins, J.E. "The Intelligence of School Children and Paternal Occupation," Journal of Educational Research, 17: 157-169, 1928.

Crawford, D.H. "The Work of Piaget as It Relates to School Mathematics," Alberta Journal of Educational Research, 6: 125-136, September, 1960.

Cronbach, Lee J. "The Logic of Experiments on Discovery," in Lee S. Shulman and Evan R. Keisler (editors), Learning By Discovery: A Critical Analysis, Rand McNally, Co., Chicago, 1966.

Davis, A. "Child Training and Social Class," in R.G. Barker Kounin and H.F. Wright, Child Behavior and Development, New York: McGraw Hill, 1943.

________. "What Are Some of the Basic Issues in Relation of Intelligence Tests to Culture Background?" in K. Eells, A. Davis, R.J. Havighurst, V.E. Herrick, and R.W. Tyler, Intelligence and Cultural Differences, Chicago: University of Chicago Press, 1951.

________. "Society, The School, and The Culturally Deprived Student," Improving English Skills of Culturally Different Youths, Bulletin No. 5, U.S. Department of Health, Education and Welfare, 1964, pp. 10-21.

Deutsch, Cynthia. "Auditory Discrimination and Hearing: Social Factors," Merrill-Palmer Quarterly, 10:270-280, 1964.

________. "The Effects of Environmental Deprivation on Basic Psychological Processes," Art Education, 22: 20-24, January, 1969.

Deutsch, Martin. "Early Social Environment: Its Influence on School Adaptation," in D. Schreiber (editor), The School Dropout, National Education Association, Washington, D.C., 1964.

________. "Social and Psychological Perspectives on the Development of the Disadvantaged Learner," Journal of Negro Education, 33: 232-44, Summer, 1964.

________. "Social Intervention and the Malleability and the Child," Annual School of Education Lecture, Cornell University, Ithaca, New York, May 6, 196.

________. "The Role of Social Class in Language Development and Cognition," American Journal of Orthopsychiatry, 35: 85-92, January, 1965.

________. "Some Psychological Aspects of Learning in the Disadvantaged," in The Disadvantaged Child, Martin Deutsch and Associates, New York: Basic Books, Inc., 1967, pp. 31-5.

________, and others. "Guidelines for Testing Minority Group Children," Journal of Social Issues, 20: 125-130, April, 1964.

________, and Bert Brown. "Social Influences of Negro-White Intelligence Differences," Journal of Social Issues, 20: 24-35, April, 1965.

________, and Bert R. Brown. "Social Influence in Negro-White Intelligence Differences," Chapt. 14 of The Disadvantaged Child, New York: Basic Books, Incorporated, 1967.

Dewey, John, "The Psychological and the Logical in Teaching Geometry," Educational Review, 25: 387-399, April, 1903.

Dexter, E.S. "The Relation Between Occupation of Parent and Intelligence of School Children," School and Society, 17: 612-614, 1923.

Dienes, Zoltan P. "Insight Into Arithmetical Processes," The School Review, 72: 183-200, Summer, 1964.

Dodes, T.A. "The Science of Teaching Mathematics," Mathematics Teacher, 46: 157-66, 1953.

Duncker, Karl. "On Problem Solving," translated by Lynne S. Lees, in Psychological Monographs, edited by John F. Dashiell, 58: 1-111, 1945.

Dunkley, M.E. "Some Number Concepts of Disadvantaged Children," Arithmetic Teacher, 12: 359-361, May, 1965.

Dutton, Wilbur H. "Attitudes of Junior High School Pupils Toward Arithmetic," School Review, 64: 18-22, January, 1956.

Eells, K. "Some Implications for School Practices of the Chicago Studies of Cultural Bias in Intelligence Tests," Harvard Educational Review, 23: 284-97, Fall, 1953.

Efroymson, M.A. "Multiple Regression Analysis," in Mathematical Methods for Digital Computers, by A. Ralston and H.S. Wilf (editors), Vol. 1, John Wiley and Sons, Inc., 1967.

Empey, LaMar T. "Social Class and Occupational Aspirations: A Comparison of Absolute and Relative Measurement," American Sociological Review, December, 1956, pp. 703-709.

Erickson, LeLand H. "Certain Ability Factors and Their Effect on Arithmetic Achievement," Arithmetic Teacher, 5: 287-293, December 1958.

Fehr, Howard F. "Theories of Learning Related to the Field of Mathematics," The Learning of Mathematics, Twenty-First Yearbook of the National Council of Teachers of Mathematics. Washington, D.C.: National Council of Teachers of Mathematics, 1953, pp. 1-41.

Findlay, D.C., and C. McGuire. "Social Status and Abstract Behavior," Journal Abnormal Social Psychology, 54: 135-137, 1957.

Fleming, C.M. "Socioeconomic Level and Test Performance," British Journal of Educational Psychology, 13: 74-82, 1943.

Floud, Jean. "Social Class Factors in Educational Achievement," A.H. Halsey (Editor), Ability and Educational Opportunity, O.E.C.D. Publications, Paris, France, 1961, p. 102.

Frazier, Alexander. "A Research Proposal to Develop the Language Skills of Children With Poor Background," Improving English Skills of Culturally Different Youths, Bulletin No. 5, pp. 69-79, U.S. Department of Health, Education and Welfare, Bulletin, Washington, 1964.

Freeman, Ellen N. "The Influence of the Environment of the Intelligence, School Achievement, and Conduct of Foster Children," Chapter VI of Nature and Nurture, Part II; Their Influence Upon Achievement, pp. 102-217, Twenty-Seventh Yearbook of the National Society for The Study of Education, Bloomington, Illinois, Public School Publishing Company, 1928.

________. "Textbook Trends in Plane Geometry," The School Review, 40: 282-94, April, 1932.

Fukuda, T. "A Survey of the Intelligence and the Environment of School Children," American Journal of Psychology, 36: 124-139, 1925.

Garrison, K.C. "The Relationship of Intelligence and Socio-Cultural Status Upon The Information Possessed By First-Grade Children," Journal of Social Psychology, 3: 362- 67, 1932.

Goff, Regina M. "Some Educational Implications of the Influence of Rejection on Aspiration Level of Minority Group Children," Journal of Experimental Education, 23: 175-180, December, 1954.

Goodenough, F.L. "The Relation of The Intelligence of Pre-School Children to the Occupation of Their Fathers," American Journal of Psychology, 40: 28-94, 1928.

_______, and G. Shapiro. "The Performance of Preschool Children of Different Social Groups on Kuhlman-Binet Test," Journal of Educational Research, 18: 356-362, 1928.

Gordon, Edmund W. "Counseling Socially Disadvantaged Children," in Mental Health of the Poor, edited by Frank Reissman, Jerome Cohen, and Arthur Pearl, New York: Free Press of Glencoe, 1964, pp. 275-82.

Gould, Rosalind. "Some Sociological Determinants of Goal Strivings," Journal of Social Psychology, 13: 461-73, May, 1941.

Gould, S.H. "Origins and Development of Concepts of Geometry," Insights Into Modern Mathematics, Twenty-Third Yearbook of the National Council of Teachers of Mathematics. Washington, D.C.: 1957, pp. 273-305.

Haggerty, M.E., and H.B. Nash. "Mental Capacity of Children and Paternal Occupation," Journal of Educational Psychology, 15: 559-572, 1924.

Hatt, P.K., and C.C. North. "Jobs and Occupations; A Popular Evaluation," in Class Status and Power, edited by R. Bendix and S.M. Lipset, The Free Press of Glencoe, 1949, pp. 411-426.

Havighurst, Robert J. "Child Development in Relation to Community Social Structure," Child Development, 17: 85-89, 1946.

________. "Who Are the Socially Disadvantaged?" Journal of Negro Education, 33: 217-225, 1964.

________, and L.L. Janke. "Relations Between Ability and Social Status in a Midwestern Community, I: Ten-Year-Old Children," Journal of Educational Psychology, 35: 357-368, 1944.

Heilman, J.D. "The Relative Influence Upon Educational Achievement of Some Heredity and Environmental Factors," Nature and Nurture, Part II: Their Influence Upon Achievement, pp. 35-65, Twenty-Seventh Yearbook of the National Society for the Study of Education, Bloomington, Illinois, Public School Publishing Company, 1928.

Heimer, Ralph T. "Conditions of Learning in Mathematics Sequence Theory Development," Review of Educational Research, 39: 506, October, 1967.

Hillard, George H. , and Eleanor Troxell. "Informational Background as a Factor in Reading Readiness and Reading Progress," Elementary School Journal, 38: 258, December, 1937.

Hlavaty, Julius H. "Mathematics in Transition," The Mathematics Teacher, 54: 27-30, 1961.

Hoepfner, Ralph. "Characteristics of Standardized Tests as Evaluation Instruments," in Evaluation Comment, Bulletin of the U.C.L.A. Center for the Study of Evaluation of Instructional Programs, September, 1971.

Hoyt, Cyril. "Testing Reliability Estimated By Analysis of Variance," Psychometrika, 6: 153-160, 1941.

Hunt, J. McVicker. "Motivation Inherent in Information Processing and Action," in O.J. Harvey (editor), Motivation and Social Interaction: Cognitive Determinants, New York: Ronald Press, 1963.

Hyram, G.A. "An Experiment in Developing Critical Thinking in Children," Journal of Experimental Education, 26: 125-132, 1957.

Inhelder, B. "Some Aspects of Piaget's Genetic Approach to Cognition," In Cognitive Development in Children, The University of Chicago Press, 1970, p. 28.

Irwin, C. Orvis. "Language and Communications," Handbook of Research Methods in Child Development, Edited by Paul H. Mussen, New York: John Wiley and Sons, 1960, Chapter 12.

Jensen, Arthur R. "Learning Ability in Retarded, Average and Gifted Children," Merrill-Palmer Quarterly, 9: 123-40, April, 1963.

________. "Verbal Mediation and Educational Potential," Psychology in the Schools, 3: 99-109, 1966.

________. "Patterns of Mental Ability and Socioeconomic Status," Proceedings of the National Academy of Sciences, 60: 1330-1337, 1968.

________. "How Much Can We Boost IQ. and Scholastic Achievement?," Harvard Educational Review, 39: 449-483, 1969.

________. "The Role of Verbal Mediation in Mental Development," The Journal of Genetic Psychology, 118: 44, 1971.

John, Vera P. "The Intellectual Development of Slum Children: Some Preliminary Findings," American Journal of Orthopsychiatry, 33: 813-22, October, 1963.

________, and Leo S. Goldstein. "The Social Context of Language Acquisition," Merrill-Palmer Quarterly, 10: 265-270, July, 1964.

Jones, H.E. "Environmental Influences on Mental Development," Chapt. XI of Manual of Child Psychology, Leonard Carmichael (editor), pp. 582-623, New York: John Wiley and Sons, Inc., 1946.

Jones, Phillip S. "Early American Geometry," The Mathematics Teacher, 37: 3-11, January, 1944.

Jordan, A.M. "Parental Occupation and Children's Intelligence Scores," Journal of Applied Psychology, 17: 103-119, 1933.

Jordan, Thomas E. "Early Developmental Adversity and Classroom Learning: A Prospective Inquiry," American Journal of Mental Deficiency, 69: 360-71, November, 1964.

Kahl, J.A. "Educational and Occupational Aspirations of 'Common Man' Boys," Harvard Educational Review, 23: 186-203, 1953.

Keller, Suzanne. "The Social World of the Urban Slum Child: Some Early Findings," American Journal of Orthopsychiatry, 33: 823-31, October, 1963.

Knief, Lotus M., and James B. Stroud. "Intercorrelations Among Various Intelligence, and School Achievement, and Social Class Scores," Journal of Educational Psychology, 50: 117-120, 1959.

Kobler, F.J. "Cultural Differentials in Intelligence," Journal of Social Psychology, 18: 279-303, 1943.

Kornhauser, A.W. "Economic Standing and Intelligence of School Children," Journal of Educational Psychology, 9: 159-164, 1918.

Kruteskie, V.A. "Some Characteristics of the Thinking of Pupils With Little Capacity for Mathematics," in B. and J. Simon (editors), Educational Psychology in the U.S.S.R., Stanford University Press, Stanford, Calif., 1963.

Leahy, A.M. "Nature and Intelligence," Genetic Psychology Monograph, 17: 236-308, 1935.

LeShan, Lawrence L. "Time Orientation and Social Class," Journal of Abnormal and Social-Psychology, 47: 589-92, July, 1952.

Lewis, O. "The Culture of Poverty," Scientific American, 215: 19-25, October, 1966.

Loevinger, Jane. "Intelligence as Related to Socioeconomic Factors," Chapt. V of Intelligence: Its Nature and Nurture, Part I: Comparative and Critical Exposition, pp. 159-210, Thirty-Ninth Yearbook of the National Society for the Study of Education, Bloomington, Illinois: Public School Publishing Co., 1940.

Longley, W.R. "What Shall We Teach in Geometry?," The Teaching of Geometry, pp. 29-38, Fifth Yearbook of the National Council of Teachers of Mathematics, New York: Bureau of Publications, Teachers College, Columbia University, 1930.

Lorimer, F., and F. Osborn. "Variations in Cultural Intellectual Development Among Classified by Occupation or Social Status," Chapt. VIII of Dynamics of Population, by F. Lorimer and F. Osborn, pp. 157-176, New York: McMillan Co., 1934.

Lovell, K. "A Follow Up Study of Inhelder and Piaget's The Growth of Logical Thinking," British Journal of Psychology, 52: 143-154, May, 1961.

Lunzer, Eric A. "Problems of Form Reasoning in Test Situations," in European Research in Cognitive Development, pp. 19-46, edited by Paul H. Mussen, Monograph of the Society for Research in Child Development, Vol. 30, No. 2, University of Chicago Press, Chicago, 1965.

Maas, H.S. "Some Social Class Differences in The Family System and Group Patterns of Pre and Early Adolescents," Child Development, 22: 145-152, June, 1951.

McCandless, Boyd. "Environment and Intelligence," American Journal of Mental Deficiency, 56: 512, May, 1949.

Meserve, Bruce E. "The Evolution of Geometry," The Mathematics Teacher, 49: 372-82, May, 1956.

________. "New Trends in Algebra and Geometry," The Mathematics Teacher, 55: 452-61, October, 1962.

________. "Euclidean and Other Geometries," The Mathematics Teacher, 60: 2-11, January, 1967.

Milner, Ester. "A Study of the Relationship Between Reading Readiness in Grade One School Children and Patterns of Parent-Child Interaction, Child Development, 22: 95-122, June, 1951.

Mitchell, Jr., James V. "A Comparison of the Factorial Structure of Cognitive Functions for a High and Low Status Group," Journal of Educational Psychology, 47: 397-414, November, 1956.

Montague, David O. "Arithmetic Concepts of Kindergarten Children in Contrasting Socioeconomic Areas," Reading Teacher, 13: 40-44, October.

Morrisett, Lloyd, and John Vinsonhaler, editors. Mathematical Learning, Monograph of the Society for Research in Child Development, Vol. 30, No. 1, University of Chicago Press, Chicago, 1965.

Murphy, Gardner, and Lois Barclay Murphy, and Theodore Newcomb. "Nature and Nurture in Relation to Social Differences," Chapt. II of Experimental Social Psychology, pp. 27-75, New York: Harper and Bros., 1937.

Mussen, Paul. "Discussion," in Mathematical Learning, pp. 126-130, edited by Lloyd Morrisett and John Vinsonhaler, Monograph of the Society for Research in Child Development, Vol. 30, No. 1, University of Chicago, Chicago, 1965.

Nelson, V.L. "An Analytical Study of Child Learning," Child Development, 7: 95-114, June, 1936.

Newton, Eunice Shaed. "Planning for the Language Development of Disadvantaged Children and Youth," Journal of Negro Education, 33: 264-74, Summer, 1964.

________. "Verbal Destitution: The Pivotal Barrier to Learning," Journal of Negro Education, 29: 497-99, Fall, 1960.

Noble, C.E. "The Learning of Psychomotor Skills," Annual Review of Psychology, 19: 203-250, 1968.

Parsons, Charles. " Review of Inhelder and Piaget's The Growth of Logical Thinking: A Logicians Viewpoint," British Journal of Psychology, 51: 75-84, February, 1960.

Pavenstedt, Eleanor. "A Comparison of the Child-Rearing Environment of Upper-Lower and Very Low Lower Class Families," American Journal of Orthopsychiatry, 35: 90, January, 1963.

Peel, E.A. "Experimental Examination of Some of Piaget's Schemata Concerning Children's Perception and Thinking, and a Discussion of Their Educational Significance," British Journal of Educational Psychology, 29: 89-103, June, 1959.

Pettigrew, Thomas Franklin. "Negro American Intelligence," in The Disadvantaged Child, by Frost and Hawkes (editors), New York: Houghton Mifflin Company, 1966.

Piaget, Jean. "How Children Learn Mathematical Concepts," Scientific American, 189: 74-79, 1953.

Polya, George. Induction and Analogy in Mathematics (Vol. 1 in Mathematics and Plausible Reasoning), Princeton University Press, Princeton, 1954, 278 pp.

________. Mathematical Discovery, Vol. 1, John Wiley and Sons, Inc., New York, 1962, 212 pp.

Pressey, S.L., and R. Ralston. "The Relation of General Intelligence of School Children to the Occupation of their Fathers," Journal of Applied Psychology, 3: 366-373, 1919.

Raaheim, Kjell. "Problem Solving and Past Experience," in European Research in Cognitive Development, pp. 58-67, edited by Paul H. Mussen, Monograph of the Society for Research in Child Development, Vol. 30, No. 2, University of Chicago Press, Chicago, 1965.

Reeve, William David. "The Teaching of Geometry," The Teaching of Geometry, pp. 1-28, Fifth Yearbook of the National Council of Teachers of Mathematics. New York: Bureau of Publications, Teachers College, Columbia University, 1930.

Reissman, Frank. "The Culturally Deprived Child: A New View," Programs for Educationally Disadvantaged, U.S. Department of Health, Education, and Welfare, Office of Education, Bulletin Number 17, Government Printing Office, Washington, D.C., 1963.

________. "The Culturally Deprived Child: A New View," School Life, 45: 6, April, 1963.

________. "The Overlooked Positives of Disadvantaged Groups," Journal of Negro Education, 34: 160-66, Spring, 1965.

Romberg, Thomas A. "Current Research in Mathematics Education," Review of Educational Research, 39: 473-474, October, 1969.

Rosskopf, Myron F. "Transfer of Training," The Learning of Mathematics, pp. 205-227, Twenty-First Yearbook of the National Council of Teachers of Mathematics. Washington D.C.: National Council of Teachers of Mathematics, 1953.

________, and Robert M. Exner. "Modern Emphasis in the Teaching of Geometry," The Mathematics Teacher, 50: 272-79, April, 1957.

Salkind, Charles. "The War on Euclid," The Mathematics Teacher, 35: 205-207, May, 1942.

Saltzman, S. "The Influence of Social and Economic Background on Stanford-Binet Performance," Journal of Social Psychology, 12: 71-81, 1940.

Sandiford, P. "Paternal Occupation and the Intelligence of Offspring," School and Society, 23: 117-119, 1926.

Schieffelin, Barbara, and Gladys C. Schwesinger. "Heredity and Environment," Part II of Mental Tests and Heredity, pp. 19-58, New York: Galton Publishing Co., 1930.

Schulman, Lee S. "Psychology and Mathematics Education," Mathematics Education, Sixty-Ninth Yearbook of National Society for the Study of Education, Part I, University of Chicago Press, Chicago, 1970, p. 71.

Schwesinger, Gladys. "Studies on Environmental Influences as They Affect the Development of Intelligence," Chapt. IV of Heredity and Environment: Studies in the Genesis of Psychological Characteristics, by G. C. Schwesinger, pp. 165-351, New York: MacMillan Co., 1933.

Sigel, Irving E. "Developmental Trends in Abstraction Ability of Children," Child Development, 24: 131-144, June, 1953.

________, and L.M. Anderson, and H. Shapiro. "Categorization Behavior of Lower and Middle-Class Negro Preschool Children" Differences in Dealing with Representation of Familar Objects," Journal of Negro Education, 35: 218-229, Summer, 1966.

________, and B. McBane. "Cognitive Competence and Level of Symbolization Among Five-Year-Old Children," The Disadvantaged Child, Vol. 1, editor J. Hellmuth, Seattle Washington: Special Publications, 1967.

Siller, Jerome. "Socioeconomic Status and Conceptual Thinking," Journal of Abnormal and Social Psychology, 55: 365-71, November, 1957.

Sirkin, M. "The Relation Between Intelligence, Age, and Home Environment of Elementary School Pupils," School and Society, 20: 304-308, 1929.

Skeels, H.M., and E.A. Fillmore. "The Mental Development of Children from Under-Privileged Homes," Journal of Genetic Psychology, 50: 427-439, 1937.

Skemp, Richard R. "Reflective Intelligence and Mathematics," British Journal of Educational Psychology, 31: 45-55, February, 1961.

________. "The Need for a Schematic Learning Theory," The Journal of Educational Psychology, 32: 133-142, June, 1962.

Smith, M. "An Empirical Scale of Prestige of Occupations," American Sociological Review, 8: 185-192, April, 1943.

Sorokin, Pitirim A., and Carle C. Zimmerman, and Charles J. Galpin. "Rural-Urban Intelligence, Mental Health, Psychological Processes, and Predominant Attitudes," Chapt. XX of A Systematic Source Book in Rural Sociology, III, 226-351, Minneapolis: University of Minnesota Press, 1932.

Spence, Kenneth W. "Cognitive Versus Stimulus-Response Theories of Learning," Psychological Review, 57: 159-172, May, 1950.

Stoddard, Barbara Burks. "The Relative Influence of Nature and Nurture Upon Mental Development," Chapt. X of Nature and Nurture, Part I: Their Influence Upon Intelligence, pp. 219-316. Twenty-Seventh Yearbook of the National Society for the Study of Education, Bloomington, Illinois: Public School Publishing Co., 1928.

________. "A Summary of Literature on the Determiners of the Intelligence Quotient and the Educational Quotient," Chapt. XVI of Nature and Nurture, Part II: Their Influence Upon Achievement, pp. 248-350. Twenty-Seventh Yearbook of the National Society for the Study of Education, Bloomington, Illinois, Public School Publishing Co., 1928.

Stoddard, George D., and Beth L. Wellman. "Environment and the IQ," Chapt. XIV of Intelligence: Its Nature and Nurture, Part I: Comparative and Critical Exposition, pp. 405-42, Thirty-Ninth Yearbook of the National Society for the Study of Education, Bloomington, Illinois: Public School Publishing Co., 1940.

Stroud, J.B. "A Study of the Relation of Intelligence Test Score of Public School Children to the Economic Status of Their Parents," Journal of Genetic Psychology, 35: 105-111, 1928.

Suppes, Patrick. "Experimental Teaching of Mathematical Logic in the Elementary School," in Analysis of Research in the Teaching of Mathematics, pp. 26-27, by Kenneth E. Brown and Theodore L. Abell, United States Department of Health, Education, and Welfare, Office of Education, bul. no. 28 (OE-29007-62), Washington, D.C., 1965.

________. "On the Behavioral Foundations of Mathematical Concepts," in Mathematical Learning, pp. 60-95, edited by Lloyd Morrisett and John Vinsonhaler, Monograph of the Society for Research in Child Development, vol. 30, no. 1, University of Chicago, Chicago, 1965.

________. "Mathematical Concept and Formation in Children," American Psychologist, 21: 140-45, 1966.

Symonds, P.M. "Study Habits of High School Pupils," Teachers College Record, 28: 713-24, 1926.

Thomas, J. Allen. "Governmental Cooperation to Improve Efficiency in Education," in The Schools and the Challenge of Innovation, Committee for Economic Development, New York, 1969.

Tomlinson, H. "Differences Between Preschool Negro Children and Their Older Siblings on the Stanford-Binet Scales," Journal of Negro Education, 13: 474-479, 1944.

Tyler, Ralph W. "The Possibilities of Educational Evaluation," in School and the Challenge of Innovation, John Burns (Chairman), Committee for Economic Development, New York.

Uzgiris, Ina C. "Situational Generality of Conservation," Child Development, 35: 831-834, September, 1964.

Vanderplas, James M. "Perceptual Factors in the Learning of Mathematics," in Research Problems in Mathematics Education, pp. 84-97, United States Department of Health, Education, and Welfare, Office of Education, Cooperative Research Monograph no. 3 (OE-12008), Washington, D.C., 1960.

Vygotsky, Lev Semenovich. Thought and Language, edited and translated by Eugenia Hanfmann and Gertrude Vakar, The M.I.T. Press, Cambridge, 1962, 153 pp.

Wahlstrom, Ebba. "The Computational Arithmetic of Social Experiences of Third Grade Children," Journal of Educational Research, 30: 124-29, October, 1936.

Weintrob, J., and R. Weintrob. "The Influence of Environment on Mental Ability as shown by the Binet-Simon Tests," Journal of Educational Psychology, 3: 577-583, 1912.

Wellman, B. "The Effect of Preschool Attendance Upon the IQ," Journal of Experimental Education, 1: 48-69, 1932.

________. "Some New Bases for Interpretation of the IQ," Journal of Genetic Psychology, 41: 116-125, 1932.

________. "Growth in Intelligence Under Differing School Environments," Journal of Experimental Education, 3: 59-83, 1934.

________. "Mental Growth from Preschool to College," Journal of Experimental Education, 6: 127-138, 1937.

Welte, Herbert D. "A Psychological Analysis of Plane Geometry," in University of Iowa Monographs in Education, pp. 1-47, edited by Charles L. Robbins, First Series, no. 1, University of Iowa, Iowa City, 1926.

White, Sheldon. "Learning," in Child Psychology, edited by Harold Stevenson, Jerome Kagan, and Charles Spiker, pp. 196-235, Sixty-second Yearbook of the National Society for the Study of Education, pt. 1, University of Chicago Press, Chicago, 1963.

Whiteman, Martin. "Developmental Theory and Enrichment Programs," in Environmental Deprivation and Enrichment, New York, Ferkhauff Graduate School, Yeshiva University, 1965.

________. "Some Effects of Social Class and Pace on Children's Language and Intellectual Abilities," Paper read at the Biennial Meeting of the Society for Research in Child Development, Minneapolis, Minnesota, March, 1965.

Witty, P.A., and H.C. Lehman. "Racial Differences: The Dogma of Social Psychology," Journal of Social Psychology, 1: 394-419, 1930.

Wolff, Georg. "Abstract and Concrete in the Development of School Geometry," The Mathematics Teacher, 29: 365-373, December, 1936.

Woodruff, Asabel D., "The Use of Concepts in Teaching and Learning," The Journal of Teacher Education, 15: 81-97, March, 1964.

Woodsworth, J.G. "Some Theoretical Bases for a Psychology of Instruction," Canadian Education and Research Digest, 5: 14-26, March, 1965.

Yerkes, R., and H. Anderson. "The Importance of Social Status as Indicated by Results of the Point Scale Method of Measuring Mental Capacity," Journal of Educational Psychology, 6: 137-150, 1915.

Yourman, Julius. "The Case Against IQ Testing in Schools With Culturally Disadvantaged Pupils," in The Disadvantaged Child, New York: Basic Books, Incorporated, 1967.

Yudin, L.W. "Formal Thought in Adolescence as a Function of Intelligence," Child Development, 37: 697-708, September, 1966.

________, and S. Kates. "Concept Attainment and Adolescent Development," Journal of Educational Psychology, 54: 177-182, August, 1963.

UNPUBLISHED ARTICLES

Battle, H.J. "Application of Inverted Analysis in a Study of the Relation Between Values and Achievement of High School Pupils," Unpublished Doctoral Dissertation, University of Chicago, 1954.

Bechtold, C. "The Use of Extraneous Material in Developing Problem-Solving Ability of Pupils in Algebra I.," Unpublished Doctoral Dissertation, Teachers College, Columbia University, 1965.

Binkley, M.E. "First Grade Entrance Variables Related to Achievement and Personality, A Study of Culturally Deprived Fourth Graders," Unpublished Doctoral Dissertation, University of Tennessee, 1967.

Hill, S.A. "A Study of the Logical Thinking Abilities of Children," Unpublished Doctoral Thesis, Stanford University, 1960.

Kline, R.D. "A Study to Determine if Educational Materials Designed Specifically for a Developing Nation are Equally Effective in Producing Student Achievement in a Developing Nation," Unpublished Doctoral Dissertation, Syracuse, University, 1967.

Meconi, L.J. "An Experimental Study of Concept Learning and Retention in Mathematics," Unpublished Doctoral Dissertation, The Ohio State University, 1966.

Post, R. "A Study of Certain Factors Affecting the Understanding of Verbal Problems in Arithmetic," Unpublished Doctoral Dissertation, Teachers College, Columbia University, 1958.

Rosner, B. "Community Socioeconomic Status in Mental Organization," Unpublished Doctoral Dissertation, Teachers College, Columbia University, 1955.

Searle, R.E. "Mathematical Abilities Passed by Kindergarten Children from Disadvantaged Communities," Unpublished Doctoral Dissertation, University of California, 1968.

Siller, J. "The Effect of Differential Socioeconomic Status Upon the Development of Conceputal Ability," Unpublished Doctoral Dissertation, New York University, 1956.

Skypak, D.H. "The Relationship of Socioeconomic Status to the Development of Conservation of Numbers," Unpublished Doctoral Dissertation, University of Wisconsin, 1967.

Spain, J.C. "Definition of Familar Nouns by Culturally Deprived and Non-Deprived Children of Varying Ages," Unpublished Doctoral Dissertation, George Peabody College for Teachers, 1962.

APPENDIXES

INDEX OF SOCIOECONOMIC STATUS

APPENDIX A

INSTITUTE FOR DEVELOPMENTAL STUDIES

Department of Psychiatry
New York Medical College

Instructions in Use of the Index of Socioeconomic Status*

The index of socioeconomic status (SES) developed at the Institute for Developmental Studies in New York City utilizes two factors to estimate the relative social positioning of individuals in a given community. These factors are identified as:

1. occupation of main support of the family
2. education of main support of the family

Implicit assumptions in the use of the scale are that:

1. within any family unit, the social status of an individual can be derived from certain characteristics of the head of that family, and
2. within a community certain individuals are accorded more prestige than others on the basis of their occupation, education and/or income.

The following instructions outline the steps in obtaining an SES rating for children who are to be tested. The procedure involved is simple and the rating can be

---

* Original, 1961; revised, 1965.

obtained in a few short steps.

INSTRUCTIONS

1. Find the occupation of the specified head of the family in the occupational classification given in the following pages:

OCCUPATIONAL RATING SCALE

OCCUPATION	RATING
U.S. Supreme Court Justice	
U.S. Diplomat or Foreign Service	
State Governor, Mayor of large city	
U.S. Cabinet Member	
U.S. Senator, Congressman	10
Physician	
College President or Chancellor	
College Professor	
Scientist (Government or other)	
State Attorney	
Bank Executive	
Investment Broker	
Captain of ocean-going vessel	
County Judge	
Department Head, State Government	
Motion Picture Actor, (not "extra")	
Minister	
Lawyer	
Architect	
Postmaster, City	
Chemist	
Dentist	
Electronic Engineer	
Nuclear Physicist	
Civil Engineer	9
Mathematician	
Radio entertainer (except announcer)	
Director, Large Corporation Business Executive, Advertising Executive	
Airplane Pilot	
Inventor	

OCCUPATION	RATING
Editor-Owner newspaper	
Psychologist	
Veterinarian	
Historian, Economist	
Sociologist	
Medical Researcher, Biologist	
Author	8
Accountant, C.P.A.	
Registered Nurse	
Justice of the Peace	
Government Investigator (FBI, Justice Dept., etc.)	
Artist, performing artist	
Professional Athlete	
Interior Decorator, Industrial Designer, Fashion Designer	
Factory, Department Store Owner	
High School Teacher	
Building Contractor	
Radio Operator	
Mine owner-operator	
Owner of logging camp	
Musician in symphony orchestra	
Small Retail Owner	
Sheriff-County	
Army-Captain or above	
Elementary School Teacher	7
Railroad-Supervisor	
Real Estate Agent	
Agricultural Agent-County	
Laboratory Technician	
Detective of Police	
Fire Lt. or above	

OCCUPATION	RATING
Private Secretary	
Undertaker	
Social, Welfare Worker	
Foreman or Supervisor, Factory	
Labor Union official-National only	
Radio Announcer	
Farm owner-operator	
Hotel Manager	6
Newspaper Columnist	
Owner-operator print shop	
Railroad-Engineer	
Electrician	
Watchmaker, factory	
Trained Machinist	
Mason	
Dental Technician	
Auto Salesman	
Office Manager	
Owner-operator dry cleaning	
Linotype operator, printer	
Newspaper reporter, proofreader	
Oil well driller (not engineer)	
Manager small store	
Policeman, private investigator	5
Mail clerk, carrier	
Bookkeeper	
Insurance Agent	
Traveling Salesman	
Receptionist, typist secretary	
Bank Clerk	
Railroad Conductor, ticket agent	
Practical Nurse	
I.B.M. Keypunch operator	

OCCUPATION	RATING
Playground worker	
Teachers Aid	
Structural Iron worker	
Carpenter	
Pawnbroker	
Tenant farmer	
Auto mechanic	
Dressmaker	
Beautician	4
Plumber	
Telephone operator, lineman	
Labor union official-Local only	
Lunch stand operator	
Painter, house and/or non factory	
Salesclerk, grocery clerk	
Musician-popular, dance, singer	
Furniture finisher	
T.V. repairman	
Fireman	
Welder, offset pressman	
Machinist-Factory	
Barber	
Shoe repair man	
Railroad baggage handler	
Other semi-skilled	
Cook-restaurant or hotel, short order	3
Chauffer-private	
Fisherman	
Motorman, bus driver, conductor	
Milk route man	
Shipping clerk	
Cashier	
Merchant seaman	
Truck driver	

Gas station attendant Quarry worker Night club singer Porter-railroad Taxi driver Waiter-Bartender Farm worker All unskilled laborers Coal miner Night watchman Janitorial-Building superintendent Elevator operator Freight handler Nurse's Aide	2
Laundry worker Newsboy Soda clerk Peddler Grinder-tool, etc. Odd job worker Share cropper-migratory worker Scrub woman Garbage collector Street sweeper Shoe shiner	1

2. Occupational categories have been grouped into clusters; each has a prestige rating. Assign a rating to each child based on the occupation of main support of his family. For example, U.S. Supreme Court Justice is rated "10", Milk Route Man is rated "3". This number will be the occupation rating of each child.

3. Similarly, the education level of the head of the child's family is to be rated.

4. The following table specifies the ratings to be assigned for level of education of the main support in

the child's family.

EDUCATION	RATING
0-4 years	1
5-6 years	2
7-8 years	3
Some high school	4
High School graduate	5
Some college	6
College graduate	7
Post graduate or professional training	8

5. You now have two (2) ratings for each child. One the basis of these two ratings (occupations and education) you can now derive an estimated SES rating for each child as follows:

6. Referring to the table on the following page:

SES CONVERSION TABLE

Education of Main Support

	1	2	3	4	5	6	7	8	
1	I	I	I	I	I	II	II	II	
2	I	I	I	I	II	II	II	III	Occupa-
3	I	I	I	I	II	II	III	III	tion
4	I	I	I	II	II	III	III	III	of Main
5	I	I	I	II	II	III	III	III	Support
6	I	I	II	II	III	III	III	III	
7	I	II	II	III	III	III	III	III	
8	II	II	II	III	III	III	III	III	
9	II	II	III	III	III	III	III	III	
10	II	II	III	III	III	III	III	III	

1. locate the occupation rating of main support for a given child on the left hand side of the figure;
2. locate the education of main support for a given child across the top of the figure;

3. find the coordinate of these two by bringing your finger down to the point where they both meet. You will find that they meet in a box numbered I, II or III. This numerical value is the overall SES rating for the child.

7. Enter this number in the space marked "SES-A" in the lower right hand corner of the child's Background Information Sheet.

8. In the space marked "SES-B" enter your own judgmental estimate of the child's relative social status based on any familiarity that you may have with the child or his family. Use the numerals I, II or III where I will represent "Low" and III will represent "High".

QUESTIONNAIRE

APPENDIX B

Dear Teacher,

It is possible that some of your students may have a reading difficulty. Please feel free to assist them in reading and/or interpreting the questions as this information is of extreme importance to this study.

Thank you for your cooperation in this regard and on the other phase of the program.

Sincerely,

Steven Newstat

(This letter was sent with the packet of questionnaires to each cooperating teacher involved in this study.)

QUESTIONNAIRE

FOR EACH QUESTION CIRCLE THE LETTER THAT IS NEXT TO YOUR ANSWER. MARK ONLY ONE ANSWER FOR EACH QUESTION. YOU MAY OMIT ANY QUESTION WHICH YOU WOULD PREFER NOT TO ANSWER, BUT PLEASE ANSWER THEM ALL IF YOU POSSIBLY CAN.

1. Are you male or female?
   (a) Male
   (b) Female

2. How old were you on your last birthday?
   (a) 10
   (b) 11
   (c) 12
   (d) 13
   (e) 14
   (f) 15
   (g) 16 or older

3. Where were you born?
   (a) Alabama
   (b) Alaska
   (c) Arizona
   (d) Arkansas
   (e) California
   (f) Colorado
   (g) Connecticut
   (h) Delaware
   (i) District of Columbia
   (j) Florida
   (k) Georgia
   (l) Hawaii
   (m) Idaho
   (n) Illinois
   (o) Indiana
   (p) Iowa
   (q) Kansas
   (r) Kentucky
   (s) Louisiana
   (t) Maine
   (u) Maryland
   (v) Massachusetts
   (w) Michigan
   (x) Minnesota
   (y) Mississippi
   (z) Missouri
   (aa) Montana
   (bb) Nebraska
   (cc) Nevada
   (dd) New Hampshire
   (ee) New Jersey
   (ff) New Mexico
   (gg) New York
   (hh) North Carolina
   (ii) North Dakota
   (jj) Ohio
   (kk) Oklahoma
   (ll) Oregon
   (mm) Pennsylvania
   (nn) Rhode Island
   (oo) South Carolina
   (pp) South Dakota
   (qq) Tennessee
   (rr) Texas
   (ss) Utah
   (tt) Vermont
   (uu) Virginia
   (vv) Washington
   (ww) West Virginia
   (xx) Wisconsin
   (yy) Wyoming
   (zz) U.S. possession (American Samoa, Canal Zone, Guam, & Virgin Islands)
   (aaa) Puerto Rico
   (bbb) Mexico
   (ccc) Canada
   (ddd) Country other than the U.S. or its possessions, Puerto Rico, Canada or Mexico
   (eee) I don't know

4. Where was your mother born?

____

5. Where was your father born?

____

6. Where have you spent most of your life?
   (a) In this city, or county
   (b) In this state but outside this city, town, or county
   (c) In another state in the U.S.
   (d) In Puerto Rico or another U.S. possession
   (e) In Mexico
   (f) In Canada
   (g) In a country other than the U.S., Canada or Mexico

7. In what type of community have you spent most of your life? (Give your best estimate if you are not sure.)
   (a) In the open country or in a farming community
   (b) In a small town (less than 10,000 people) that was not a suburb
   (c) Inside a medium size city (10,000 to 100,000 people)
   (d) In a suburb of a medium size city
   (e) Inside a large city (100,000 to 500,000 people)
   (f) In a suburb of a large city
   (g) in a very large city (over 500,000 people)
   (h) In a suburb of a very large city

8. When was the last time you changed schools (not counting promotions from one school to another)?
   (a) I have not changed schools
   (b) Less than a year ago
   (c) About one year ago
   (d) About two years ago

9. How far do you want to go in school?
   (a) I do not want to finish high school
   (b) I want to finish high school only
   (c) I want to go to technical, nursing, or business school after high school
   (d) Some college training, but less than 4 years
   (e) I want to graduate from a 4 year college
   (f) I want to do professional or graduate work after I finish college

10. Circle the items that your family now has.
    (a) Television Set
    (b) Telephone
    (c) Record player, hi-fi, or stereo
    (d) Electric or gas refrigerator
    (e) Dictionary
    (f) Set of encyclopedias
    (g) Automobile
    (h) Vacuum cleaner
    (i) Daily newspaper

11. How many books are in your home?
    (a) None or very few (o-9)
    (b) A few (10-24)
    (c) One bookcase full (25-99)
    (d) Two bookcases full(100-249)
    (e) Three or more bookcases full (250 or more)

12. Do you usually find writing papers a difficult task, or do you have relatively little difficulty getting your ideas down on paper?
    (a) I find writing papers a very difficult task
    (b) I frequently have some difficulty writing
    (c) Usually I do not have much difficulty writing
    (d) I have little if any difficulty expressing myself in writing

13. Do you make notes while reading a book?
    (a) No or almost never
    (b) Once in a while, depending upon the subject
    (c) I generally do, but I have no particular notemaking system
    (d) I almost always make notes while reading, and I have a systematic method for doing so.

14. Did you go to kindergarten?
    (a) Yes.
    (b) No.

15. Did you go to nursery school before you went to kindergarten?
    (a) Yes.
    (b) No.
    (c) I don't remember.

16. When you were in grade school, about how often did you use a public library for reading not required by your school?
    (a) Once a week or more.
    (b) Two or three times a month.
    (c) Once a month or less.
    (d) Never.

17. How many magazines do you and your family get regularly at home?
    (a) None
    (b) 1 or 2
    (c) 3 or 4
    (d) 5 or 6
    (e) 7 or more.

18. Which of the following magazines do you and your family get regularly?
    (a) Jet
    (b) Good Housekeeping
    (c) Ladies Home Journal
    (d) Family Circle
    (e) McCall's
    (f) Reader's Digest
    (g) Saturday Review
    (h) Time
    (i) Look
    (j) Life
    (k) Newsweek
    (l) Astro Science
    (m) Ramparts
    (n) Nation
    (o) Ebony
    (p) Better Homes and Gardens
    (q) Scientific American
    (r) Jack and Jill
    (s) The Instructor
    (t) None
    (u) Other ....

19. Did anyone at home read to you before you started going to school?
    (a) No.
    (b) Once in a while.
    (c) Many times, but not regularly
    (d) Many times and regularly.
    (e) I don't remember.

GO ON TO THE NEXT PAGE............

20. Who is now a father to you?
(a) My real father, who is living at home.
(b) My real father, who is not living at home.
(c) My stepfather.
(d) My foster father.
(e) My grandfather.
(f) Another relative (uncle, etc.)
(g) Another grownup (not a relative).
(h) No one.

21. Who is now acting as your mother? Answer "real mother" if you are adopted.
(a) My real mother, who is living at home.
(b) My real mother, who is not living at home.
(c) My stepmother.
(d) My foster mother.
(e) A grandmother.
(f) Other relative(aunt, etc.)
(g) Other adult.
(h) No one.

22. How far in school did your father go?
(a) None, or some grade school.
(b) Completed grade school.
(c) Some high school, but did not graduate.
(d) Graduated from high school.
(e) Technical or business school after high school.
(f) Some college but less than 4 years.
(g) Graduated from a 4-year college.
(h) Attended graduate or professional school.
(i) I don't know.

23. How far in school did your mother go?
(a) None, or some grade school.
(b) Completed grade school.
(c) Some high school, but did not graduate.
(d) Graduated from high school.
(e) Technical, nursing, or business school after high school.
(f) Some college but less than 4 years.
(g) Graduated from a regular 4-year college.
(h) Attended graduate or professional school.
(i) I don't know.

24. Does your mother have a job outside your home?
(a) Yes, full-time.
(b) Yes, part-time.
(c) No.

25. Where does most of the money come from that pays for your family expenses?
(a) My father's work.
(b) My mother's work.
(c) Your own work.
(d) Welfare Department
(e) Relatives
(f) Friends
(g) Other

26. What work does your father do? You probably will not find his exact job listed, but check the one that comes closest. If he is now out of work or if he is retired, mark the one that he usually did. Mark only his main job if he works on more than one.
(a) Draftsman, surveyor, medical or dental technician, etc.
(b) Manufacturer, officer in a large company, banker, government official or inspector, etc.
(c) Sales manager, store manager, office manager, factory supervisor, etc.
(d) Owner of a small business, wholesaler, retailer, contractor, restaurant owner etc.
(e) Factory machine operator, bus or cab driver, meat cutter, etc.
(f) Bank teller, bookkeeper, sales clerk, office clerk, mail carrier, messenger, etc.
(g) Barber, waiter, etc.
(h) Policeman, detective, sheriff, fireman, etc.
(i) Real estate or insurance salesman, factory representative, etc.
(j) Farm or ranch manager or owner.
(k) Farm worker on one or more than one farm.
(l) Factory or mine worker, fisherman, filling station attendant, longshoreman, etc.
(m) Accountant, artist, clergyman dentist, doctor, engineer, lawyer, librarian, scientist, college professor, social worker, school teacher.
(n) Baker, carpenter, electrician enlisted man in the armed forces, mechanic, plumber, plasterer, tailor, foreman in a factory or mine.
(o) I don't know.

27. How good a student does your mother want you to be in school?
(a) One of the best in my class.
(b) Above the middle of the class
(c) In the middle of my class.
(d) Just good enough to get by.
(e) I don't know.

GO ON TO THE NEXT PAGE.........

28. How good a student does your father want you to be in school?
(a) One of the best in my class.
(b) Above the middle of the class.
(c) In the middle of my class.
(d) Just good enough to get by.
(e) I don't know.

29. How often do you and your parents talk about your school work?
(a) Just about every day.
(b) Once or twice a week.
(c) Once or twice a month.
(d) Never or hardly ever.

30. How much education does your father want you to have?
(a) Doesn't care if I finish high school or not.
(b) Finish high school only.
(c) Technical, nursing, or business school after high school.
(d) Some college but less than 4 years.
(e) Graduate from a 4-year college.
(f) Professional or graduate school.
(g) Father is not at home.
(h) I don't know.

31. How much education does your mother want you to have?
(a) Doesn't care if I finish high school or not.
(b) Finish high school only.
(c) Technical, nursing, or business school after high school.
(d) Some college but less than 4 years.
(e) Graduate from a 4-year college.
(f) Professional or graduate school.
(g) Mother is not at home.
(h) I don't know.

32. How many of your brothers and sisters left high school before finishing?
(a) Have no older brothers or sisters.
(b) None.
(c) 1
(d) 2
(e) 3
(f) 4
(g) 5
(h) 6
(i) 7
(j) 8 or more
(k) I don't know.

33. How many of your brothers and sisters attended a year or more of college?
(a) Have no older brothers or sisters.
(b) None.
(c) 1
(d) 2
(e) 3
(f) 4
(g) 5
(h) 6
(i) 7
(j) 8 or more.
(k) I don't know.

34. How many of your brothers or sisters graduated from college?
(a) Have no older brothers or sisters.
(b) 1
(c) 2
(d) 3
(e) 4
(f) 5
(g) 6
(h) 7
(i) 8 or more.
(j) I don't know.
(k) None.

35. How much education do you want t have?
(a) I don't care.
(b) Some college training, but less than 4 years.
(c) Graduate from a 4-year colle
(d) A graduate degree such as M. A. or Ph.D.
(e) A professional degree such a law (LL.B) or medicine (M.D.
(f) Undecided.

36. Do you ever find yourself bored in class?
(a) Almost all of the time.
(b) Fairly often.
(c) Occasionally.
(d) Almost never.

37. During the last school year, did you ever stay away from school just because you didn't want to come?
(a) No.
(b) Yes, for 1 or 2 days.
(c) Yes, for 3 to 6 days.
(d) Yes, for 7 to 15 days.
(e) Yes, for 16 or more days.

38. On an average weekday, how much time do you spend studying?
(a) None or almost none.
(b) About 1/2 hour a day.
(c) About 1 hour a day.
(d) About 1 & 1/2 hours a day.
(e) About 2 hours a day.
(f) About 3 hours a day.
(g) 4 or more hours a day.

39. Compared with your classmates here in school, do you study more or less than they do?
(a) More than others.
(b) About the same as others.
(c) Less than others.
(d) I don't know.

40. How do you and your friends rate socially in school?
(a) At the top.
(b) Near the top.
(c) About the middle.
(d) Near the bottom.

41. How bright do you think you are in comparison with the other students in your classes this year?
(a) Among the brightest.
(b) Above average.
(c) Average.
(d) Below average.
(e) Among the lowest.

42. I would make any sacrifice to get ahead in the world.
(a) Agree
(b) Not sure.
(c) Disagree.

43. If I could change, I would be someone different from myself.
(a) Agree.
(b) Not sure.
(c) Disagree.

44. I sometimes feel that I just can't learn.
(a) Agree.
(b) Not sure.
(c) Disagree.

45. I would do better in school work if teachers didn't go so fast.
(a) Agree.
(b) Not sure.
(c) Disagree.

46. People like me don't have much of a chance to be successful in life.
(a) Agree.
(b) Not sure.
(c) Disagree.

47. The tougher the job, the harder I work.
(a) Agree.
(b) Not sure.
(c) Disagree.

48. I am able to do many things well.
(a) Agree.
(b) Not sure.
(c) Disagree.

49. About how long does it take you to get from your home in the morning to school?
(a) 10 minutes or less.
(b) 20 minutes.
(c) 30 minutes.
(d) 45 minutes.
(e) One hour or more.

50. How do you usually come to school in the morning?
(a) Automobile.
(b) Walk.
(c) School Bus.
(d) Train, trolley, subway, or bus other than a school bus.
(e) Bicycle.
(f) Other.

51. How many people are living in your home at the present time including yourself, brothers, sisters, parents, relatives, and others who lived with you?

(a) 2	(e) 6	(i) 10
(b) 3	(f) 7	(j) 11 or more.
(c) 4	(g) 8	
(d) 5	(h) 9	

52. How many rooms are there in your family's house? Count only the rooms your family lives in. Count the kitchen (if separate) but not the bathrooms.

(a) 1	(e) 5	(i) 9
(b) 2	(f) 6	(j) 10 or more.
(c) 3	(g) 7	
(d) 4	(h) 8	

53. Does anyone in your home speak a language other than English most of the time? (Spanish, Italian, Polish, German, etc.)
(a) Yes. (b) No.

54. Do you speak a foreign language other than English outside of school?
(a) Yes, frequently.
(b) Yes, occasionally.
(c) Yes, rarely.
(d) No.

55. Are you planning to go to high school?
(a) Definitely yes.
(b) Probably yes.
(c) Probably not.
(d) Definitely not.

56. Are you planning to finish high school?
(a) Definitely yes.
(b) Probably yes.
(c) Probably not.
(d) Definitely not.

57. When you finish school, what sort of job do you think you will have? Pick the one that is closest.

BOYS ANSWER FROM SELECTIONS BELOW:
(a) Draftsman or medical technician.
(b) Banker, company officer, or government official.
(c) Store owner or manager, office manager.
(d) Sales clerk, office clerk, truck driver, waiter, policeman, bookkeeper, mailman, barber.
(e) Salesman.
(f) Farm or ranch manager or owner.
(g) Farm worker on one or more than one farm.

GO ON TO THE NEXT PAGE................

(h) Factory worker, laborer, or gas station attendant.
(i) Doctor, lawyer, clergyman, engineer, scientist, teacher, professor, artist, accountant.
(j) Carpenter, electrician, mechanic, tailor, or foreman in a factory.
(k) I don't know.

GIRLS ANSWER FROM THE SELECTIONS BELOW:

(a) Housewife only.
(b) Doctor, lawyer, scientist.
(c) Beautician.
(d) Bookkeeper or secretary.
(e) Waitress or laundry worker.
(f) School teacher.
(g) Nurse.
(h) Saleslady
(i) Maid or domestic servant.
(j) Factory worker.
(k) I don't know.

THANK YOU FOR YOUR COOPERATION.

GEOMETRY WORKBOOK

GEOMETRY CONSTRUCTIONS

AN

AUDIO-VISION COURSE

STUDENT NOTES

LESSONS 1-10

Lesson 1

PLANE
SOLID
POINT
LINE
RAY

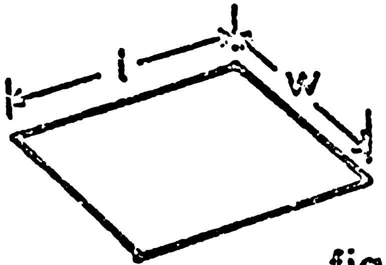


fig.1

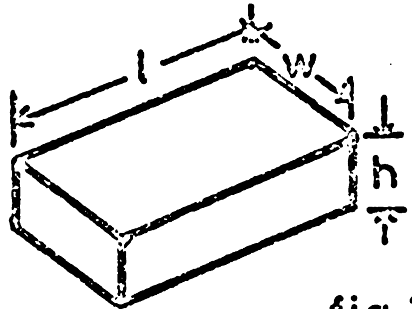


fig. 2

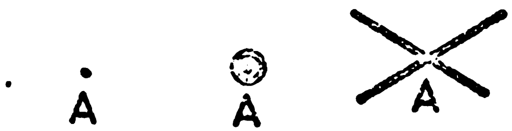


fig. 3

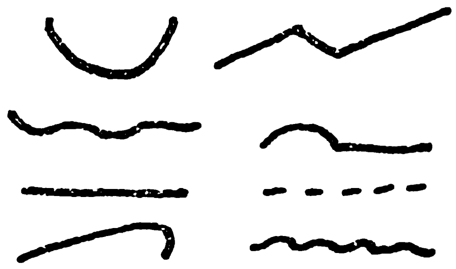


fig. 4

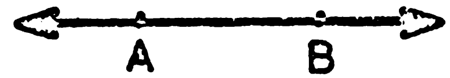


fig. 5

fig. 6

fig. 7

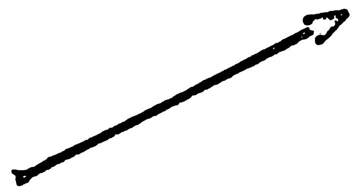


fig. 8

1. Can you measure a point? if not, why not? If you can, what are the measurments of this point? $\longrightarrow \bullet$

2. Fill in the names of the following:

   a) $\bullet$ = ______________

   b) $\longleftrightarrow$ = ______________

   c) $\overset{}{\underset{a}{\bullet}}\!\longrightarrow$ = ______________

   d) $\underset{A}{\bullet}\!\text{———}\!\underset{B}{\bullet}$ = ________ ________

3. What is the name we may use during this course for a straight line?

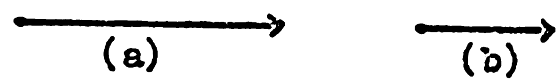
4. How many points can you locate on a given line segment?

5. Can one point be larger than another?

6. Can one line (not line segment) be longer than another?

7. What determines how long a (regular) curved line may be?

8. Is ray (a) longer than ray (b)? If not, why not?



9. If AB is a line segment and BC is a line segment, what is AC?

10. Give a short but good reason why Geometry will help you in your future life.

Lesson 2

RADIUS - RADII
DIAMETER
CIRCUMFERENCE

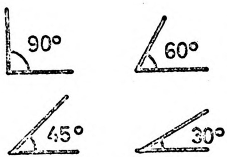


fig.1

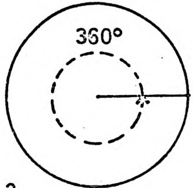


fig.2

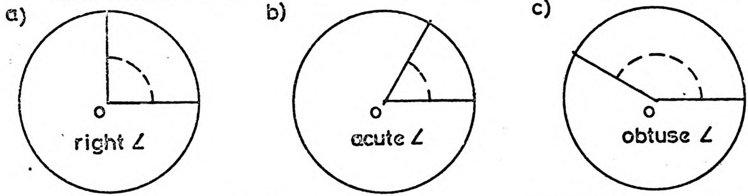
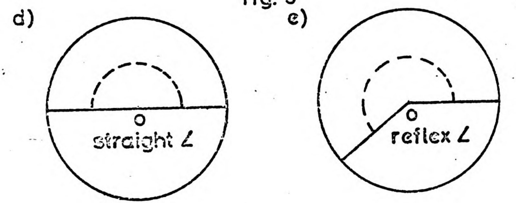


fig. 3



∠ x
∠ B
∠ ABC

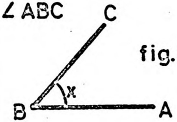
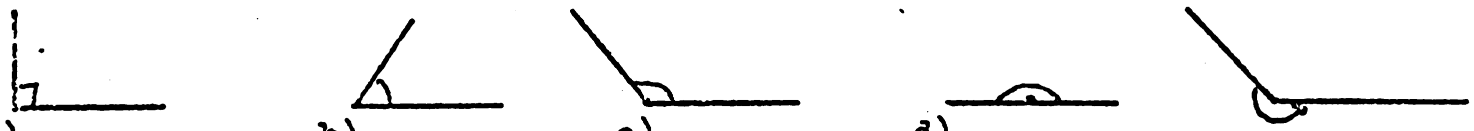


fig.4

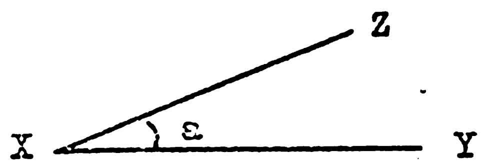
Supplementary Material - Lesson 2 **Page 4**

1. Name the following angles:



a) __________ b) __________ c) __________ d) __________ e) __________

2. Name this angle three different ways.

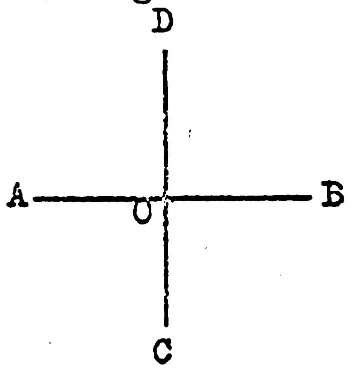


a) ____________________

b) ____________________

c) ____________________

3. List all the angles you can name in the drawing below. Do not include reflex angles. Do not name the same angle in more than one way.



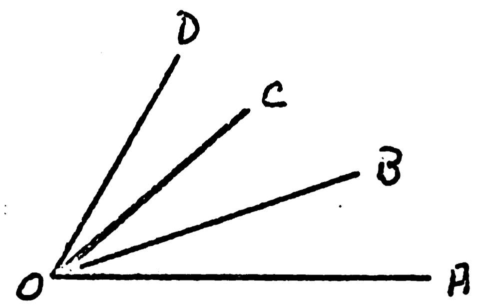
a) ____________________ e) ____________________ above

b) ____________________ f) ____________________ below

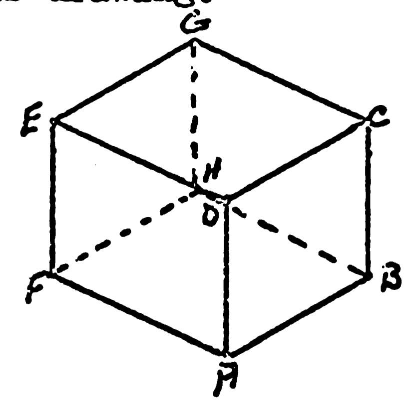
c) ____________________ g) ____________________ right side

d) ____________________ h) ____________________ left side

4. How many different angles can you name in this drawing?



5. Name all the angles you can find in this drawing.



Lesson 3

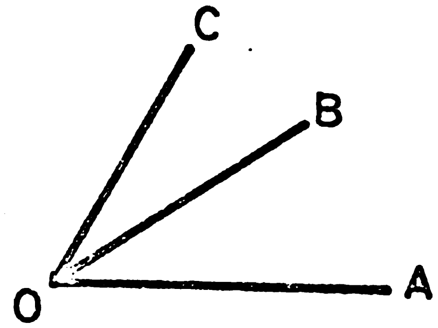


fig.1

$$\begin{array}{r} \angle AOB \\ +\ \underline{\angle BOC} \\ \angle AOC \end{array}$$

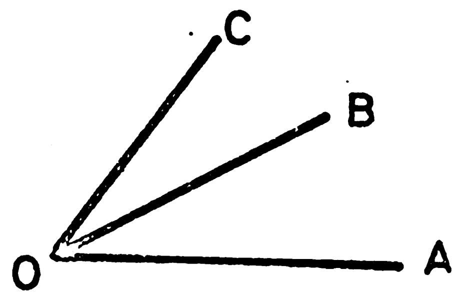
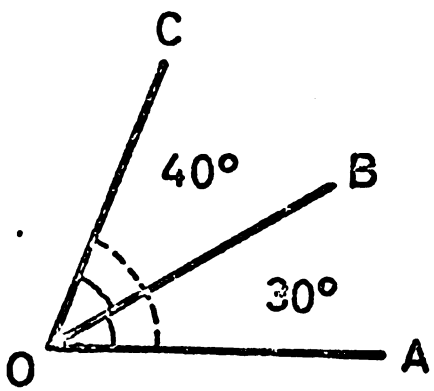


fig. 2

$$\begin{array}{r} \angle AOC \\ -\ \underline{\angle AOB} \\ \angle BOC \end{array}$$



$$\begin{array}{r} \angle AOB = 30° \\ \underline{\angle BOC = 40°} \\ \angle AOC = 70° \end{array}$$

fig. 3

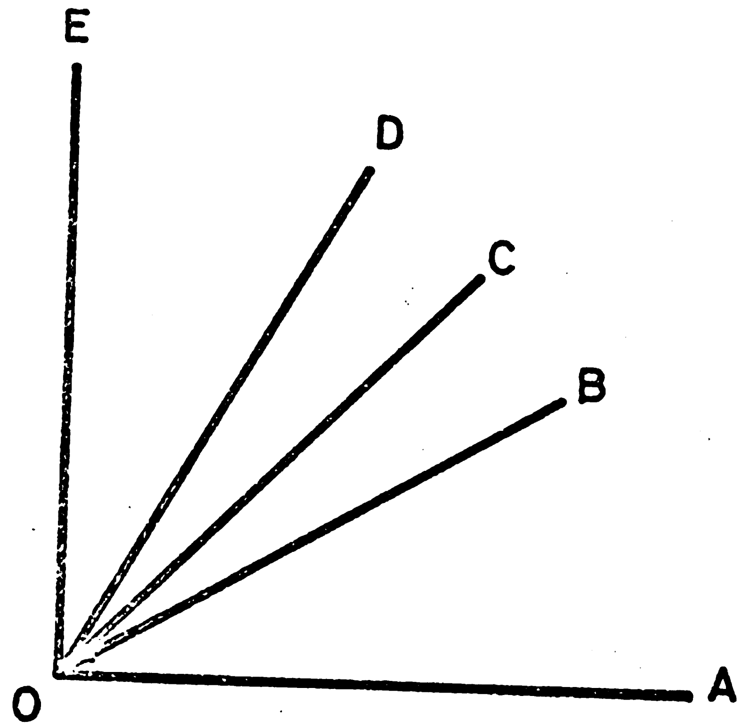
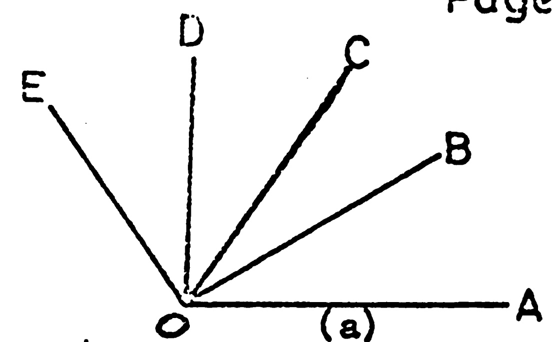


fig. 4

Supplementary Material - Lesson 3

Page 6

1. Name all of the pairs of adjacent angles. (a)



2. Draw two sets of angles having a common side or vertex which cannot be classified as adjacent angles.

3. Subtract

$$\begin{array}{r}\angle AOE\\ \underline{\angle AOB}\end{array}\qquad \begin{array}{r}\angle AOE\\ \underline{\angle DOE}\end{array}\qquad \begin{array}{r}\angle AOC\\ \underline{\angle BOC}\end{array}\qquad \begin{array}{r}\angle BOD\\ \underline{\angle BOC}\end{array}$$

4. Add

$$\begin{array}{r}\angle DOE\\ \underline{\angle COD}\end{array}\qquad \begin{array}{r}\angle BOC\\ \underline{\angle COD}\end{array}\qquad \begin{array}{r}\angle AOB\\ \angle BOC\\ \underline{\angle COD}\end{array}\qquad \begin{array}{r}\angle AOB\\ \angle BOC\\ \angle COD\\ \underline{\angle DOE}\end{array}$$

5. Name an angle smaller than $\angle AOC$. Why?

6. Name an angle larger than $\angle AOC$. Why?

7. How do you measure angles? (inches, feet, degrees, pounds, other)

8. Is $\angle BOC$ adjacent to $\angle DOE$? Why or why not?

9. Name the instrument used to measure angles.

   (ruler, protractor, compass, scale, straight edge, other)

Lesson 4

COMPLEMENTARY ∠s

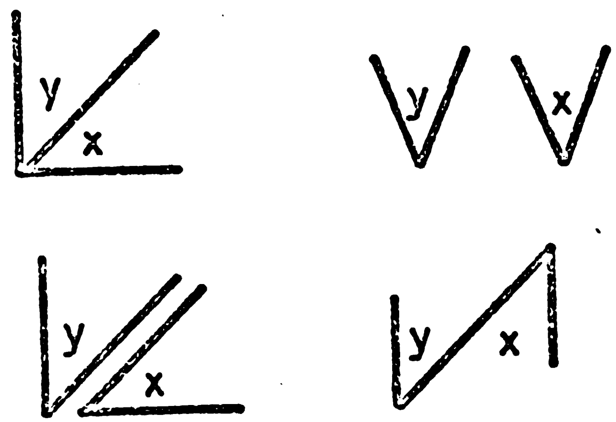


fig. 1

SUPPLEMENTARY ∠s

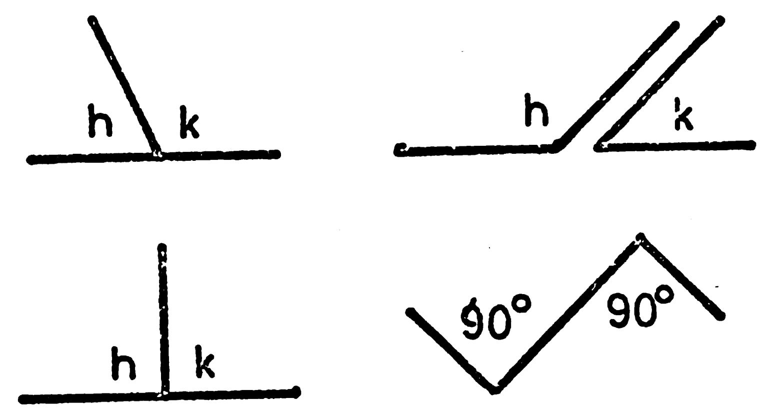


fig. 2

VERTICAL ∠s

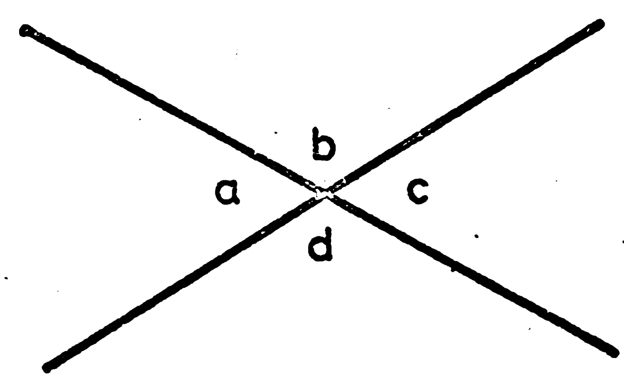


fig. 3

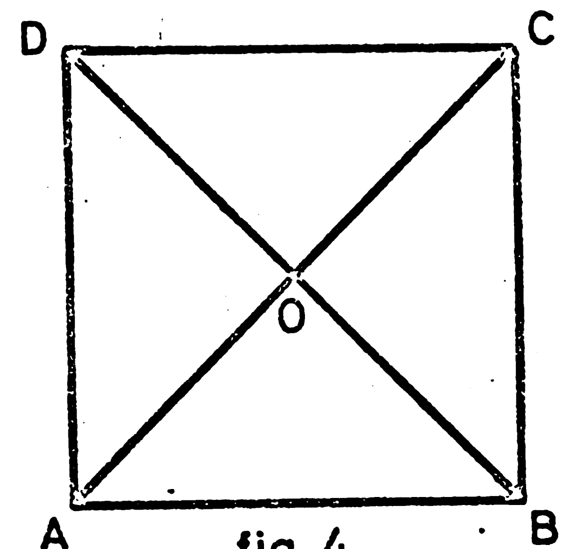


fig. 4

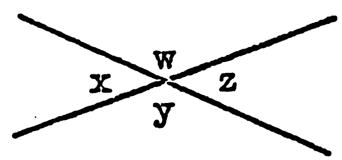
Supplementary Material - Lesson 4

1. Define complementary angles.

2. Define supplementary angles.

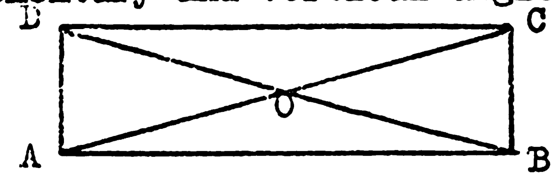
3. Define vertical angles.

4. In the figure below list the pairs of supplementary angles and the pairs of vertical angles.



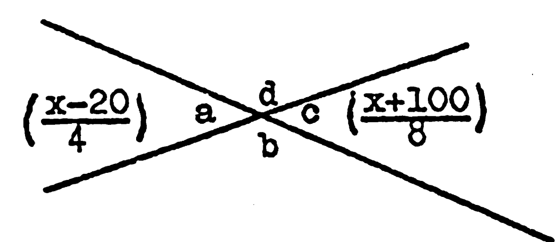
Supplementary	Vertical
___ & ___	___ & ___
___ & ___	___ & ___
___ & ___	
___ & ___	

5. In the figure below - list all of the pairs of complementary, supplementary and vertical angles.



Comp.	Supp.	Vert.
___ & ___	___ & ___	___ & ___
___ & ___	___ & ___	___ & ___
___ & ___	___ & ___	
___ & ___	___ & ___	
___ & ___	___ & ___	
___ & ___	___ & ___	
___ & ___	___ & ___	
___ & ___	___ & ___	

6. Extra work (if you can)
Find the number of degrees in each of the four angles



Lesson 5

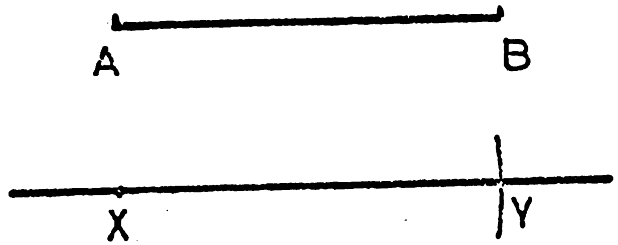
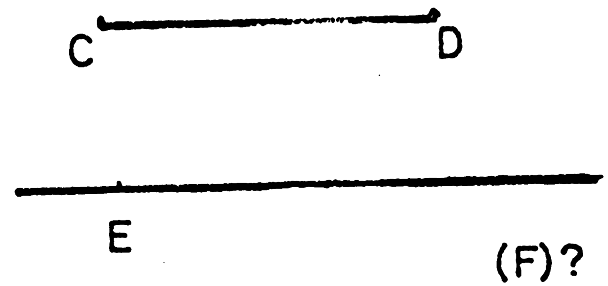


fig. 1



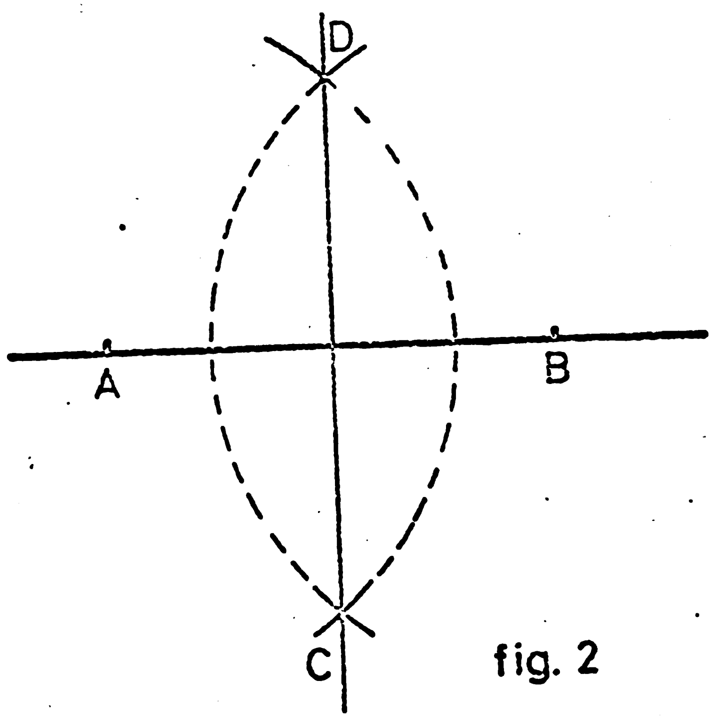
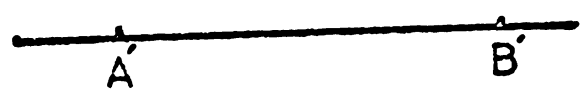


fig. 2



Lesson 5

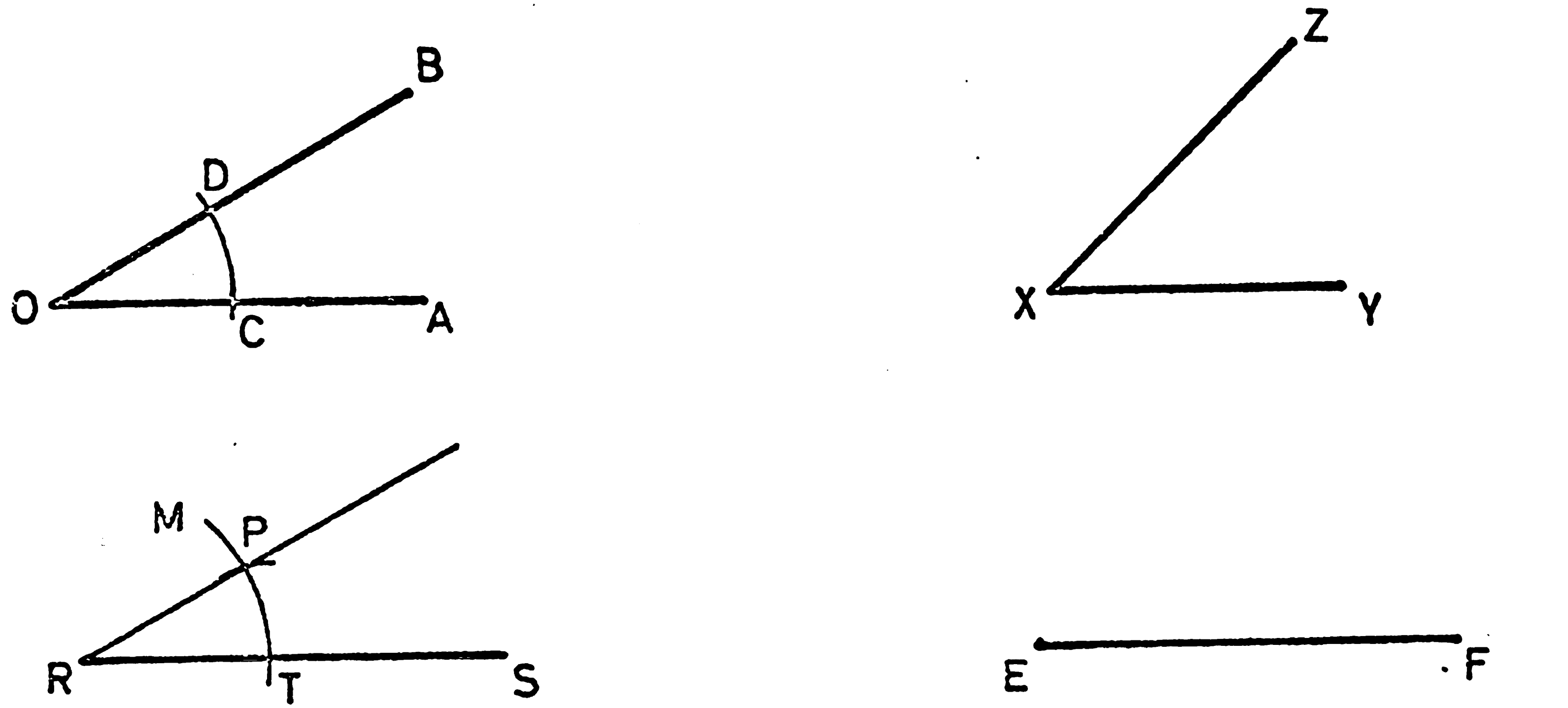
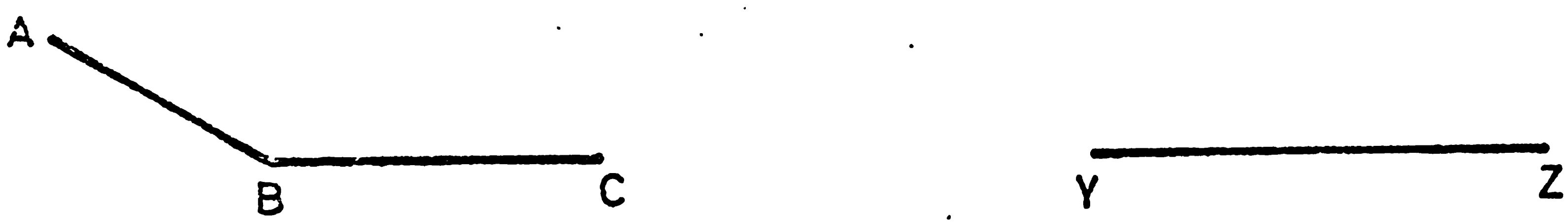


fig. 3

(extra)



Lesson 5

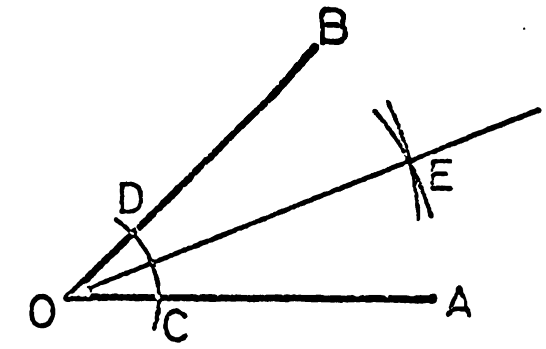
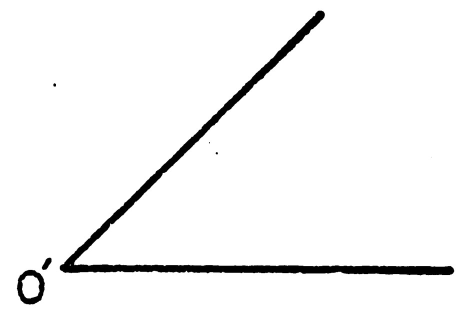


fig. 4a



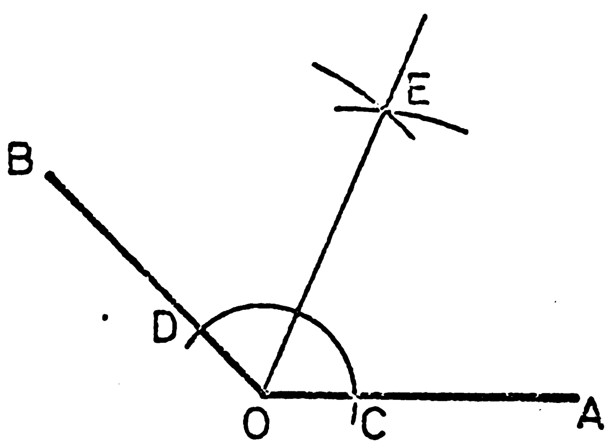
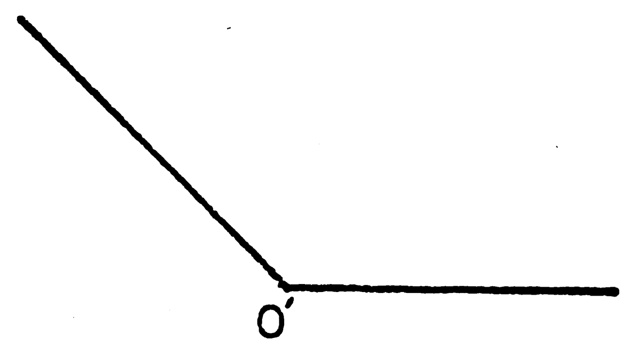


fig. 4b



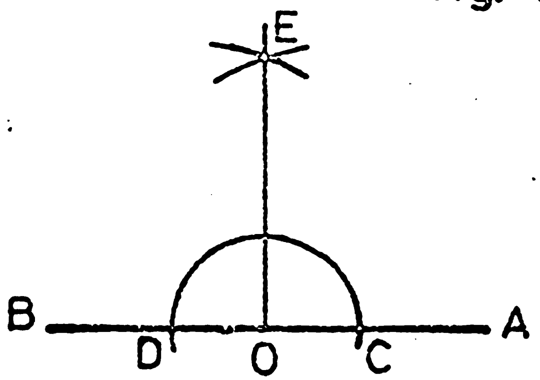
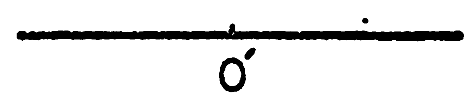
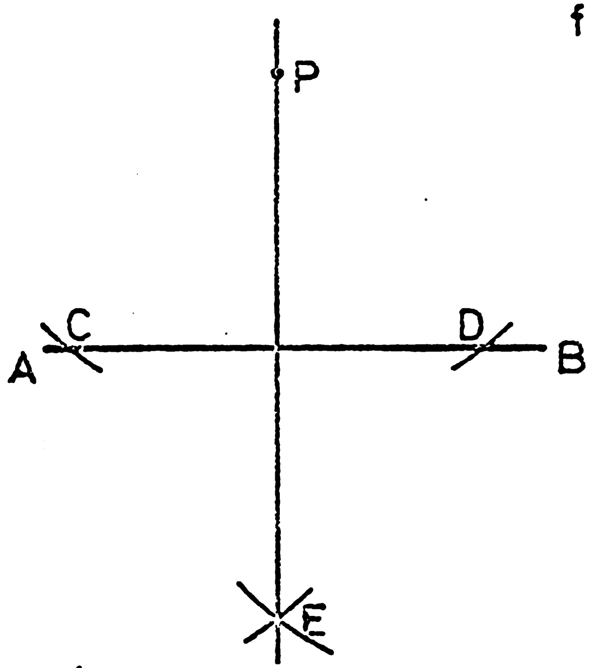


fig. 4c



Lesson 5

fig. 5a



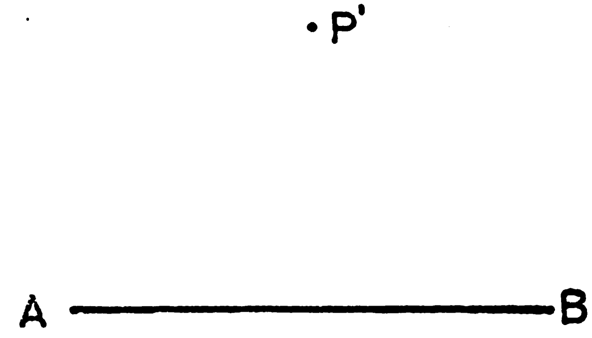
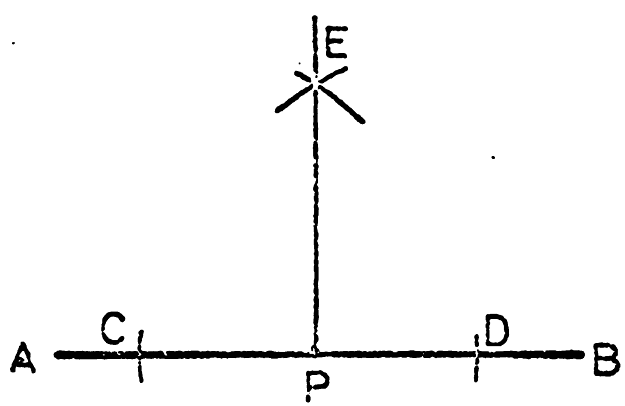
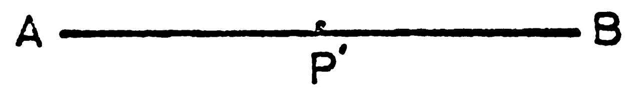
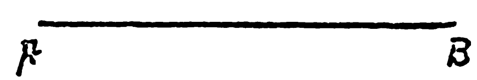


fig. 5b

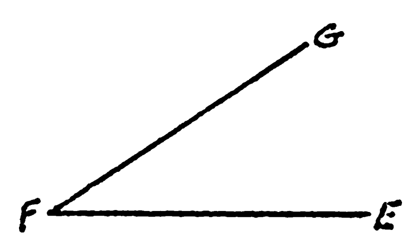




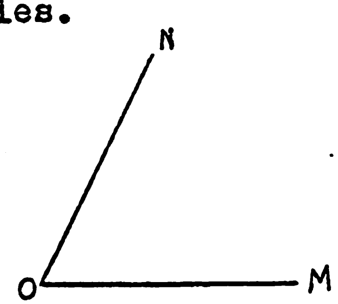
1. Divide a given line segment A B into four equal parts.



2. Bisect a given angle E F G.



3. Divide a given angle M O N into four equal angles.



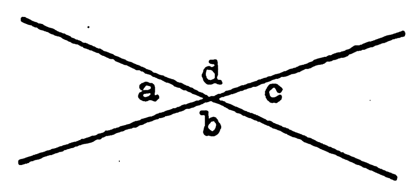
4. Divide a circle into four equal parts.

5. Draw a triangle and construct the perpendicular bisectors of its sides.

6. Extra work (if you can). Draw a circle and divide it into six equal parts.

Review Questions - Lessons (1-5)

1. What determines the size of an angle?
2. How does a line segment differ from a line?
3. Under what circumstances can you draw a straight line through three points?
4. Two straight lines can intersect at how many points?
5. Are the two sides of a right triangle always perpendicular?
6. Name the angle that is equal to its supplement; that is larger than its supplement; that is smaller than its supplement.
7. If two angles have a common vertex and a common side between them they are called __________ ________.
8. If two angles added together equal a right angle they are said to be what kind of angles? If two angles added together equal a straight angle they are said to be what kind of angles?
9. Name the tools necessary to make geometric constructions.
10. What do you call the meeting place of the two rays of an angle?
11. What is the meaning of the word bisect? (geometric terms)
12. Are all radii of the same circle equal? Why?
13. Give the number of dimensions of a point? a line? a plane, a solid?
14. What is the name of an angle equal to 90°?
15. Are perpendiculars always vertical lines?
16. If $\angle x=36^\circ$ and $\angle y=54^\circ$, then $\angle x$ and $\angle y$ are ______________ __________.
17. If $\angle a=98^\circ$ and $\angle b=82^\circ$, then $\angle a$ and $\angle b$ are ______________ __________.
18. $\angle a$ and $\angle c$ are ______________ angles.
19. $\angle d$ and $\angle c$ are ______________ angles.
20. $\angle d$ and $\angle c$ are also ______________ angles.



Lesson 6

fig. 1

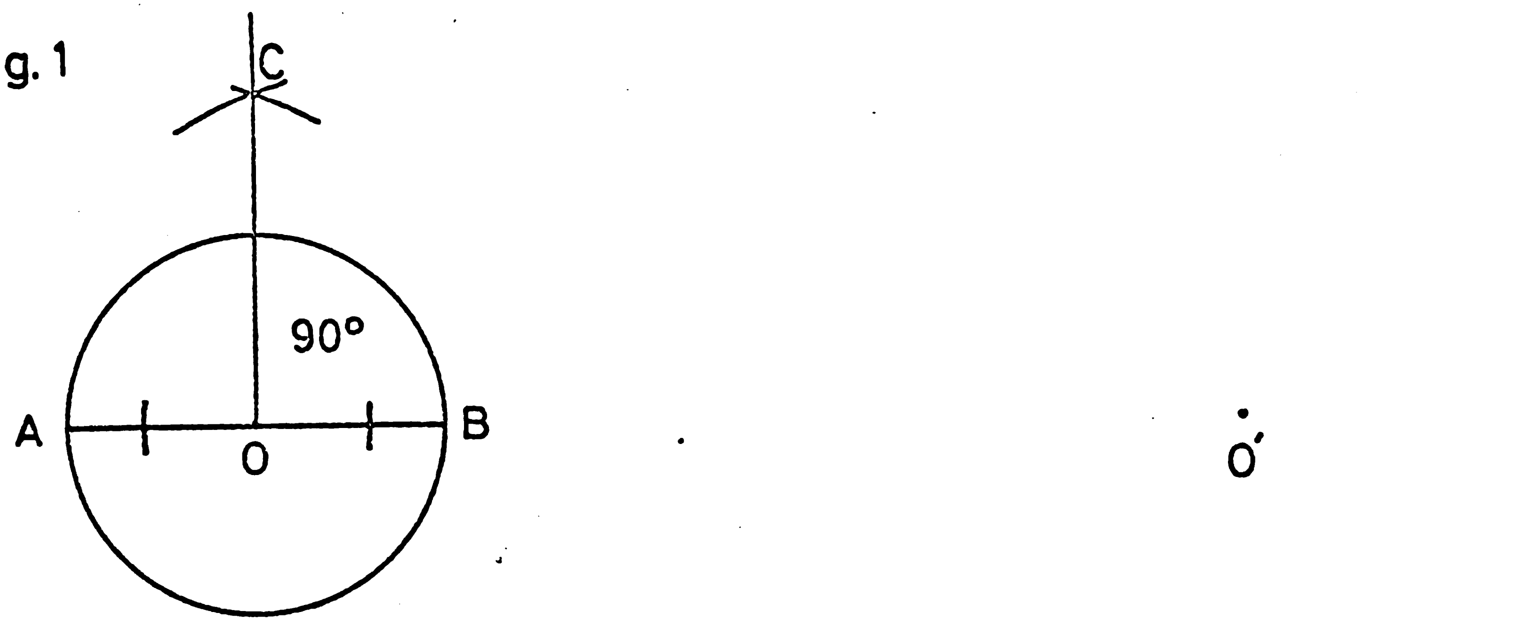
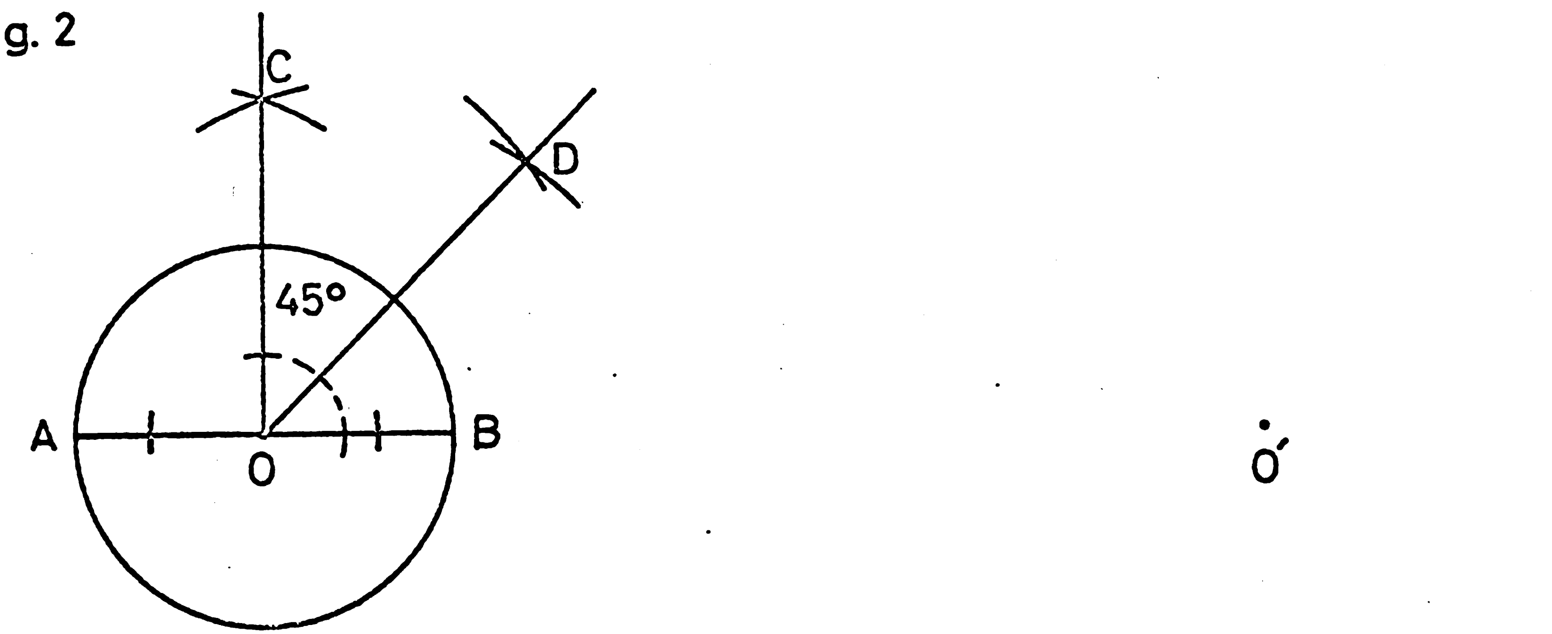


fig. 2



Lesson 6

fig. 3

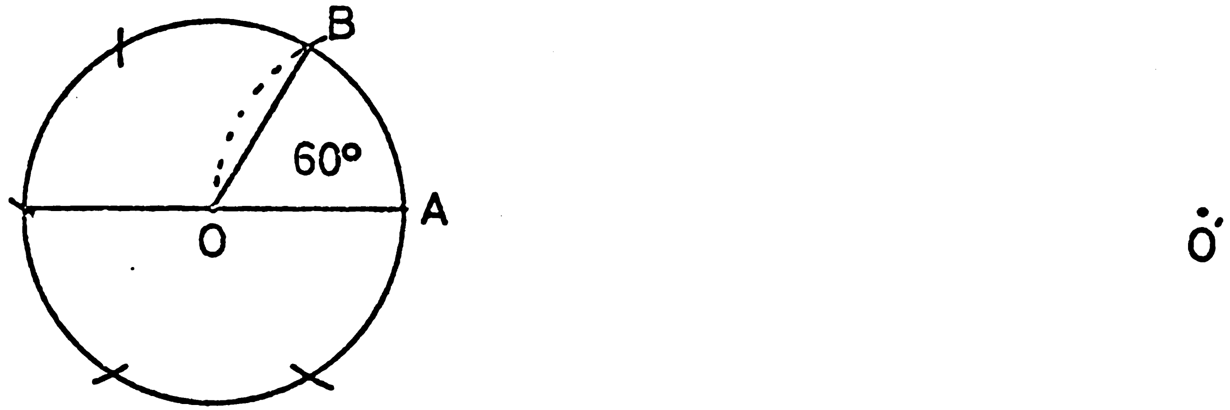
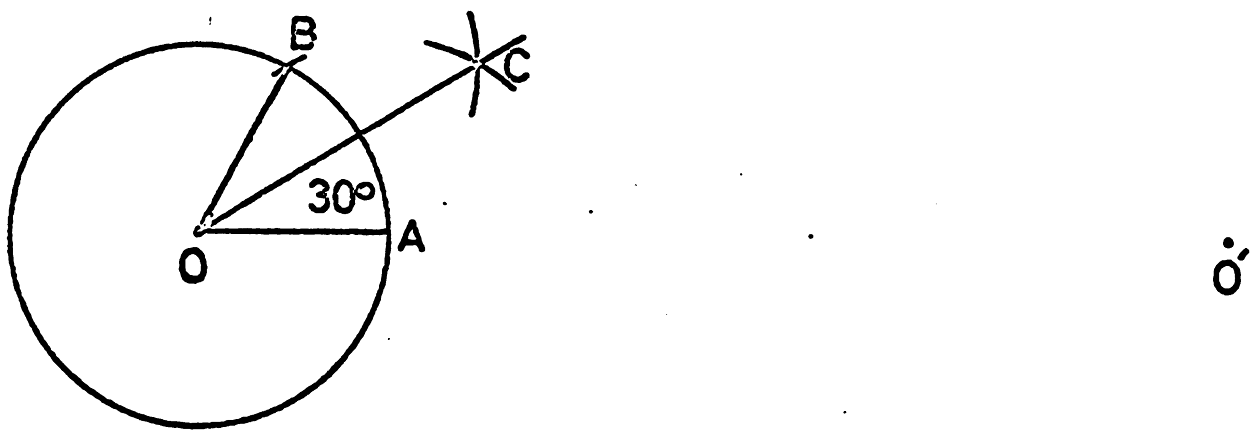


fig. 4



1. Divide a line segment into four equal parts.

2. Construct a right angle.

3. Construct a 15° angle.

4. Construct a 135° angle.

5. Divide a circle into eight equal parts.

6. Divide a circle into twelve equal parts.

7. Construct a $67\frac{1}{2}^{\circ}$ angle.

8. Divide a circle into three equal parts.

9. How many degrees are there in each part of the circle in question 5?

   How many degrees are there in each part of the circle in question 6?

   How many degrees are there in each part of the circle in question 8?

Extra Work (if you can)

A. Construct a triangle with three equal sides.

B. Construct a triangle with sides equal to $1\frac{1}{2}$", 1", 2".

C. Construct a regular hexagon.

Lesson 7

fig. 1

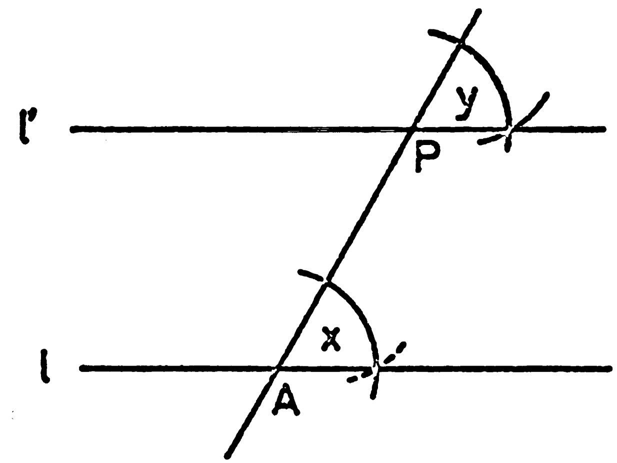
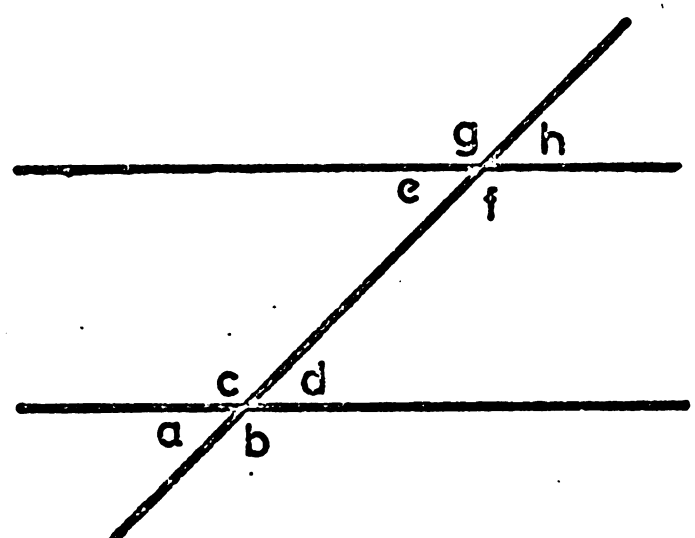


fig. 2
(QUIZ)



Supplementary Material - Lesson 7

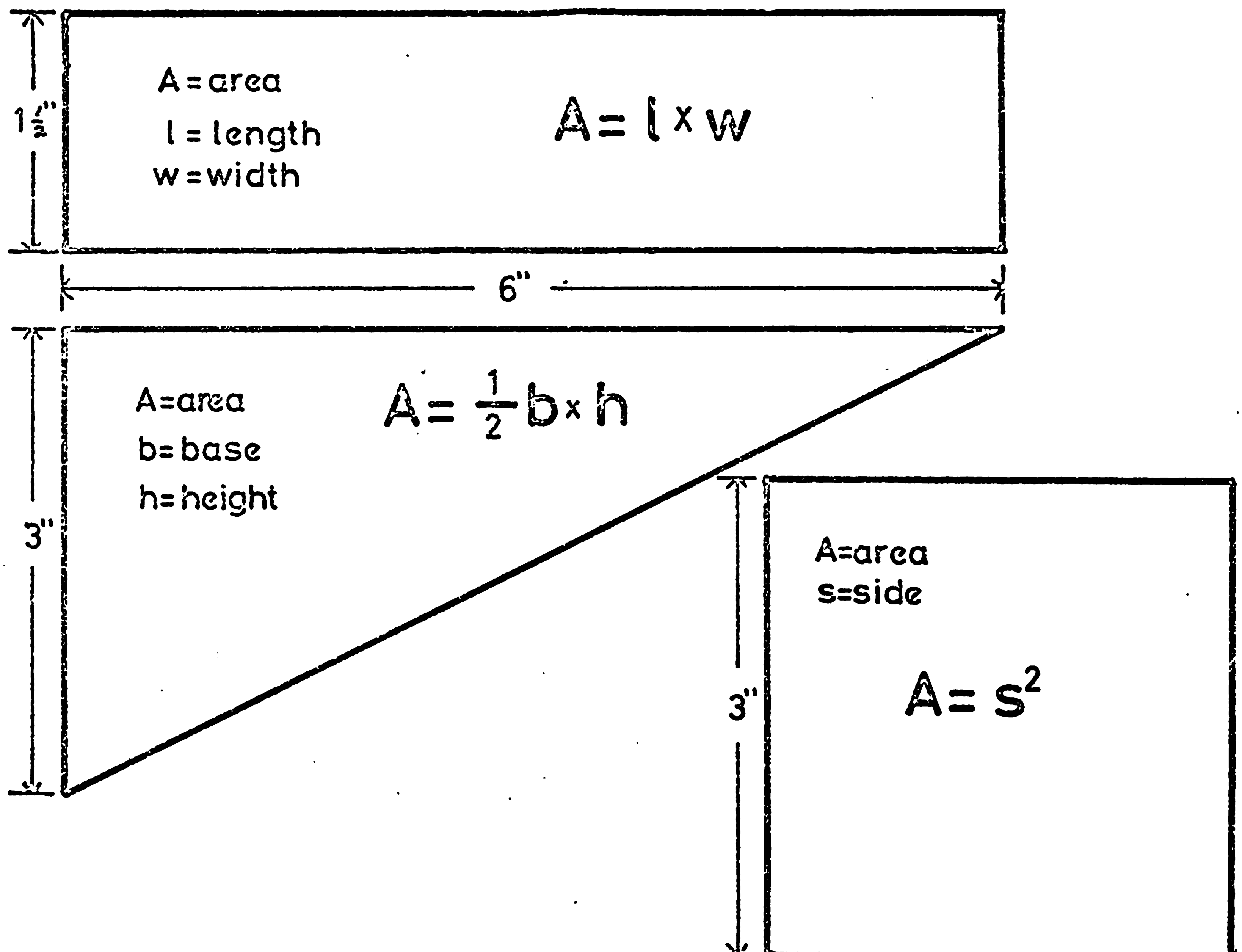
1. In figure 2 list pairs of angles under the following headings.

Vertical Angles	Supplementary Angles	Alternate-Interior Angles
______&______	______&______	______&______
______&______	______&______	______&______
______&______	______&______	**Alternate-Exterior Angles**
______&______	______&______	______&______
	______&______	______&______
	______&______	**Interior-Exterior Angles (Corresponding Angles)**
	______&______	______&______
	______&______	______&______
		______&______
		______&______

2. Construct two lines parallel to a given line - each one inch apart.

Lesson 8

fig. 1



Lesson 8

fig. 2

s= ____________ s′ ____________

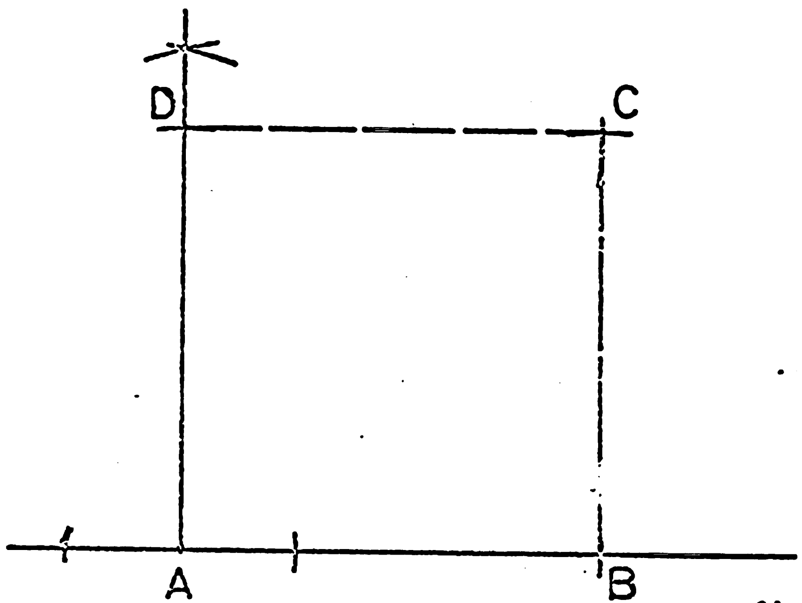
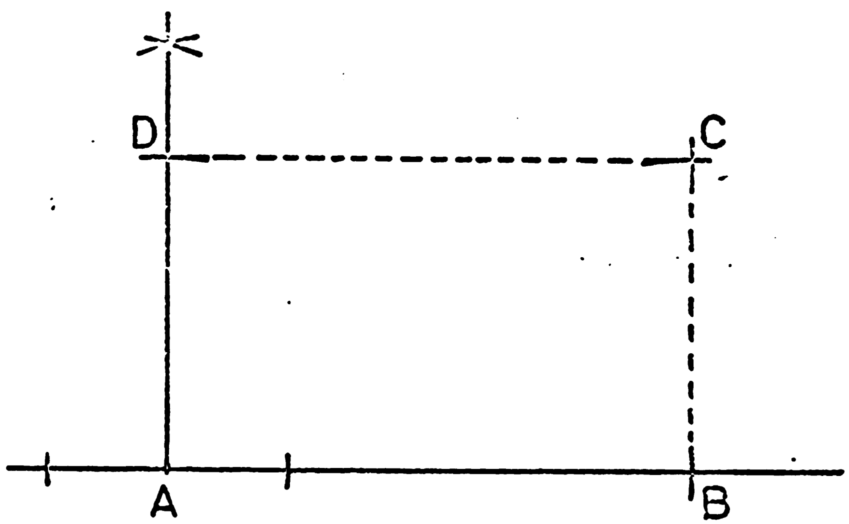


fig. 3

l= ____________ l′ ____________

w= ____________ w′ ____________



Lesson 8

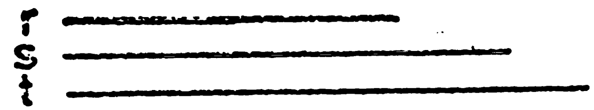
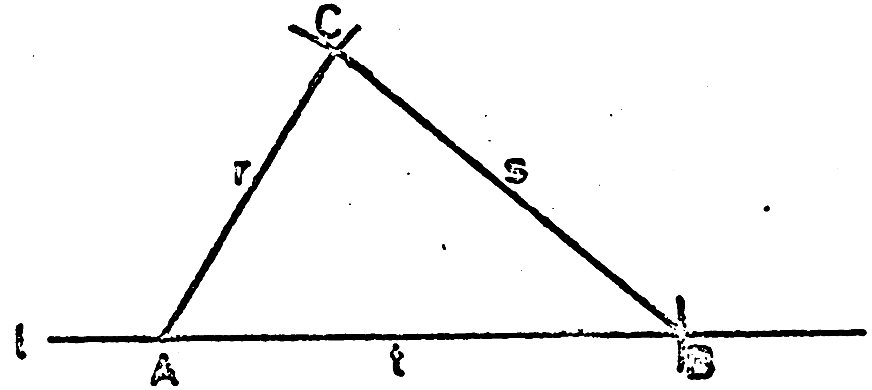
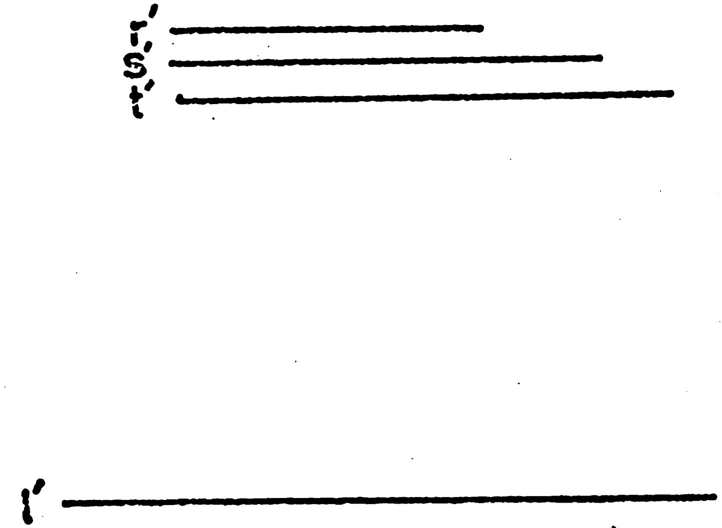


fig. 4

(S.S.S.)





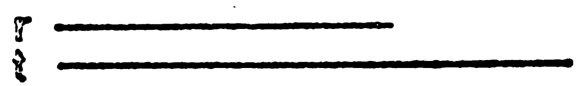
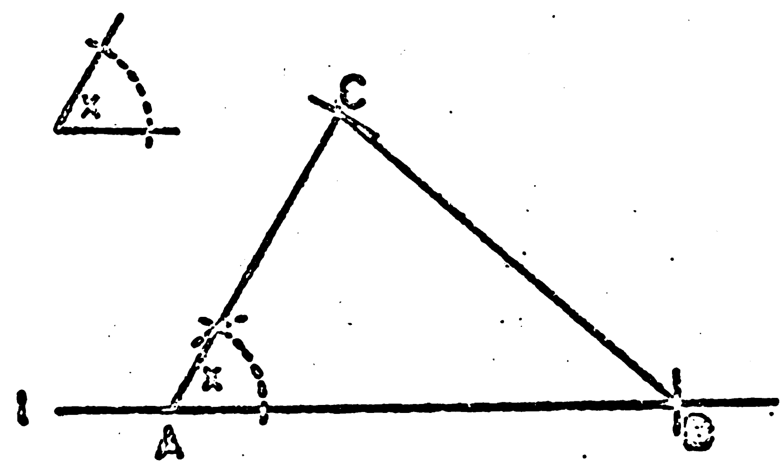
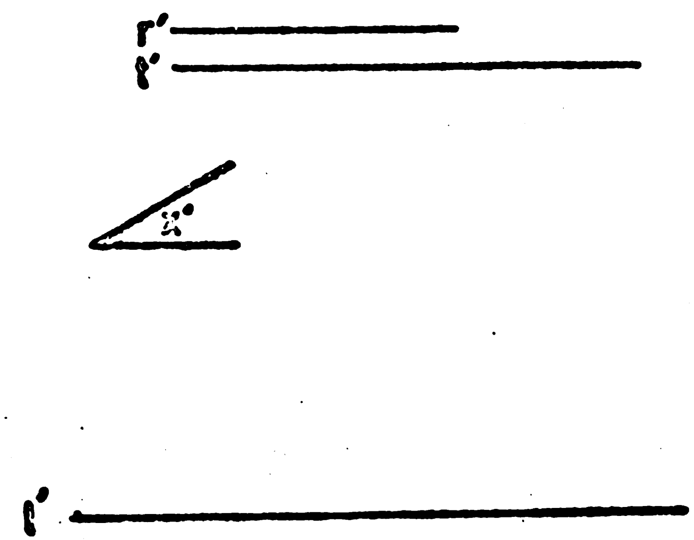


fig. 5

(S.A.S.)





Lesson 8

fig. 6

(A.S.A.)

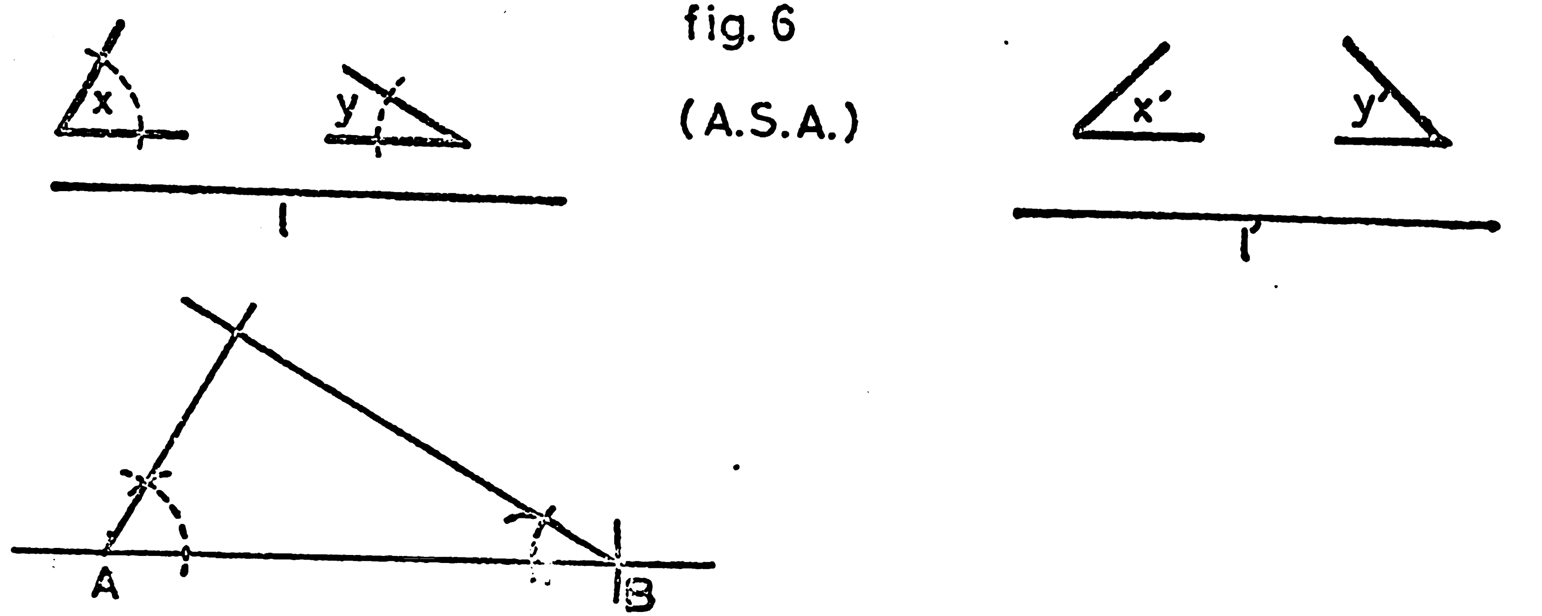
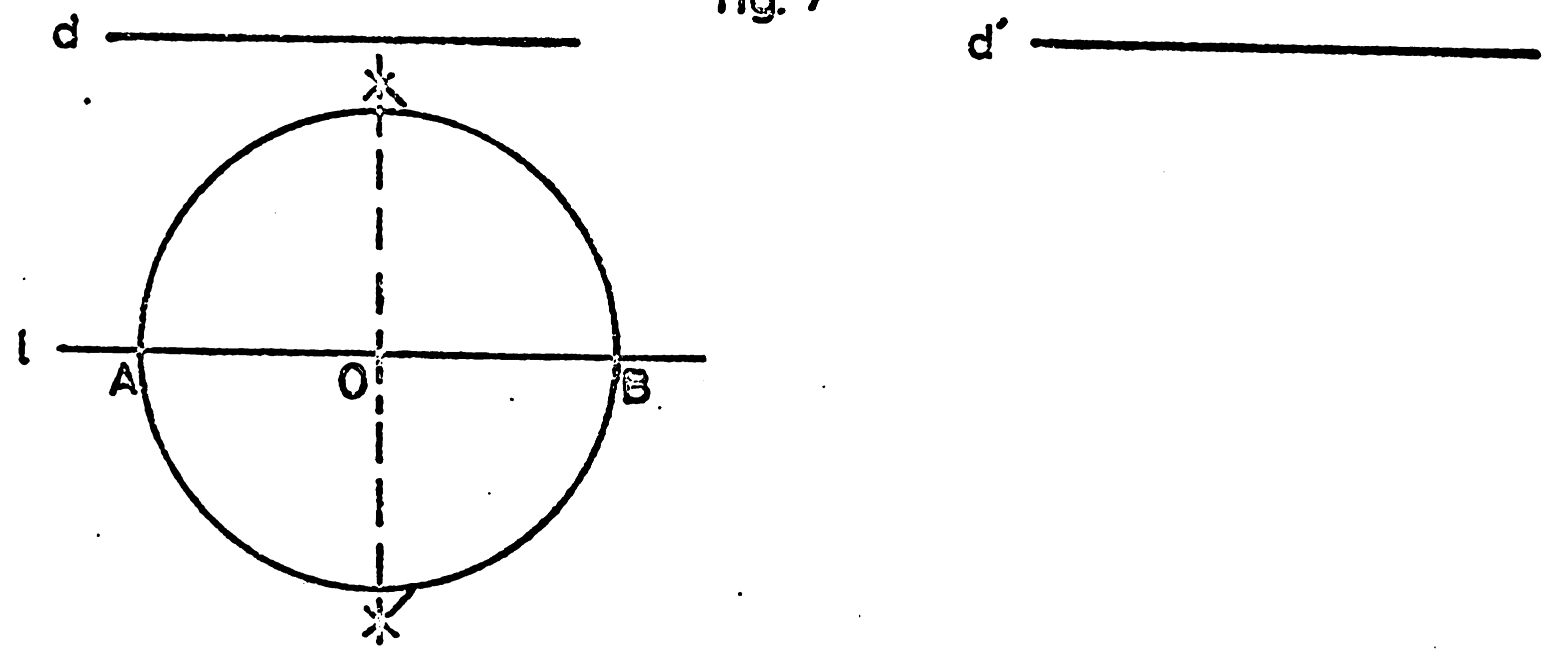


fig. 7



1. Can you find the area of a square using the formula A = l x w ?

2. If you double the length of the side of a square (s x 2) what does this do to the area of the square?

3. If you double the width (only) of a rectangle, will this double the area?

4. How many dimensions must be given to construct a square equal to a given square?

5. What dimensions must you have to construct a right triangle to a given size?

6. What do we mean in Geometry when we say S.S.S. ?

7. What do we mean in Geometry when we say S.A.S. ?

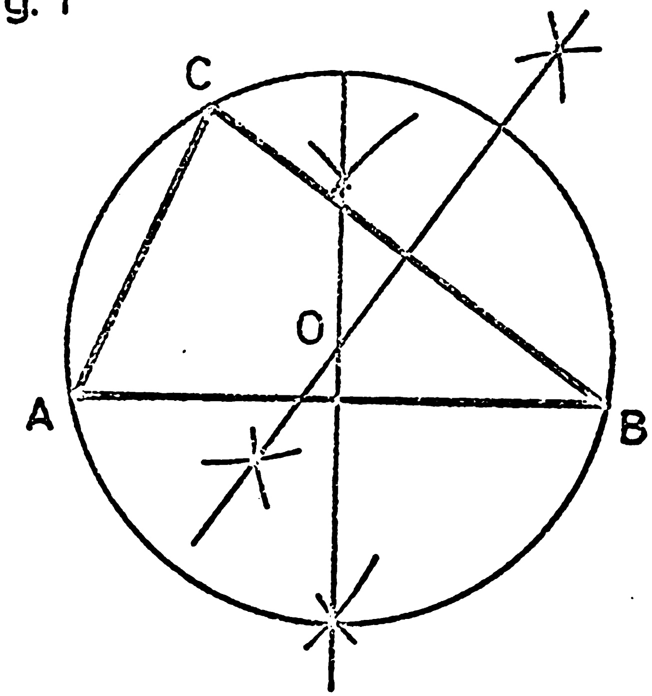
8. What do we mean in Geometry when we say A.S.A. ?

9. What determines the size of a circle?

10. Construct a triangle with sides of $1\frac{1}{2}$", 2", and $2\frac{1}{2}$". What kind of a triangle is this?

Lesson 9

fig. 1



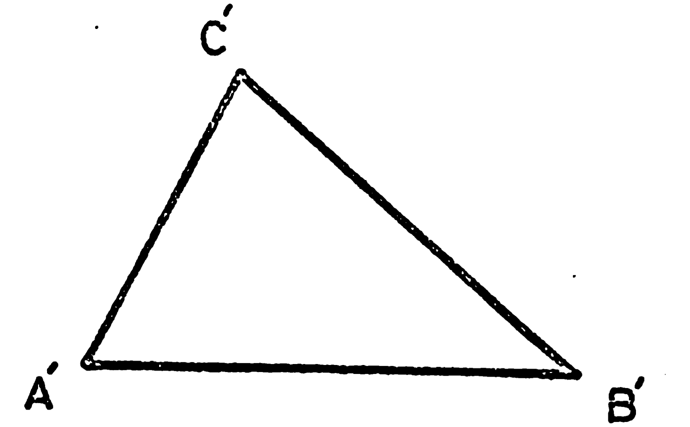
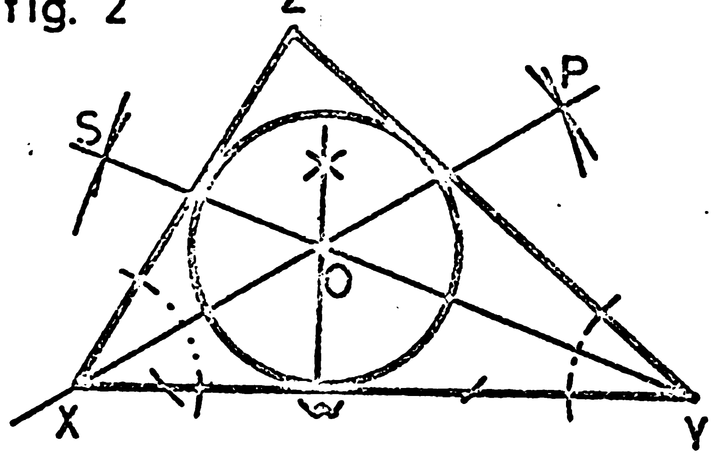
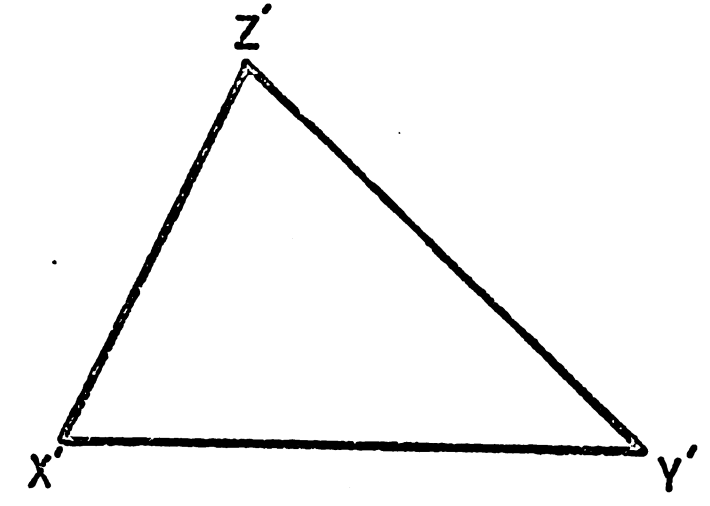


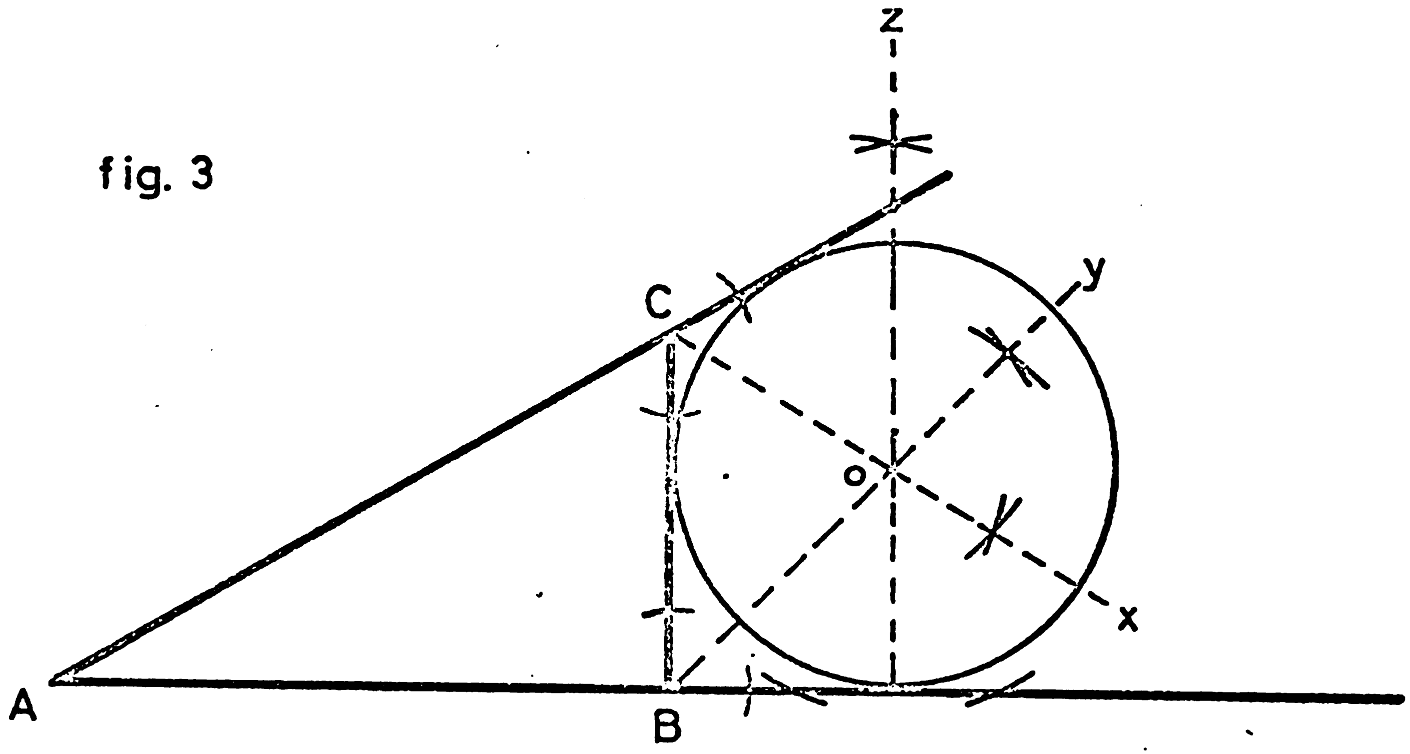
fig. 2

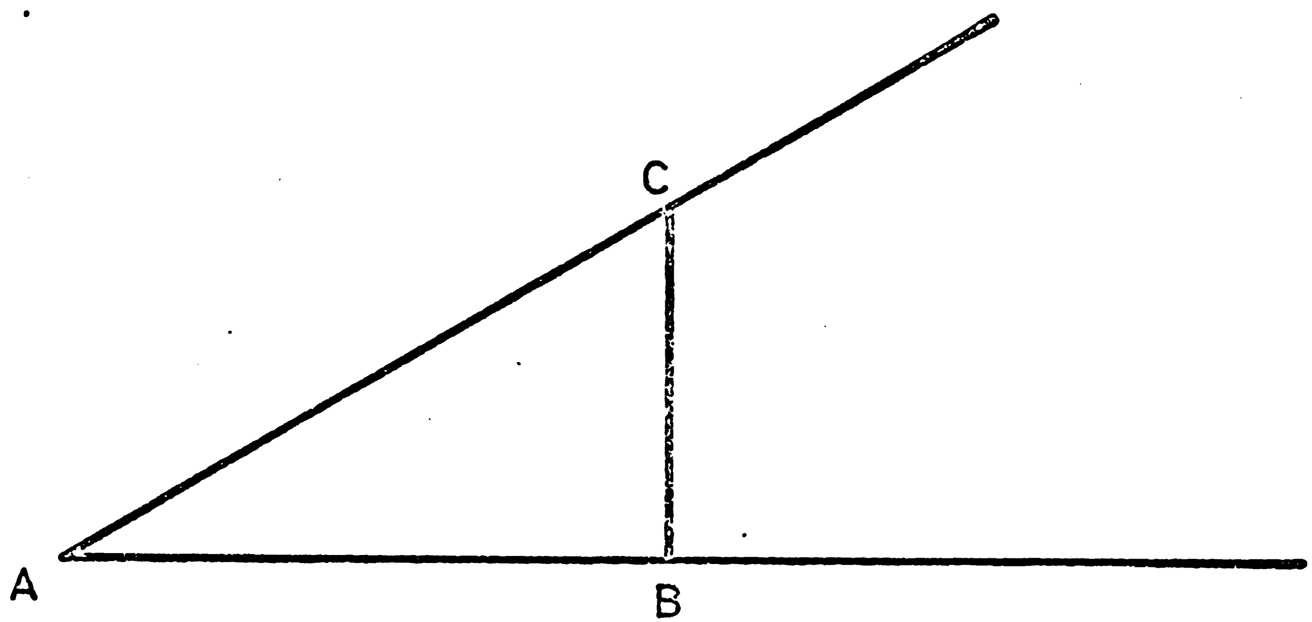




Lesson 9

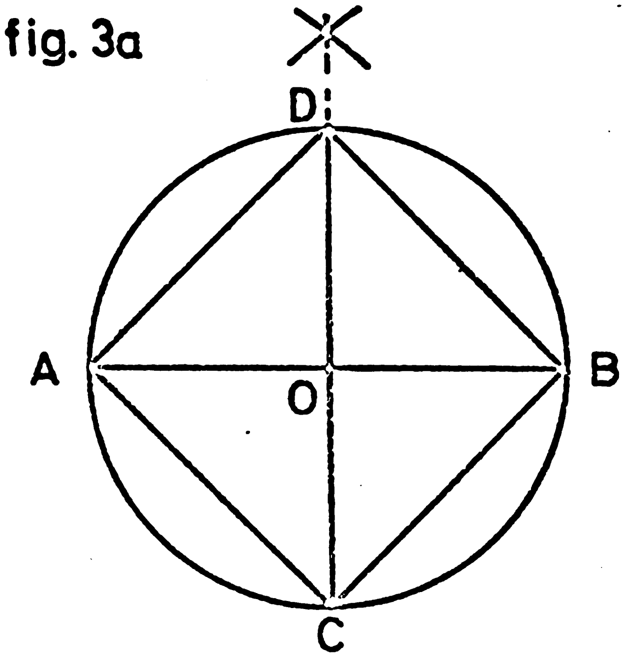
fig. 3





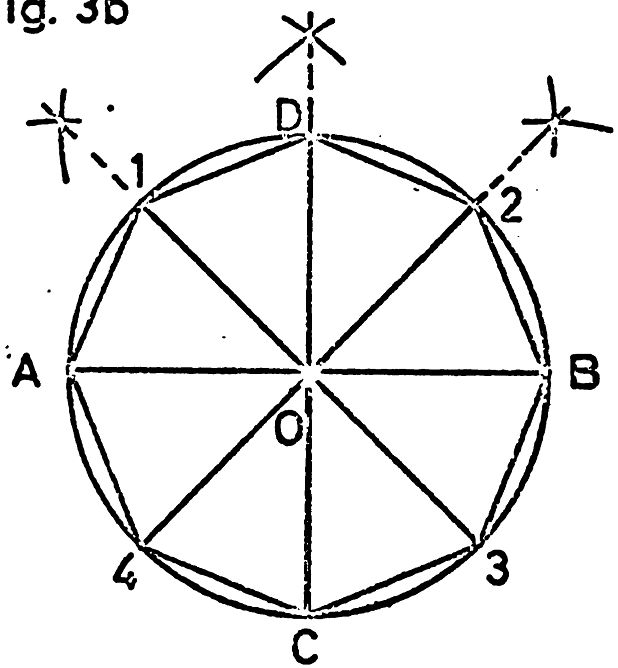
Lesson 9

fig. 3a



O

fig. 3b



O

Lesson 9

fig. 4a

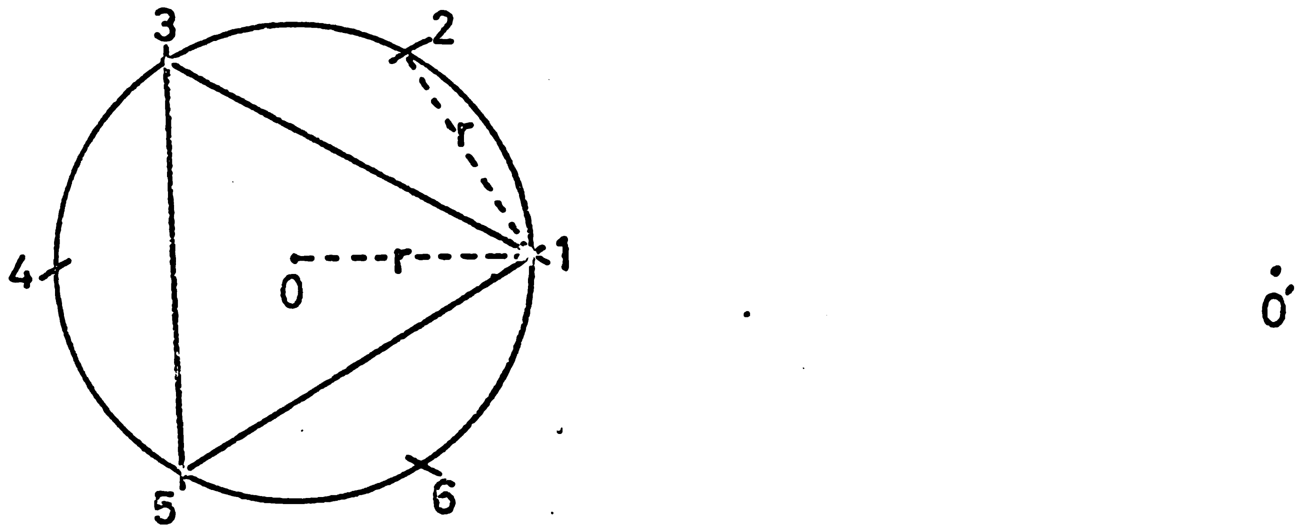
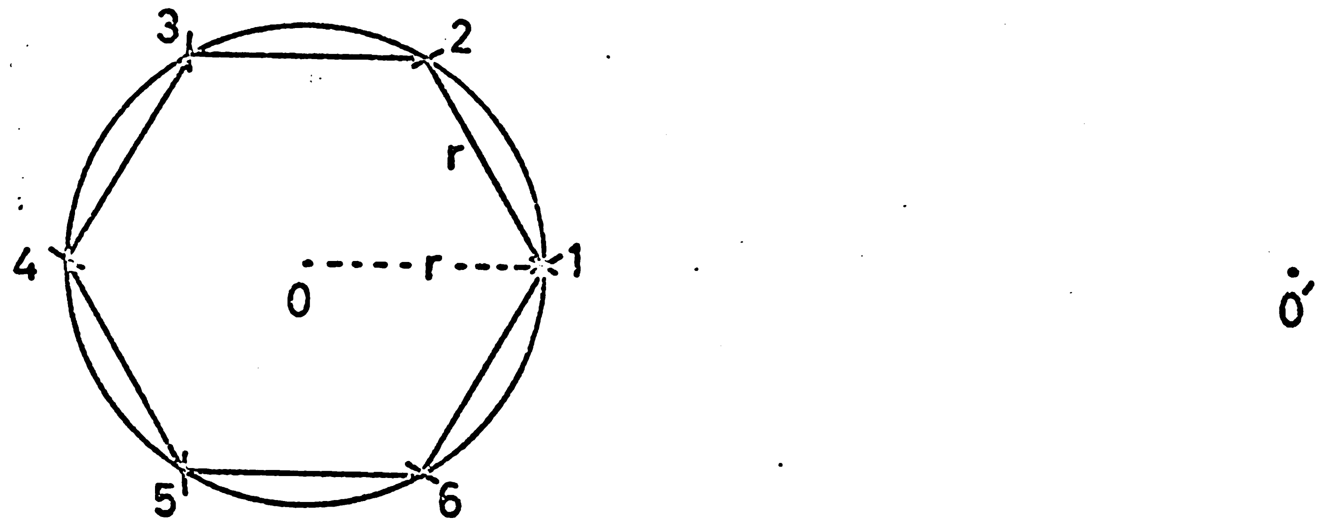


fig. 4b



Lesson 9

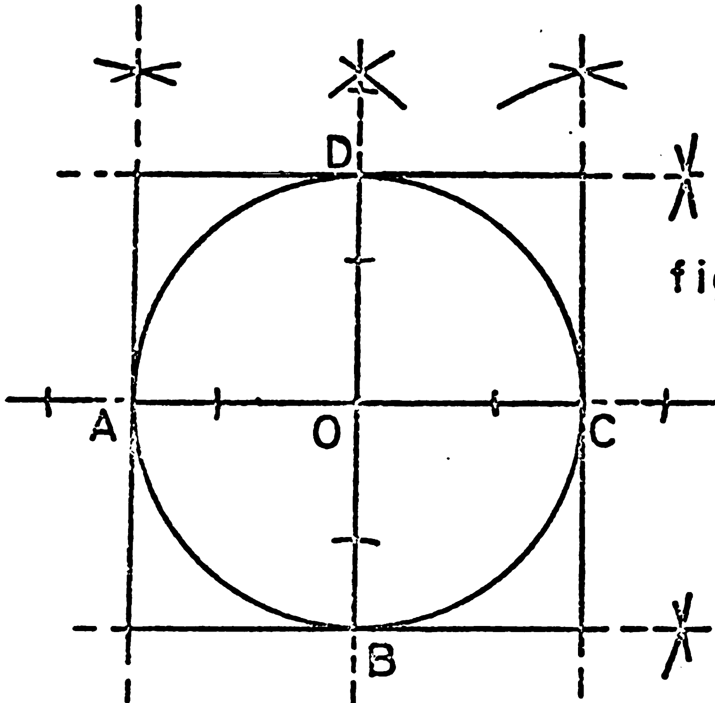


fig. 5a

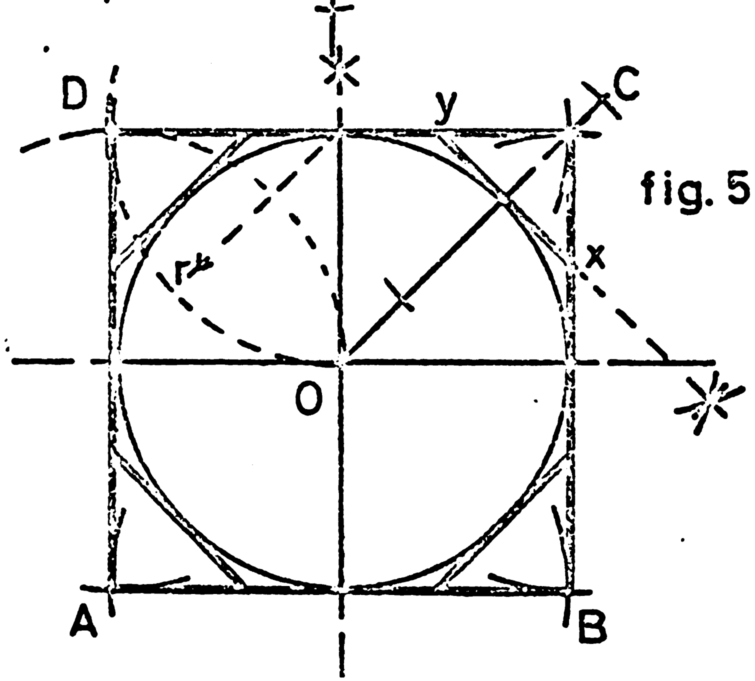
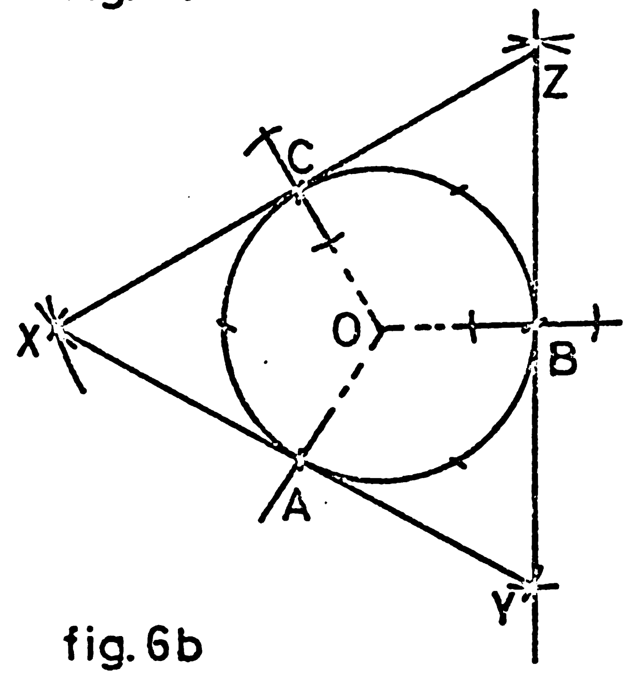


fig. 5b

Lesson 9

fig. 6a



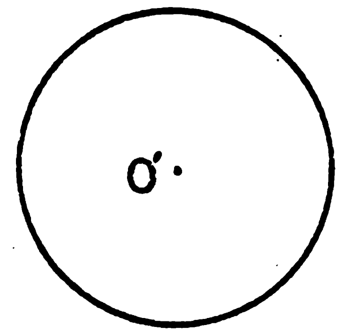
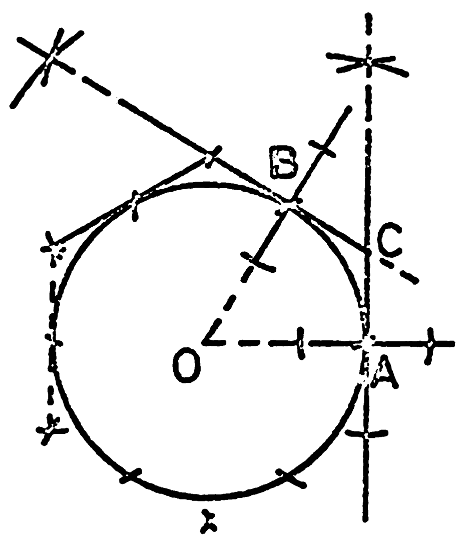
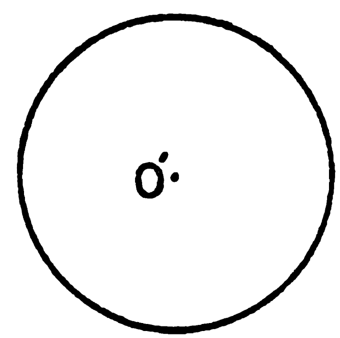


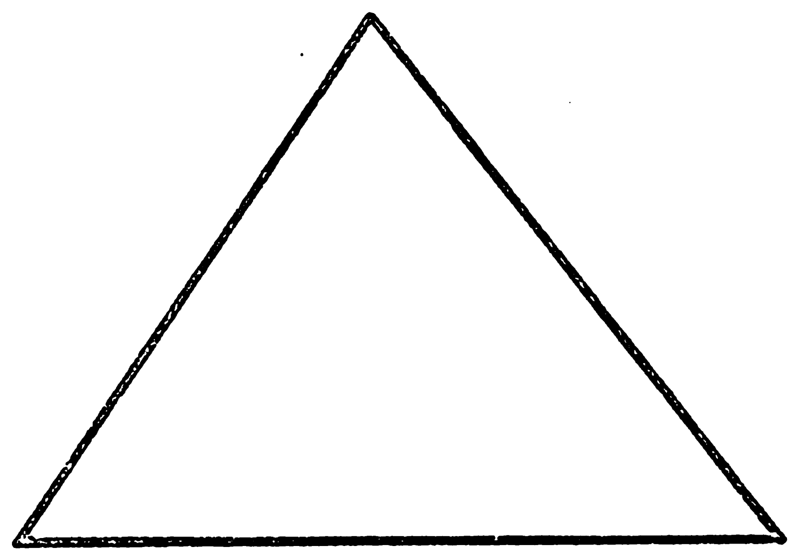
fig. 6b





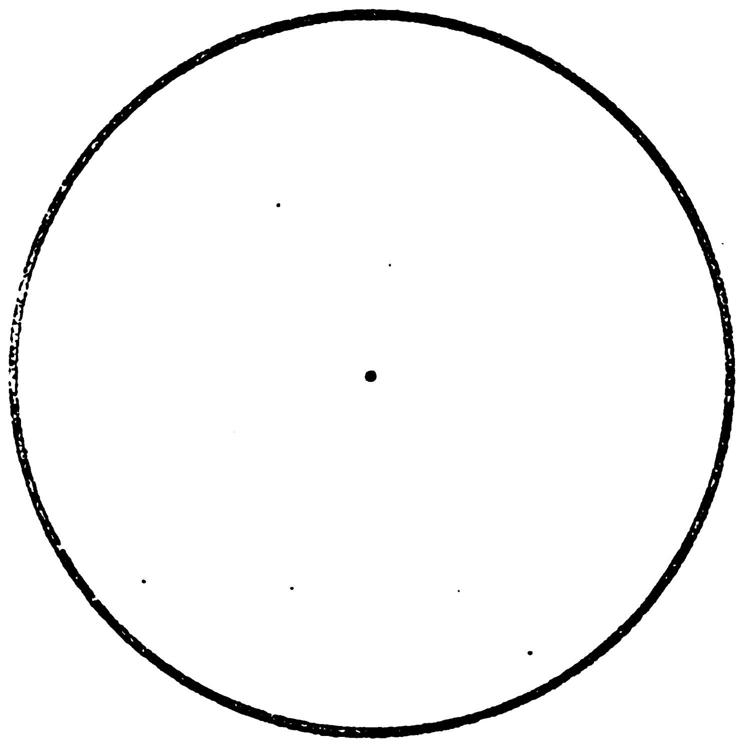
Supplementary Material - Lesson 9

1. Inscribe a circle
&
2. Circumscribe a circle

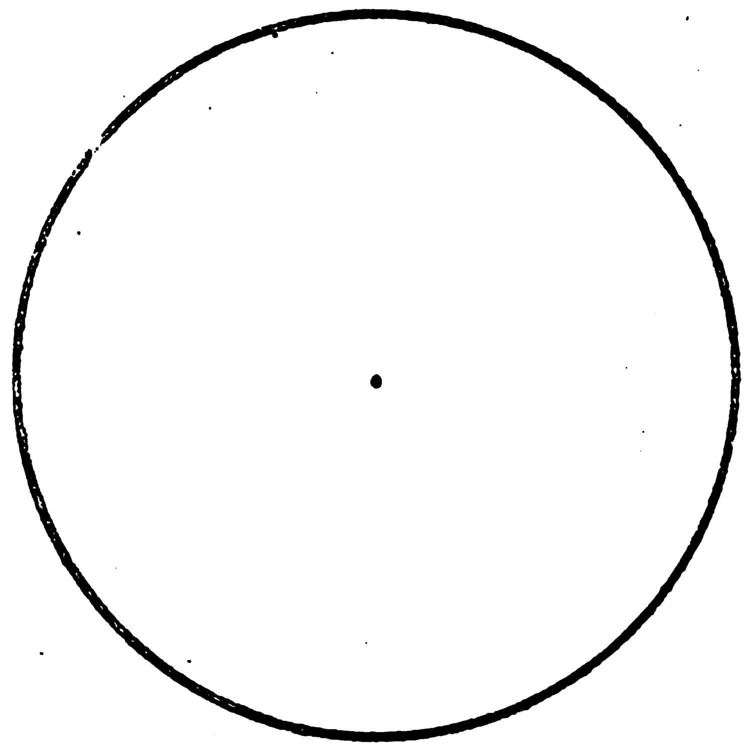


Supplementary Material - Lesson 9 (con't) Page 33

1. Inscribe an octagon
&
2. Circumscribe a square

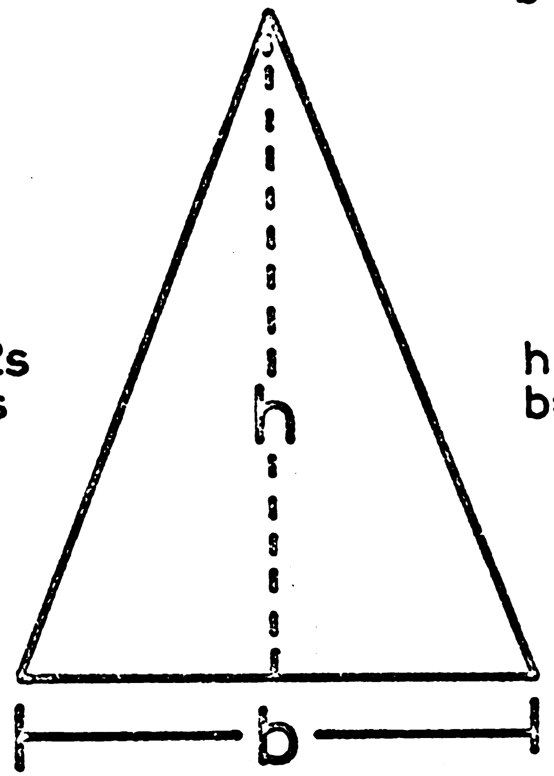


1. Inscribe a triangle
&
2. Circumscribe a hexagon

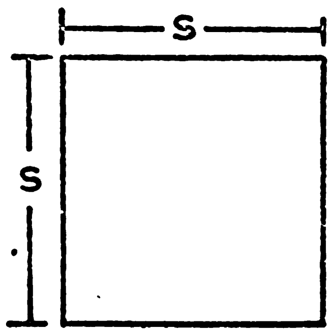


Lesson 10

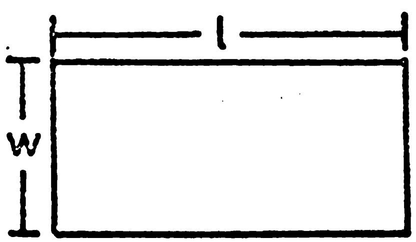
fig. 1



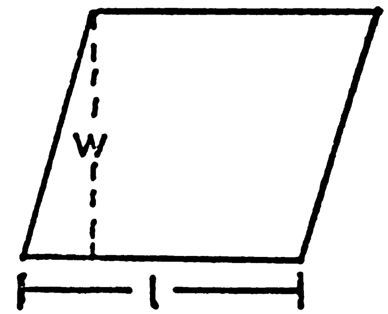
$A = \frac{1}{2} b \cdot h$



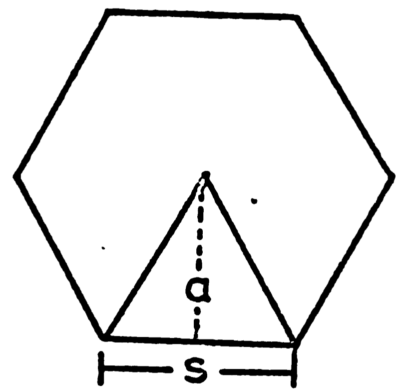
h=2s
b=s



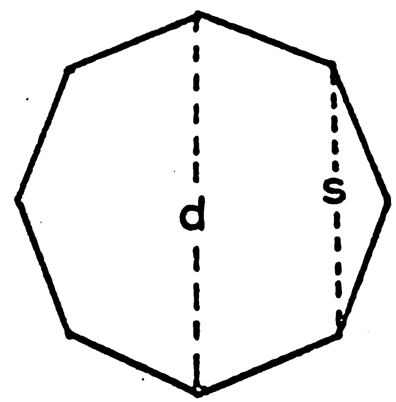
h=2w
b=l



h=2w
b=l

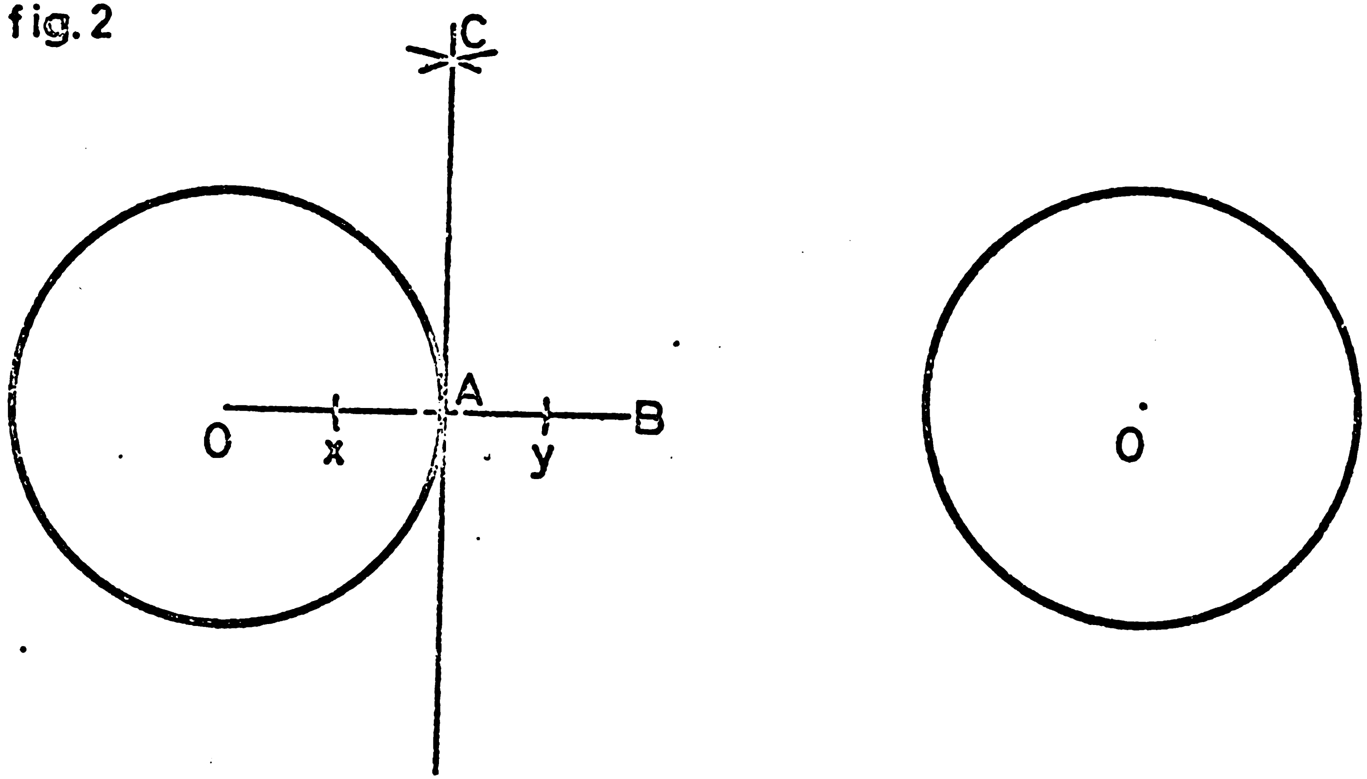


h=3a
b=2s



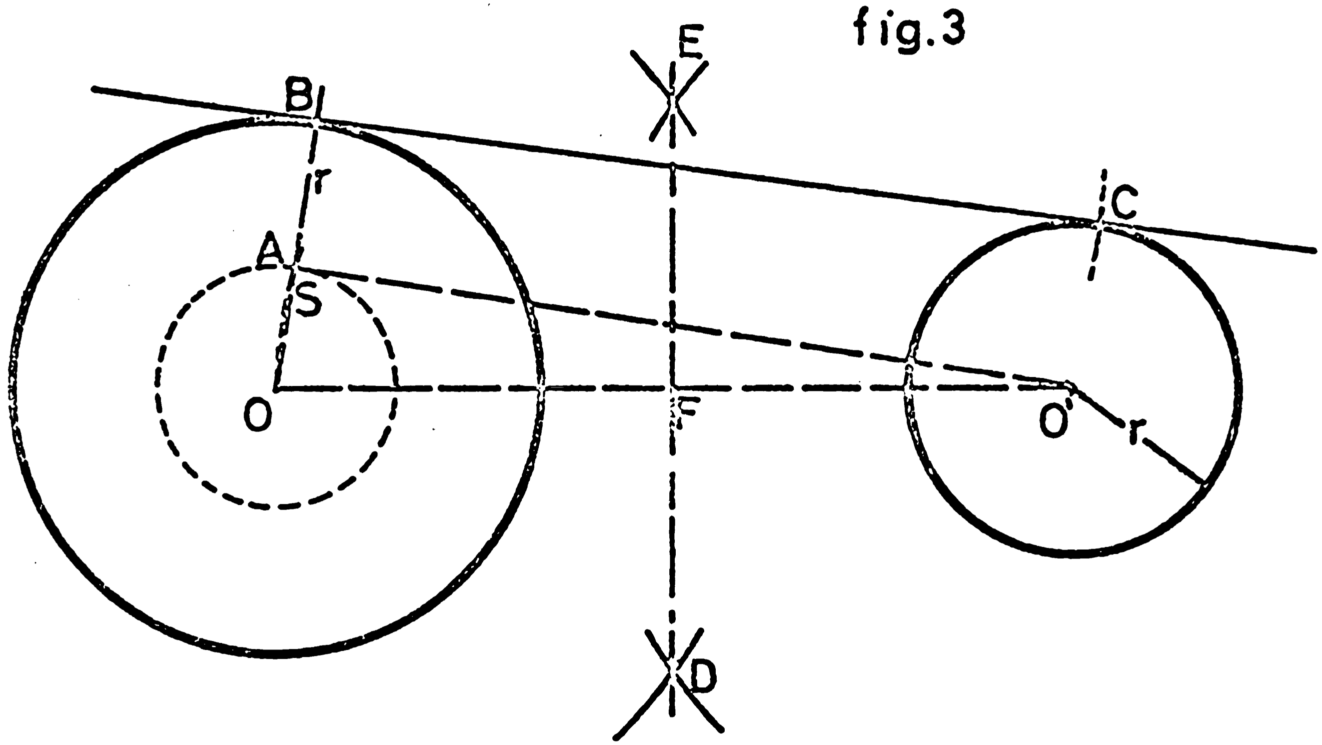
h=d
b=2s

fig. 2



Lesson 10

fig.3



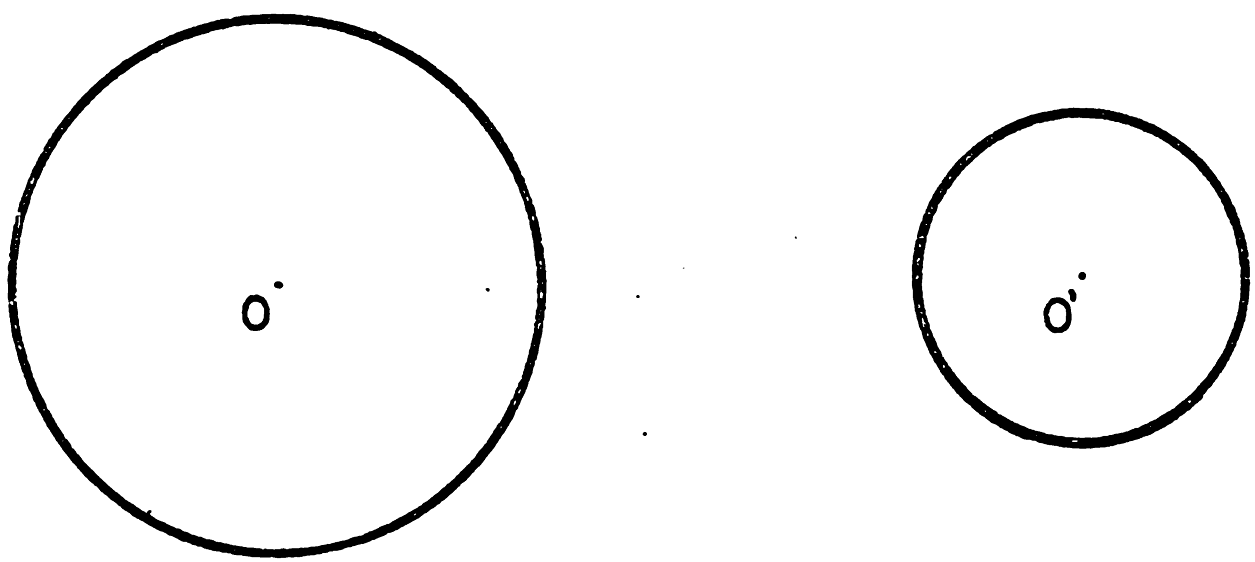
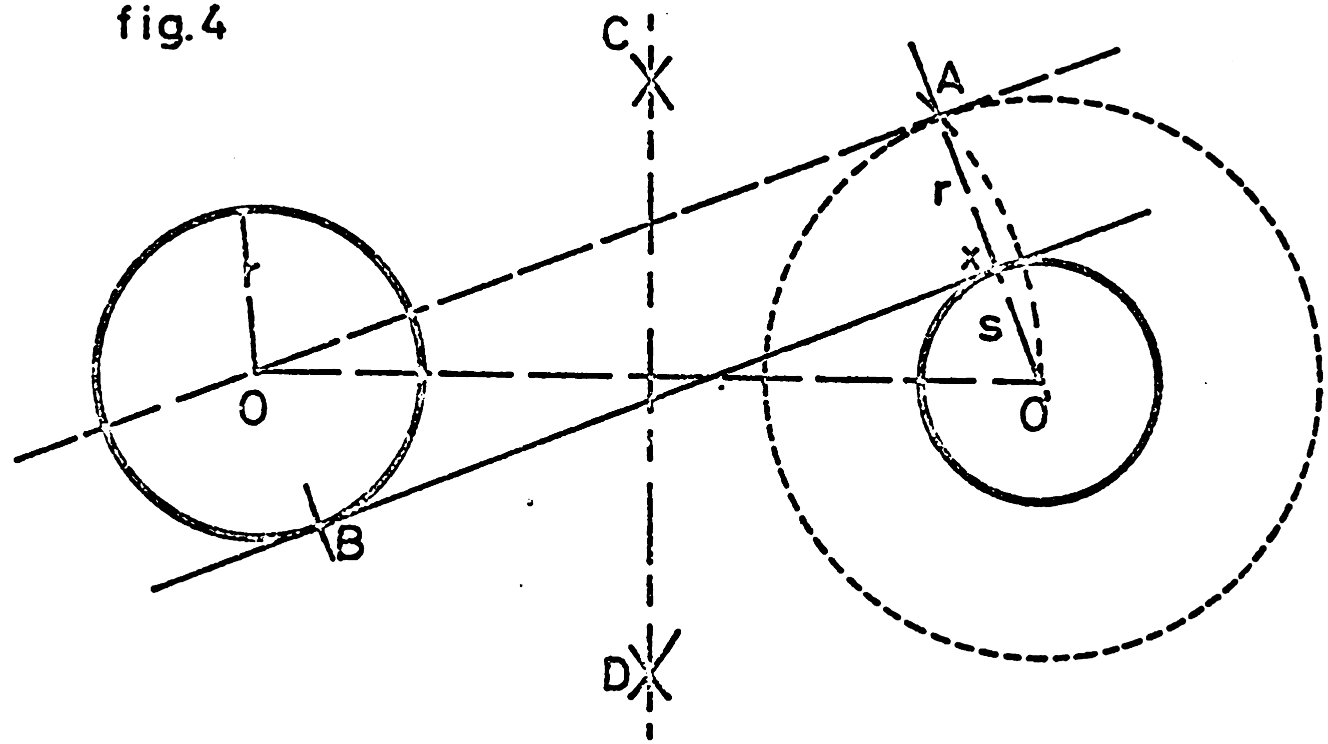


fig.4

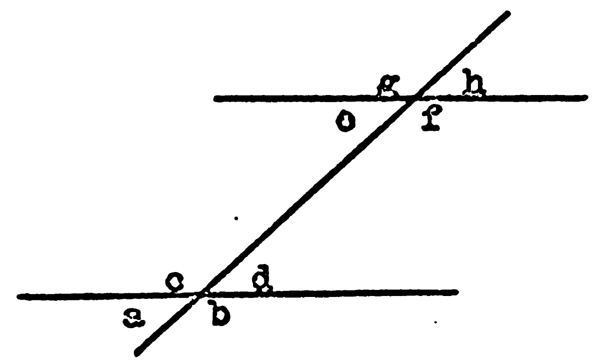


VOCABULARY

Geometry (Plane)	- A system of mathematics which deals with properties of two dimensional figures and is concerned with points, lines and planes. In plane geometry, two dimensions (numbers) are required to determine (locate) a point, as compared to 'line' geometry which requires one (a graduated ruler is an example) or solid geometry which requires three dimensions to locate a point.
Point	- A geometric point has no length, width or thickness. A point is a geometric element of zero dimension and has only position.
Line	- A one dimensional geometric figure.
Angle	- Two rays each extended from the same point.
Ray	- The side of an angle extending from the vertex.
Vertex	- The point where the two rays of an angle meet.
Right angle	- An angle having 90°.
Degree ($^\circ$)	- A measurement defined as $1/360^{th}$ of a circle.
Acute angle	- An angle having less than 90° but more than 0°.
Obtuse angle	- An angle having more than 90° but less than 180°.
Straight angle	- An angle having exactly 180°.
Reflex angle	- An angle having more than 180° but less than 360°.

Adjacent angles	- Two angles having a common vertex and a common side <u>between</u> them.
Complementary angles	- Two angles are said to be complementary when their sum is a right angle. (90°)
Supplementary angles	- Two angles are said to be supplementary when their sum is a straight angle. (180°)
Vertical Angles	- Two non-adjacent angles which are formed by two intersecting straight lines.
Congruent Figures	- Any two geometric figures are said to be congruent if they can be made to coincide (fit exactly on each other and conversely).
Bisectors	- A line segment is bisected when it is separated into two equal parts. The bisector of an angle is a line which meets the vertex and separates the angle into two equal parts.
Circle	- A circle is a plane closed curve, all points which are equal distance from a point called the centre.
Radius	- A line joining the centre of the circle with any point on the circumference of the circle.
Circumference	- A closed curved line on which all points are equidistant from the centre.
Diameter	- A diameter is a line drawn from one side of a circle to the other side, through the centre.

(Refer to figure)



Alternate-Interior /angles - angles c and f, d and e.

Alternate-Exterior /angles - angles a and h, b and g.

Corresponding Angles (Interior-Exterior) - angles a and e, c and g, b and f, d and h.

Converse - Reversed in order. Example, If A = B, then conversely B = A.

SYMBOLS

Page 41

$\angle$ angle	$\parallel$ (is) parallel to; parallel
$\frown$ arc	$\perp$ (is) perpendicular to
$\odot$ circle	$\overset{\circ}{=}$ is equal in degrees to
$=$ (is) equal to; equals; equal	$\sim$ (is)similar to; similar
$\neq$ is not equal to	$\square$ parallelogram
$>$ is greater than	$\therefore$ therefore
$<$ is less than	$\triangle$ triangle
$\cong$ (is) congruent to; congruent	The plural of any symbol representing a noun is formed by adding the letter s. Thus $\odot s$ means circles.

S.A.S.- If two triangles have two sides and the included angle of one equal respectively to two sides and the included angle of the other, the triangles are congruent.

A.S.A.- If two triangles have two angles and the included side of one equal respectively to two angles and the included side of the other, the triangles are congruent.

S.S.S.- If two triangles have the three sides of one equal respectively to the three sides of the other, the triangles are congruent.

ABBREVIATIONS

adj. - adjacent	ext. - external	rect. - rectangle
alt. - alternate	Fig. - figure	rt. - right
Ax. - axiom	int. - interior	st. - straight
comp. - complementary	isos. - isosceles	supp. - supplementary
corr. - corresponding	opp. - opposite	Prop. - proposition
Def. - definition	quad. - quadrilateral	Post. - postulate
Ex. - exercise		

Additional abbreviations (record as needed)

AXIOMS

1. If equals are added to equals, the sums are equal.

2. If equals are subtracted from equals, the remainders are equal.

3. If equals are multiplied by equals, the products are equal.

4. If equals are divided by equals, the quotients are equal. (0 may not be used)

5. A quantity may be substituted for its equal.

6. Quantities which are equal to the same quantity or to equal quantities are equal to each other.

7. Like powers or like roots of equals are equal.

8. The whole is equal to the sum of its parts and is greater than any one of them.

9. Of two quantities of the same kind, the first is greater than, equal to, or less than the second.

POSTULATES
(Geometric statements accepted as true without proof)

1. One straight line, and only one, can be drawn through two points.
2. Two straight lines cannot intersect in more than one point.
3. A straight line can be extended indefinitely in two directions.
4. A straight line is the shortest line that can be drawn between two points.
5. One circle, and only one, can be drawn with any given point as a center and any given line segment as a radius.
6. Any geometric figure can be moved without changing its size or shape.
7. A straight line segment has one midpoint, and only one.
8. An angle can be bisected by one line, and only one.
9. All right angles are equal, and all straight angles are equal.
10. At any point on a straight line one perpendicular, and only one,can be drawn to the line
11. The perpendicular is the shortest line segment that can be drawn from a given point to a given line.
12. The sum of all the angles about a point is two straight angles.
13. The sum of all the angles about a point on one side of a straight angle is a straight angle.

14. If two adjacent angles have their exterior sides in a straight line, they are supplementary.

15. If two adjacent angles are supplementary, their exterior sides lie in a straight line.

16. All radii of a circle or of equal circles are equal.

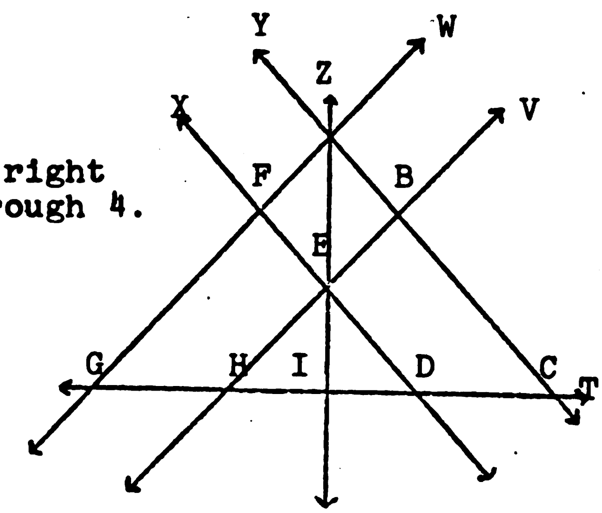
17. A straight line cannot intersect a circle in more than two points.

PRE-AND POSTTEST

APPENDIX D

Pre-and Posttest

Booklet Number___________

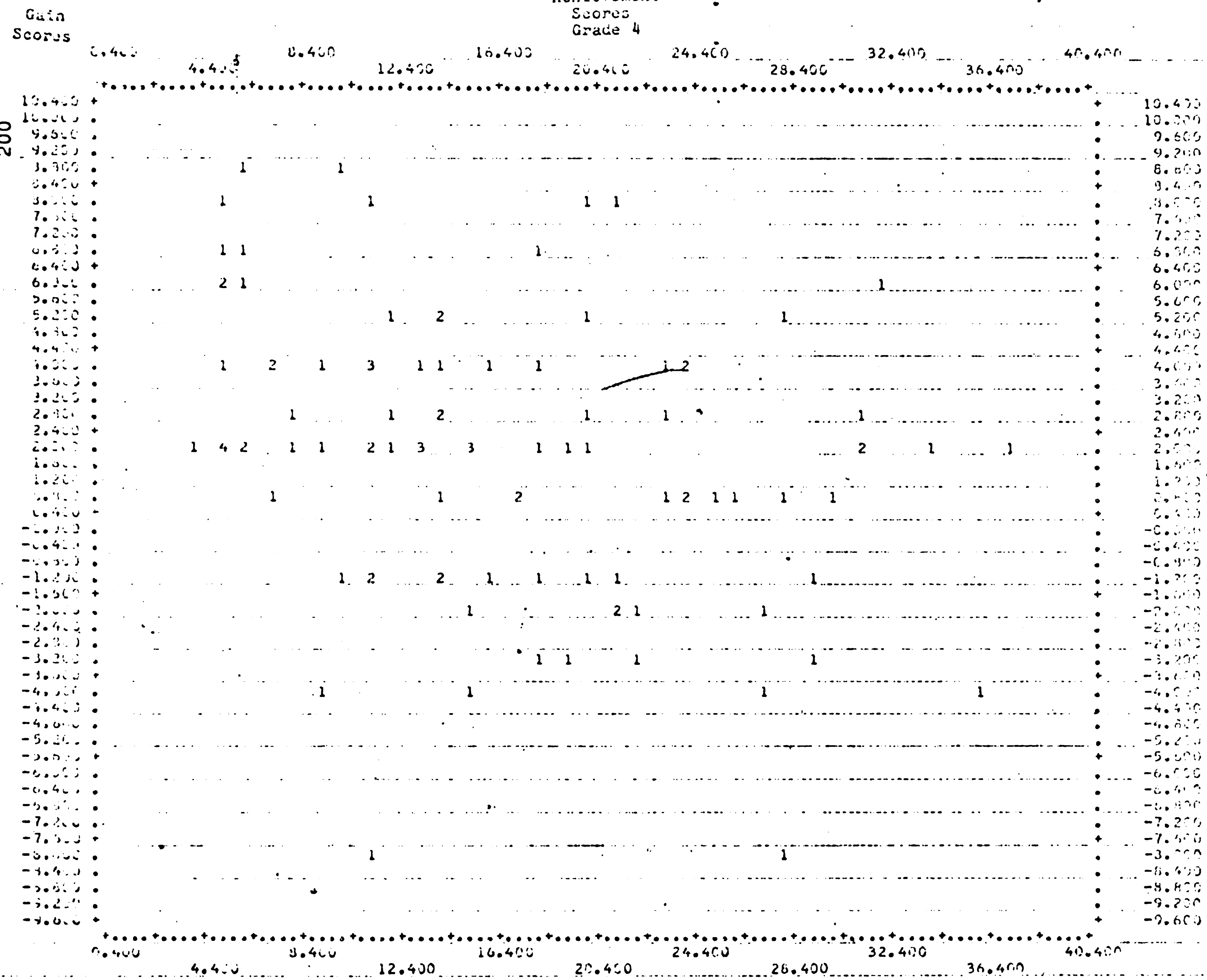


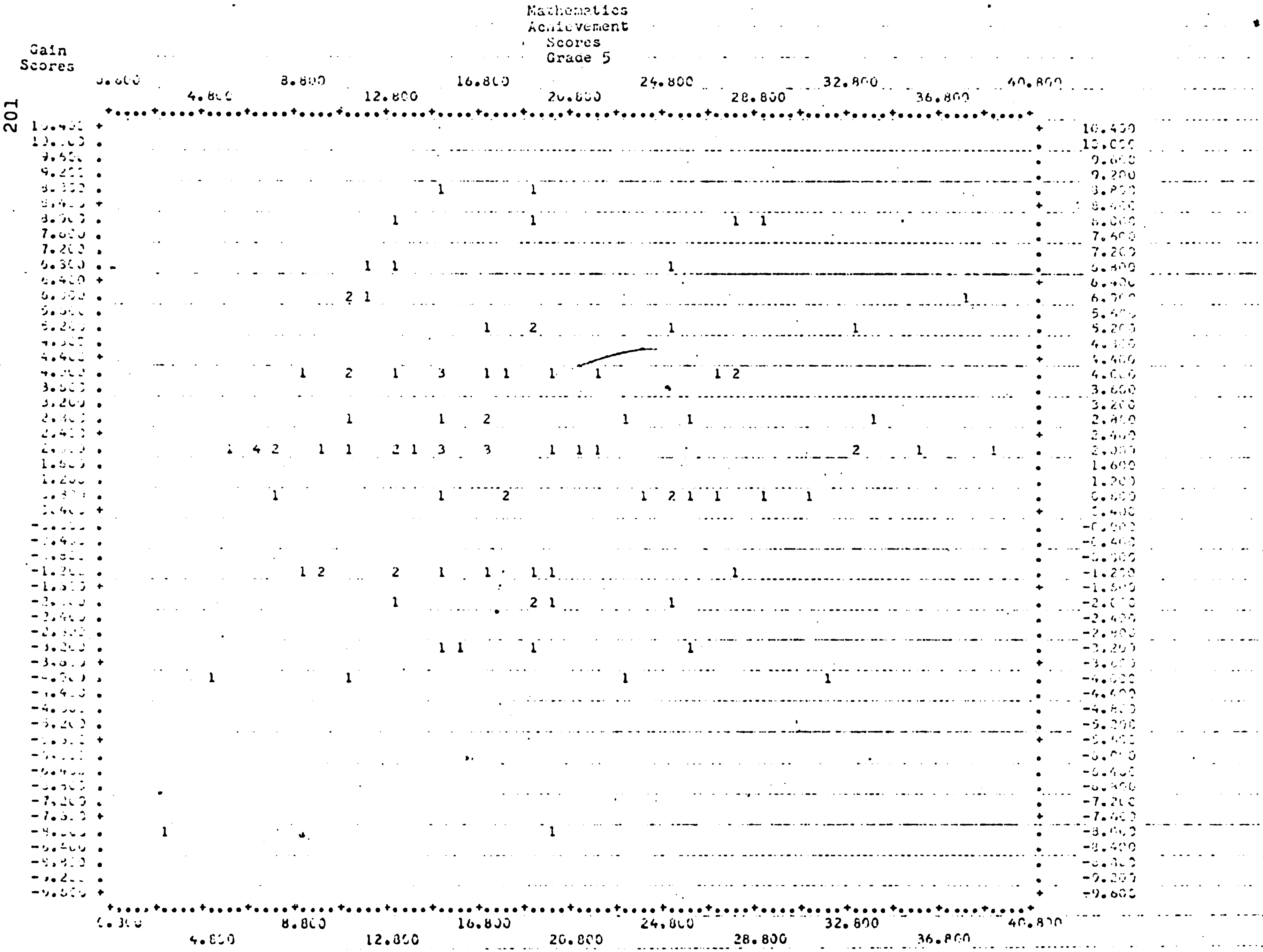
Refer to the diagram at the right in answering questions 1 through 4.

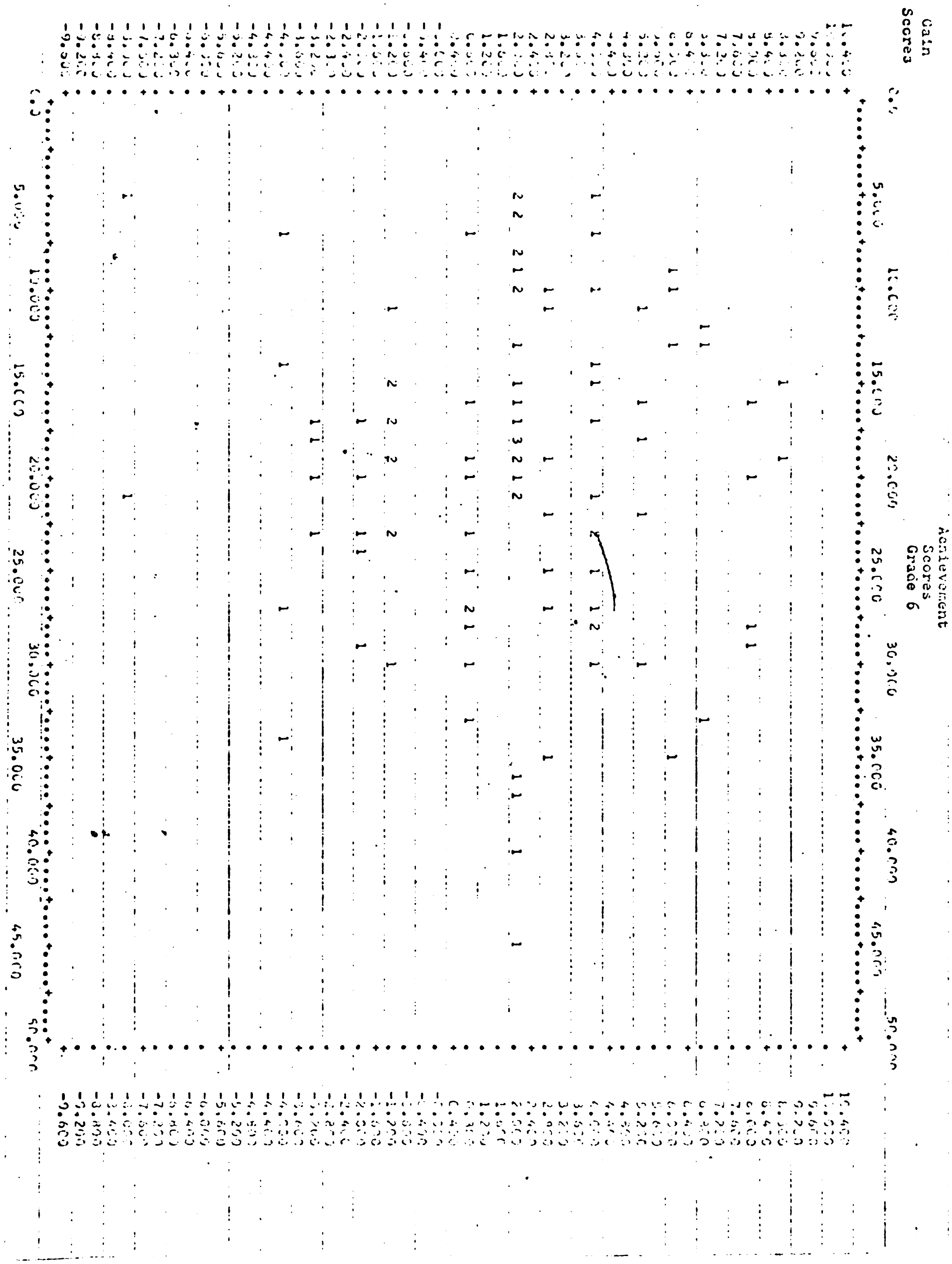
1. Name two lines containing point G.________________
2. Name three lines containing point B.______________
3. How many lines are shown that contain point I?_____
4. How many lines are shown that contain point E?_____
5. If two angles have a common vertex and a common side between them they are called_________________
6. The meeting place of two rays of an angle is called____
7. If you double the length of the side of a square what does this do to the area of the square?_______
____
8. What dimensions must you have to construct a right triangle to a given size?________________________
9. What determines the size of a circle?_____________
10. What is the name of an angle equal to ninety degrees (90°)?_____________________________________

SCATTERPLOTS

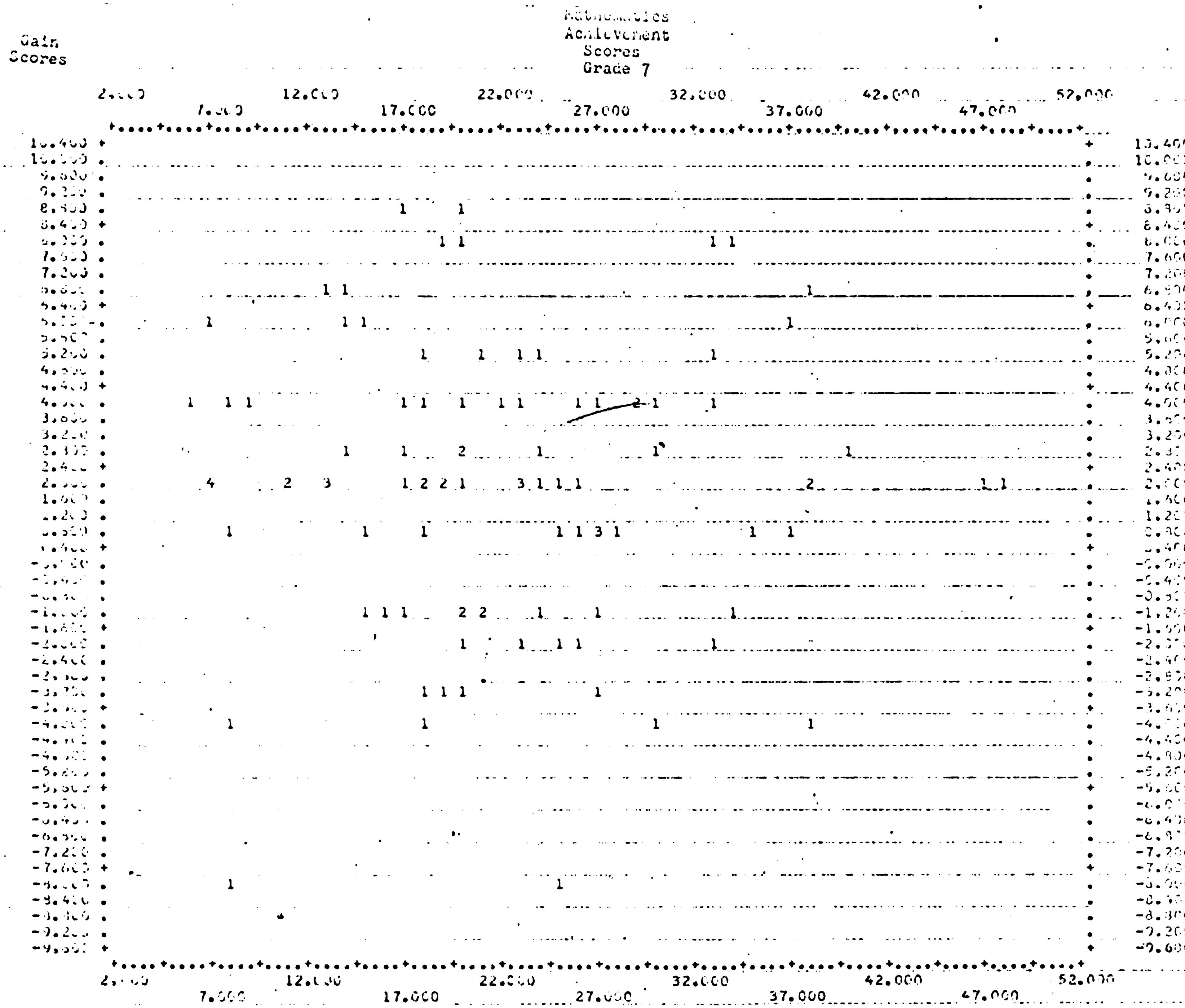
Mathematics
Mathematics
Achievement
Scores
Grade 4

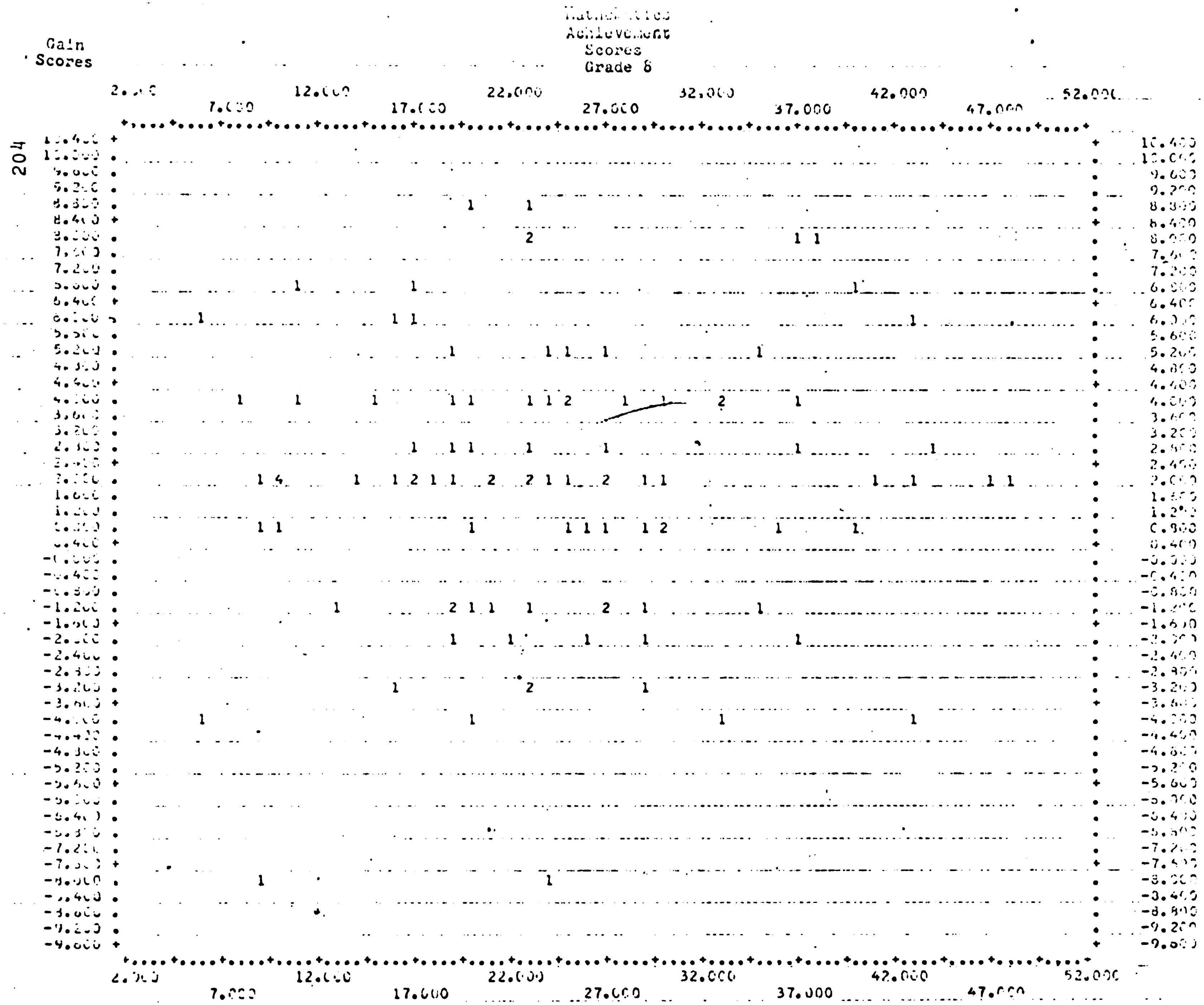


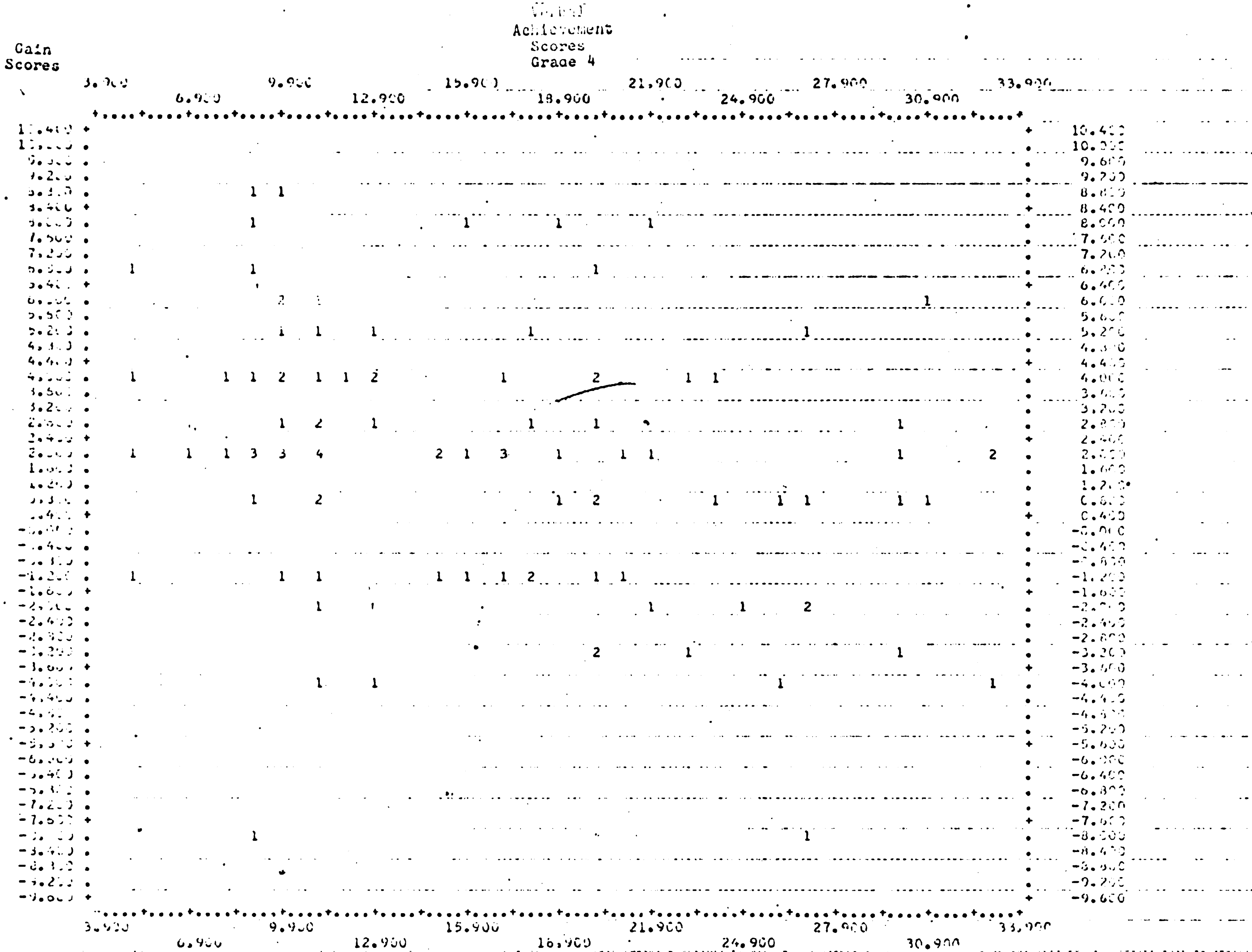

Mathematics Achievement Scores Grade 5
Gain Scores
4.800
8.800
12.800
16.800
20.800
24.800
28.800
32.800
36.800
40.800



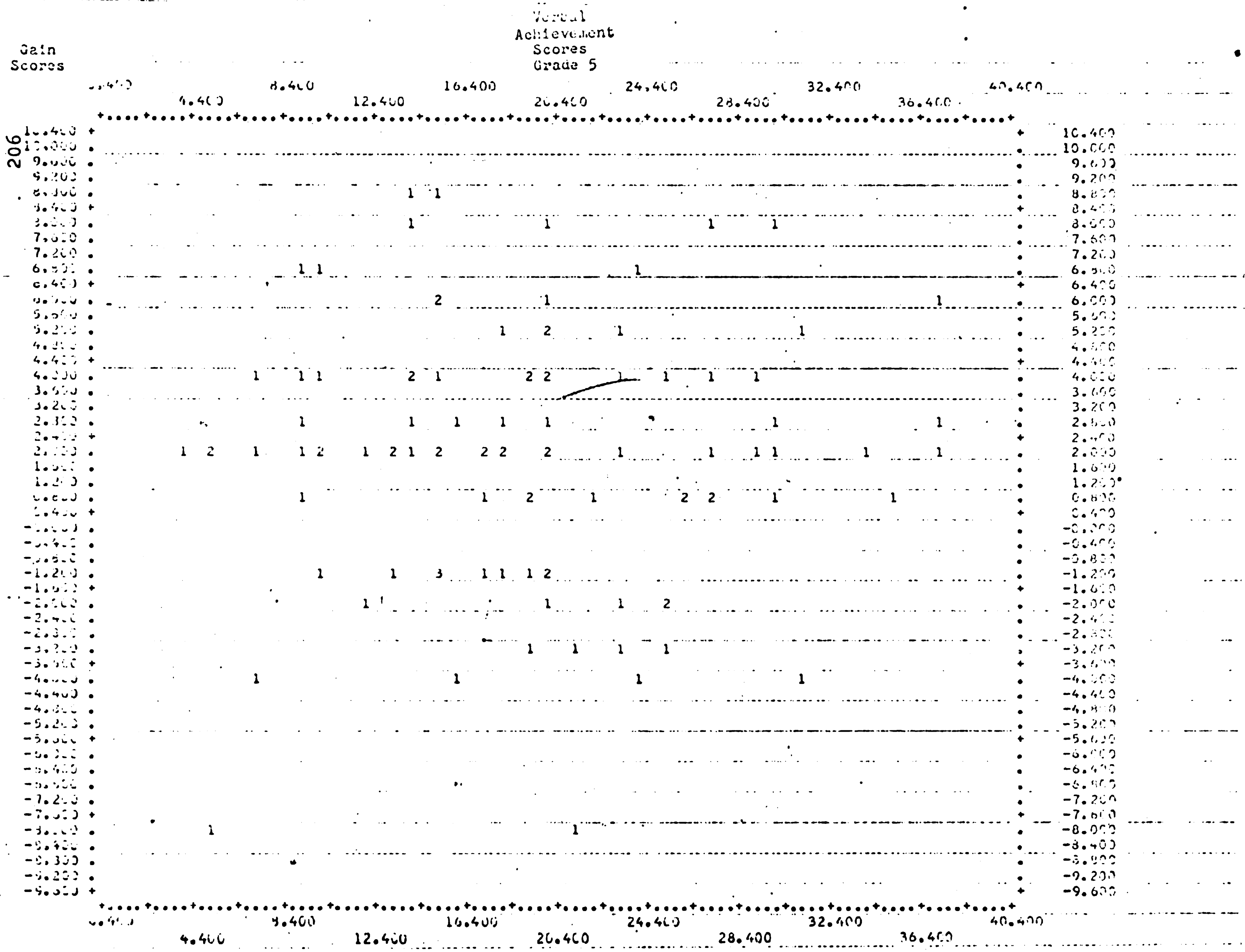
Mathematics Achievement Scores Grade 6
Gain Scores
5.000
10.000
15.000
20.000
25.000
30.000
35.000
40.000
45.000
50.000

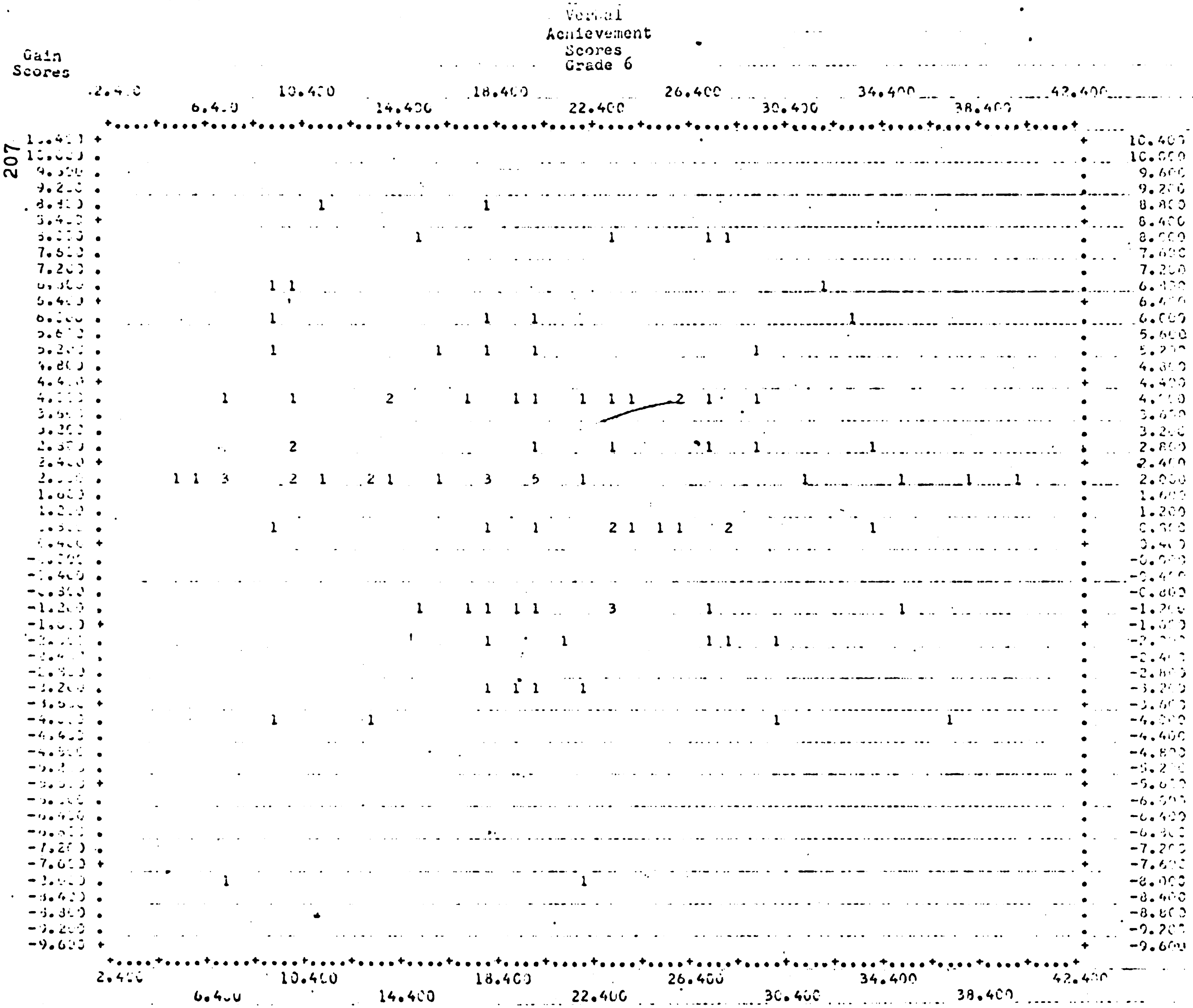

Gain Scores
Mathematics Achievement Scores Grade 7
2.000
7.000
12.000
17.000
22.000
27.000
32.000
37.000
42.000
47.000
52.000
10.400
10.000
9.600
9.200
8.800
8.400
8.000
7.600
7.200
6.800
6.400
6.000
5.600
5.200
4.800
4.400
4.000
3.600
3.200
2.800
2.400
2.000
1.600
1.200
0.800
0.400
-0.000
-0.400
-0.800
-1.200
-1.600
-2.000
-2.400
-2.800
-3.200
-3.600
-4.000
-4.400
-4.800
-5.200
-5.600
-6.000
-6.400
-6.800
-7.200
-7.600
-8.000
-8.400
-8.800
-9.200
-9.600

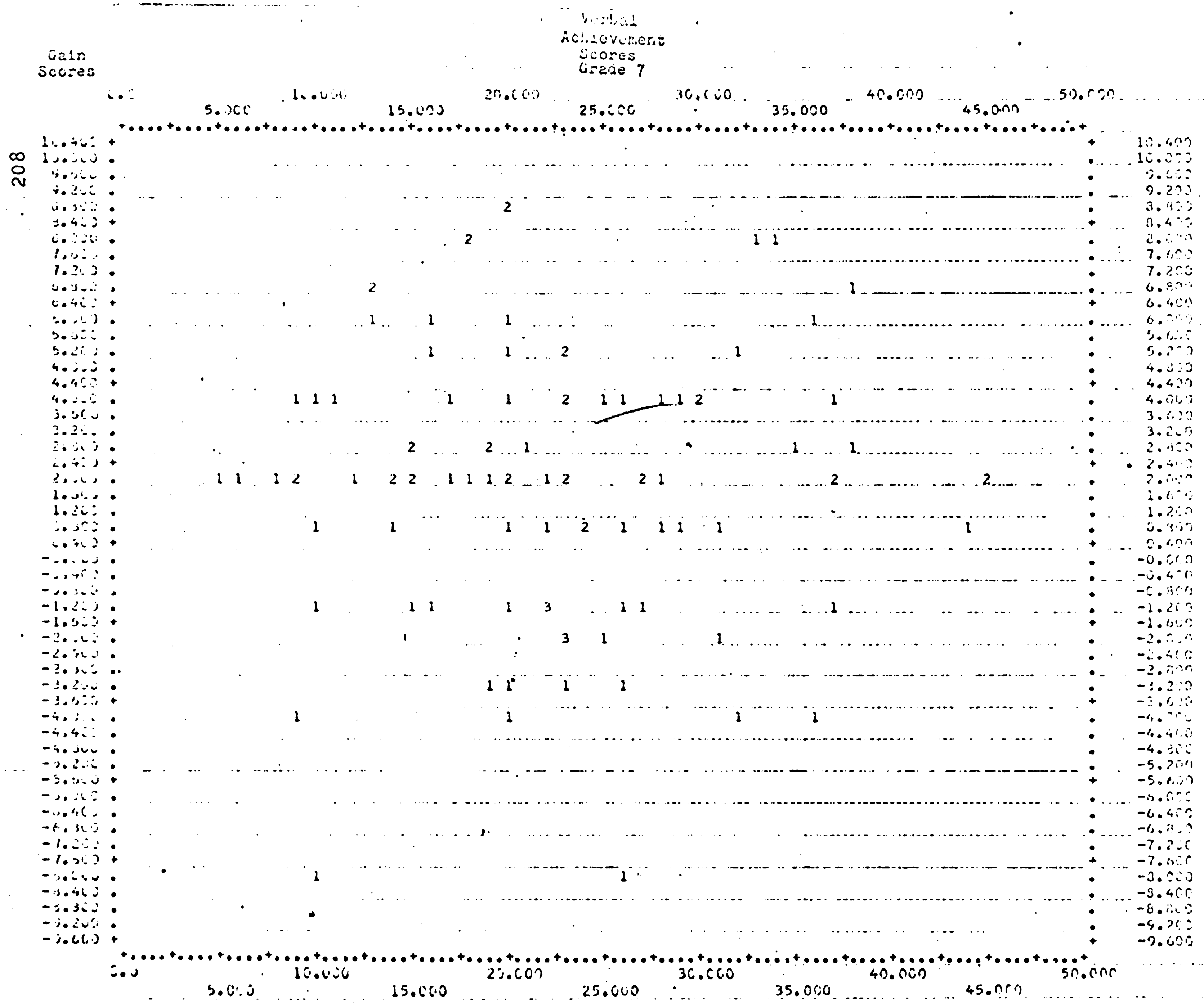

Mathematics Achievement Scores Grade 6
Gain Scores
2.000
7.000
12.000
17.000
22.000
27.000
32.000
37.000
42.000
47.000
52.000

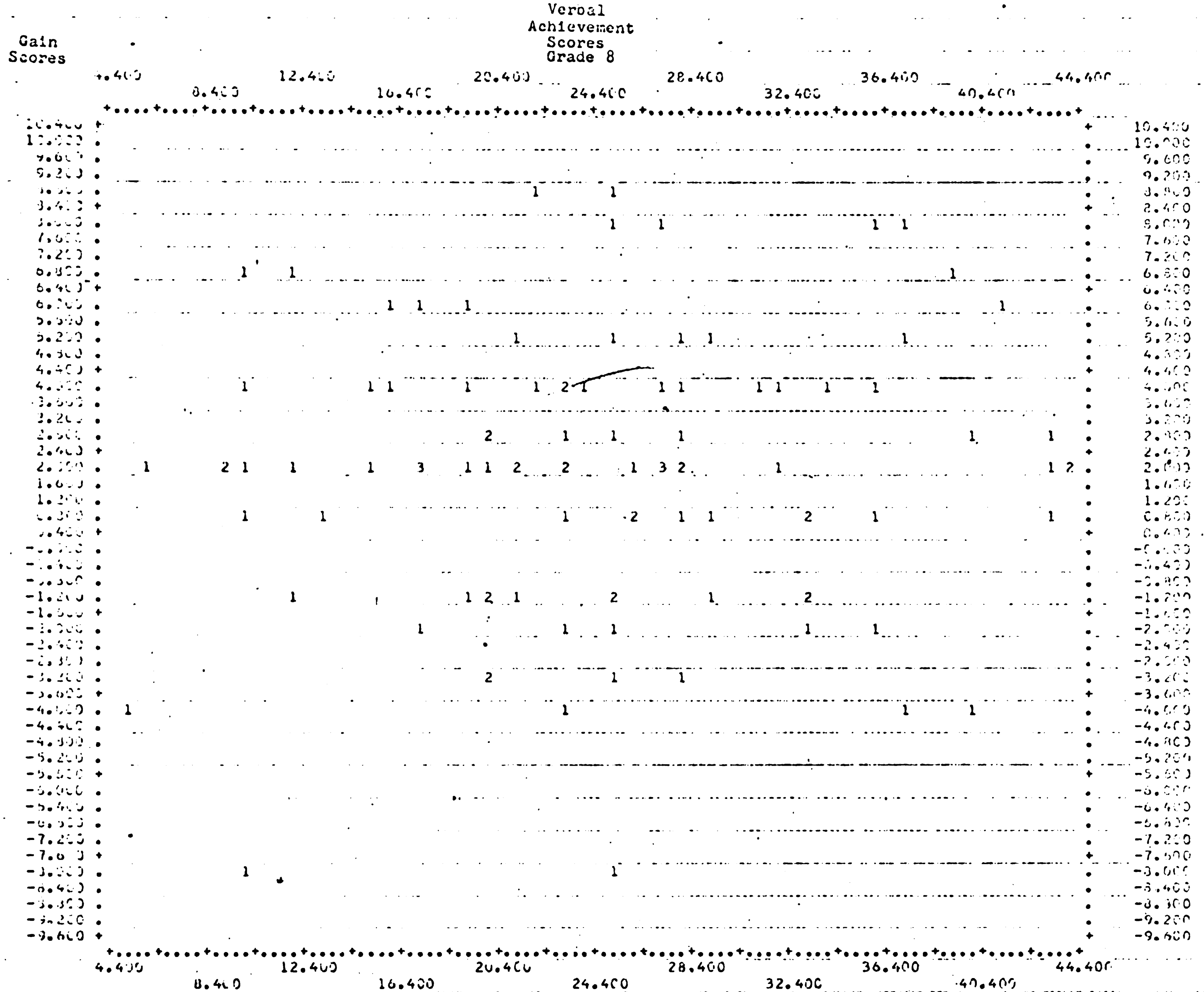


Achievement Scores Grade 4
Gain Scores
3.900
6.900
9.900
12.900
15.900
18.900
21.900
24.900
27.900
30.900
33.900
10.400
10.000
9.600
9.200
8.800
8.400
8.000
7.600
7.200
6.800
6.400
6.000
5.600
5.200
4.800
4.400
4.000
3.600
3.200
2.800
2.400
2.000
1.600
1.200
0.800
0.400
-0.000
-0.400
-0.800
-1.200
-1.600
-2.000
-2.400
-2.800
-3.200
-3.600
-4.000
-4.400
-4.800
-5.200
-5.600
-6.000
-6.400
-6.800
-7.200
-7.600
-8.000
-8.400
-8.800
-9.200
-9.600


Verbal
Achievement
Scores
Grade 5
Gain
Scores
4.400
8.400
12.400
16.400
20.400
24.400
28.400
32.400
36.400
40.400


Verbal
Achievement
Scores
Grade 6
Gain
Scores
10.400
18.400
26.400
34.400
42.400
6.400
14.400
22.400
30.400
38.400
2.400
10.400
9.600
9.200
8.800
8.400
8.000
7.600
7.200
6.800
6.400
6.000
5.600
5.200
4.800
4.400
4.000
3.600
3.200
2.800
2.400
2.000
1.600
1.200
0.800
0.400
-0.000
-0.400
-0.800
-1.200
-1.600
-2.000
-2.400
-2.800
-3.200
-3.600
-4.000
-4.400
-4.800
-5.200
-5.600
-6.000
-6.400
-6.800
-7.200
-7.600
-8.000
-8.400
-8.800
-9.200
-9.600


Verbal
Achievement
Scores
Grade 7
Gain
Scores


Veroal
Achievement
Scores
Grade 8
Gain
Scores
4.400
8.400
12.400
16.400
20.400
24.400
28.400
32.400
36.400
40.400
44.400