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ABSTRACT

The purpose of this study was to determine students' attitudes toward mathematics as a result of two instructional approaches in high school geometry. Seventy-five tenth and eleventh graders used a computerized-managed program; the control group included 75 students in a traditionally taught geometry course. Ideas and Preferences Inventory, Form 121B was used to measure students' attitudes. Findings showed that there were no significant differences in attitudes between students in the computer-assisted course and those in the traditional course. (Author/DT)

STUDENT ATTITUDES TOWARD GEOMETRY

by
Harold Fred Earle

Dissertation submitted to the Faculty of the Graduate School
of the University of Maryland in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
1972

APPROVAL SHEET

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ABSTRACT

Title of Thesis: Student Attitudes Toward Geometry

Harold F. Earle, Ph.D., 1972

Thesis directed by: Professor J. Paul Anderson

Purpose of the Study

The primary purpose of this study was to determine students' attitudes toward mathematics as a result of two instructional approaches in geometry. One of these was labeled the experimental group and consisted of students in a computerized-managed program. This was part of the Multi-Media Project developed by the Anne Arundel County Board of Education and was under the auspices of a Title III program. The other group of students was designated the control and included individuals in a traditional public senior high school course in geometry.

The major hypothesis stated that a computerized-managed program in geometry would generate more student interest toward mathematics than a traditional instructional approach.

Procedure

The instrument utilized to measure students' attitudes toward mathematics was the "Ideas and Preferences Inventory, Form 121B."

The major dependent variable was attitude as calculated by the score on the entire inventory. In addition, certain subgroups of items in the composite test were designated as dependent variables and these consisted of: mathematics versus non-mathematics, mathematics - fun versus dull, pro-mathematics composite, mathematics - easy versus hard and ideal mathematics self-concept. The major independent variables were the two types of geometry programs. A 2 X 2 X 2 multivariate analysis of covariance was used, including the factors of treatment (the program), sex (male or female) and class (tenth or eleventh grade). The two covariates employed were the verbal and non-verbal results of the Lorge-Thorndike Test of Intelligence, Level-5.

Results and Conclusions

Any other school district interested in the findings and the conclusions of this research should be cognizant that the study was limited to a specific locale and to a rather modest sample size.

No significant differences occurred between the experimental and control groups in relation to attitude toward mathematics. Thus, the null hypothesis that treatment of examinees in a computerized-managed program of geometry did not produce more interest toward mathematics than treatment in a traditional instructional approach was retained.

Other findings which deal with the statistical interpretation of the instrument and the observed classroom activities include:

1. The coefficient alpha for the entire Ideas and Preferences Inventory was .8261 and the corrected "best-split" index was .8735. These coefficients were indicative of reliability for the instrument utilized to measure students' attitudes toward mathematics.

2. The multivariate factorial analysis of covariance yielded a non-significant result with the six criteria of attitude and the two covariates. This led to the retention of the null hypothesis that no differences in students' attitudes occur as a result of treatment by the two programs in geometry.

3. The computerized-managed program lent itself to a student-oriented environment with a great deal of movement within and between the classrooms. Individualization of the instructional program was in evidence; yet, there was more of an opportunity for the students to engage in group work as well as non-subject irrelevancies.

4. The control group of students was taught in a pronounced teacher-oriented environment. There was more opportunity for the students to question the instructor directly about the problem at hand. There was little evidence of group activity or of student movement in the classroom.

ACKNOWLEDGEMENTS

Foremost acknowledgement is given to Dr. J. Paul Anderson, major advisor and member of the research committee, for his liberality and humaneness. I am indebted to Dr. William Schafer, member of the research committee, for his many hours of statistical advice; to Dr. Clarence Newell, member of the research committee, for his counsel in planning the investigation; and to Dr. Jodellano Statom, member of the research committee, for her friendship and graciousness.

Special acknowledgement is given to the principal, Mr. Richard Barr, and the staff members: Mrs. Margaretta Miller, Mr. Jay Catlin and Mr. Michael Reffner of Severna Park Senior High School. This investigation was indeed infused with their cooperation. Dr. Richard Clopper, Assistant Superintendent of the Anne Arundel County Public School System, lent encouragement and made plans for implementing the collecting of data.

Mrs. Mae Gordon, an elementary school principal in Anne Arundel County, served as an independent observer and assisted in the area of correlation of the study. Two members of the Curriculum Library of the Anne Arundel County Board of Education Annex, Mrs. Marsha Barsky and Mrs. Doris Matthews, were of tremendous help in the "hunting" and "copying" of printed materials.

Gratitude is also meant for Mrs. Virginia Ballard, a supervisor in Anne Arundel County, for her expertise in editing this manuscript.

Finally, acknowledgement is expressed for the allegiance and understanding shown by my wife, Anita; my son, Michael; my daughter, Sally; and my mother, Mrs. Ida Earle. The sacrifices they made, some of which I am probably still not aware, were undoubtedly made with a great sense of loyalty and dedication.

To all of these individuals - Thank you.

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CHAPTER I

INTRODUCTION

Background

Much information can be found in research about change in the curriculum and the effect of alteration in providing more meaningful school experiences for students. Anderson lists two demands of society on curriculum development. The first of these statements appears to fulfill the crux of this study: "[One] is to look at process for change, and--even more important--what happens to people in the process."[1] The second part deals with evaluation of the product, which must be a constant and ongoing procedure.

The effects of this change process upon curriculum have been evaluated in both the cognitive and the affective domains, although more emphasis has been placed in the former category. This study has been devised to relate primarily to the amount of difference in students' attitudes toward geometry (or mathematics, itself) as a result of their exposure to two instructional approaches--on the one hand, a computerized-managed program, which involves innovative technology, and a teacher-oriented

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[1]Vernon E. Anderson, Curriculum Guidelines in an Era of Change (New York: The Ronald Press Company, 1969), p. 4.

one, which adheres to a more conventional approach. It is not within the scope of this dissertation to relate interest to achievement in mathematics, but recommendations for future studies in this area and other related ones will be found in Chapter V.

A restructuring of the geometry curriculum to maximize appropriate utilization of educational technology in the implementation of the instructional program has been attempted in three schools in Anne Arundel County: Southern Senior High School, Glen Burnie Senior High School and Severna Park Senior High School. The computer program at Severna Park was initiated with one section of students during the 1970-1971 school year and was continued with twelve sections in 1971-1972, when data for this investigation were collected and interpreted.

The reorganization of the geometry program to individualize instruction was attempted through a Title III program, the Multi-Media Project,[2] which was approved on June 23, 1967, by the United States Office of Education under the Elementary and Secondary Education Act of 1965. In fact, the material for the computerized-managed program in geometry was compiled and written in this Title III program.

The Multi-Media Project served to implement the behavioral objectives of the geometry course, since educational media were matched with these objectives on an alleged individualized student-need basis. The computer was deemed appropriate as the mechanical device (equipment) to transmit the information to the students and was, of necessity, closely allied to specific instructional objectives. The writers of the program

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[2]Title III, <u>Multi-Media Project</u>, "Dissemination," Anne Arundel County Board of Education, ESEA, 1970.

cautioned that the connotation of the term multi-media should not imply complexity and/or sophistication. The term should be used only to imply that information has been transmitted, which is requisite to the attainment of a clearly specified instructional objective.

As stated in the preceding paragraph, the multi-media program is one of individualization. In conjunction with this operation, the program was developed as a self-paced one for the students. According to the teachers of this program, the self-pacing approach may have been deleterious to the achievement of a number of the students. They advanced the rationale for this idea in the following respects:

1. The student might strive to perform daily short-term assignments in all of the other classes and forego the long-term ones of the multi-media course.

2. High school students at this chronological age and maturity level might not be able to adjust to such an approach.

Individualization of the program seemed to be significant for this evaluator, since he could initiate his observations at any step in the package of topics. There are forty-one topics comprising the complete course, offering a wide range of starting points for the observer in the actual classroom situation. In the instructional procedure, a student has the opportunity of conferring with the teacher either for desired assistance (if the student has not mastered the objectives) or for consultation (if he wishes to coordinate his thoughts or perform enrichment activities). The teacher-oriented classes were observed during the same period of time and notes on observable classroom behaviors were made.

Purpose of the Study

The major purpose of this investigation was to determine whether differences in students' attitudes toward mathematics occurred as a result of either of these instructional approaches to geometry. Attitudes were measured utilizing the "Ideas and Preferences Inventory, Form 121B,"[3] which was obtained from Dr. Edward G. Begle of Stanford University.[4]

Another purpose for this study might include its utilization by another school district, provided that area were interested and could obtain adequate financial support to fund such a program.

The Major Hypothesis

The major hypothesis under investigation in this research was that the computerized-managed instructional program in geometry would generate more student interest toward mathematics than the teacher-oriented approach. The independent variable was the program and the dependent variable was interest in mathematics.

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[3] NLSMA Reports, No. 3, edited by James W. Wilson, Leonard S. Cahen and Edward G. Begle (Stanford, California: The Board of Trustees of the Leland Stanford Junior University, 1968), pp. 13-22.

[4] Edward G. Begle, School Mathematics Study Group; School of Education; Stanford University; Stanford, California 94305.

Subordinate Problems

Certain subgroups of students were formed in an attempt to determine whether or not being a member of these subgroups was related to a significant difference in a student's attitude toward mathematics. These selected subgroups led to the formation of subordinate problems which were the following:

1. To determine the differences for entire groups (consisting of more than one class) of students' attitudes toward mathematics after taking the designated instructional approachs in geometry.

2. To determine the effect of sex of subject upon students' attitudes toward mathematics.

3. To determine the effect of grade level of subject upon students' attitudes toward mathematics.

Certain subgroups of items in the "Description and Statistical Properties of Z-Population Scales"[5] were designated by the authors as related scales to measure the following:

1. Mathematics versus non-mathematics - how well a student likes mathematics and considers it important in relation to other school subjects (Items 1, 3, 4, 6, 8, 12, 26 and 36).

2. Mathematics - fun versus dull - the pleasure or boredom a student experiences with regard to mathematics both in the absolute sense and comparatively with other subjects (Items 25, 27, 28 and 29).

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[5] NLSMA Reports, No. 6, edited by James W. Wilson, Leonard S. Cahen and Edward G. Begle (Stanford, California: The Board of Trustees of the Leland Stanford University, 1968), pp. 93-97.

3. Pro-mathematics composite - the general attitude toward mathematics (Items 1, 2, 12, 28, 30, 35, 37, 38, 39, 40 and 45).

4. Mathematics - easy versus hard - the ease or difficulty which a student associates with mathematics performance (Items 32, 34, 38, 39, 41, 42, 43, 44 and 45).

5. Ideal mathematics self-concept - how a student wishes he were in relation to mathematics (Items 17, 18, 19, 20, 21, 22, 23 and 24).

Statistical Method

A multivariate factorial analysis of covariance was used to determine whether there were possible relationships between the six dependent variables of attitude and the three independent variables of the treatment in geometry, sex and the grade level of the student. The covariates included the verbal and numerical scores of the Lorge-Thorndike Test of Intelligence, Level-5.

Need and Significance of the Study

Many programs have been devised and implemented for the improvement of instruction in content areas and the subsequent enhancement of student achievement. In addition to competence in this area of endeavor, is the area of students' attitudes being influenced?

It appears that pupils' attitudes exert a great deal of influence upon their learning processes. In fact, Witty was one of the first proponents of this idea when he said, "In every subject area the efficacy of the instruction will be heightened by the development of an instructional program which recognizes the significance of each child's attitude."[6] It follows therefore that the type of program may also be significant in influencing difference in attitude toward mathematics of high school geometry students.

Wilson[7] stated that it is the elementary school teacher's responsibility to change the pupils' attitudes toward mathematics in high school by aiming at the real purposes of arithmetic. These purposes will then enable the student to derive a proper basis in meaning and motivation for the subject.

Findley[8] related that when negative attitudes toward mathematics are exhibited by teachers, the resultant influence upon their students' attitudes may be quite devastating. This type of attitude on the teacher's part may be derived through lack of flexibility or lack of eagerness in teaching mathematical topics, particularly at the elementary school level.

In dealing with innovations in the school system such as the computerized-managed program in geometry, one must take into account the opinions and attitudes of the parents involved. It has been reported

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[6] Paul A. Witty, "Role of Attitudes in Children's Failure and Success," National Education Association Journal, 37 (October, 1948), p. 42.

[7] Guy M. Wilson, "Why Do Pupils Avoid Mathematics in High School?" The Arithmetic Teacher, 8 (April, 1961), p. 168.

[8] Warren G. Findley, "The Ultimate Goals of Education," School Review, 64 (January, 1956), p. 14.

in The Revolution in School Mathematics[9] that a large majority of parents were cooperative and understanding of the new mathematics programs. At an open house, parents made such statements as follow about their children's placement in the program:

> "My child was never stimulated in previous mathematics classes."
>
> "Wish I were taking it too."
>
> "My son gets along better than my other children did."
>
> "Jealous because I didn't get to study this."
>
> "So different--so interesting--my child never tires of it."
>
> "It has given our youngster a better understanding of mathematics."
>
> "My child loves this mathematics. My only complaint is that it makes me feel so extremely stupid."[10]

On the other hand, some parents were not so enthralled by innovative programs. A statement from one such parent was "Take my boy out of this course and put him in a mathematics class."[11] It was stated that parents moving into a new area have attempted to locate in a school district that has one of the new programs. Evidence presented by the panelists of one new program indicates that parents who have been properly informed are generally sympathetic with the school's effort to upgrade the instruction and the learning of mathematics through the use of innovative materials of instruction.

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[9] The Revolution in School Mathematics, A Report of Regional Orientation Conferences in Mathematics (Washington, D.C.: National Council of Teachers of Mathematics, 1961), p. 34.

[10] Ibid., p. 35.

[11] Ibid., p. 35.

Allen[12] reported that parents may be responsible for hindering their children's success in mathematics by instilling the belief of an inherent lack of mathematical talent. They may state that the lack of ability in mathematics is inherited or that the subject matter was always incomprehensible to them. Such posture may produce real inhibitions in the child toward mathematics, since he now has a mental state such that he cannot master the course work. As a result, the child may even feel that he is not expected to succeed with mathematics or to enjoy it.

Another of Allen's psychological phases in the learning process of mathematics appears to have been enhanced tremendously since he posited it. He believed that success in mathematics correlates directly with the growth of interest in it. Allen concluded that ". . . one's interest grows as his knowledge of the subject grows, and interest is an essential element in learning."[13]

Johnson[14] noted that emotional vectors, or attitudes, accompany the traditional school learnings. He referred to them as concomitant or intangible learnings, which are too often included in the school program by chance; whereas the tangible learnings generally are installed

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[12] J. Eli Allen, "Some Psychological Phases of Student Success in High School Mathematics," The Mathematics Teacher, 30 (November, 1937), p 322.

[13] Ibid., p. 324.

[14] Donovan A. Johnson, "Attitudes in the Mathematics Classroom," School Science and Mathematics, 57 (February, 1957), p. 113.

by choice. The following paragraph serves to denote the uniqueness of teaching attitudes:

> One unique aspect about teaching attitudes is that we have no choice in the matter. No matter what subject we are teaching or what method we are using many concomitant learnings and changes in attitudes are taking place. While teaching how to solve equations, our students may also be learning how to dodge responsibility, to be cooperative, to cheat, to be loyal to the class, to dislike mathematics, to appreciate the power of mathematics, to lose respect for the teacher or to build confidence through checking.[15]

In addition, Johnson[16] saw no difference in the development of attitudes by poor achievers as well as by superior students. Attitudes will inevitably be learned by all students and are not dependent upon academic achievement. This tenet suggests the relevance of this investigation, since both of the geometry programs at Severna Park Senior High School included students at nearly all academic levels.

The feeling accompaniment to learning was also stressed by Clark,[17] who defined both the tangibles and the intangibles of arithmetic learning. The tangibles included: (1) ideas (meanings or concepts), (2) skills (computational techniques), and (3) reasoning or problem solving. Since arithmetic learning becomes a complex of tangible and intangible ("feeling") aspects, both must be accounted for when dealing with learning objectives. Synonyms for the intangibles include attitudes, dispositions, interests,

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[15] _Ibid_., p. 113.

[16] _Ibid_., p. 113.

[17] John R. Clark, "The Intangibles of Arithmetic Learning," _The Arithmetic Teacher_, 3 (April, 1956), p. 56.

opinions, likes, dislikes, etc. They are the precedents, the concomitants and the resultants of learning experiences which deal directly with the tangibles.

Spickerman[18] dealt with the significance of students' attitudes toward mathematics and why teachers should concentrate on the development of these concomitant aspects in the following propositions:

1. The learning of mathematics has been notorious as both difficult and boring.

2. Recent reorganization schemes from kindergarten through graduate school have focused attention upon the subject of mathematics.

3. If society considers mathematics a cultural subject, then development of a favorable attitude toward it becomes a legitimate objective.

Finally, there appears to be a need for this study when one considers the significance of the cost of the multi-media program. It is far more expensive to the system than a conventional course in geometry and this investigation may serve as a partial aid in the financial evaluation of the geometry courses in Anne Arundel County.

Definitions of Terms

In order to avoid ambiguity and inconsistency, definitions of certain terms are necessary to this study.

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[18] William R. Spickerman, "A Study of the Relationships Between Attitudes Toward Mathematics and Some Selected Pupil Characteristics in a Kentucky High School" (unpublished Ph.D. dissertation, University of Kentucky, 1965).

Attitude: An attitude is an intangible or a concomitant part of the learning process and is incorporated into a system of ideas with emotional feelings. An attitude utilizes both the negative sentiments, such as prejudice, and the positive ones, which include attachments and loyalties to persons, objects or ideals. Synonyms for the term attitude in this study include interest, enthusiasm, disposition, opinion, likes and dislikes.

Attitude toward Mathematics: Attitude toward mathematics is the summation of a student's convictions, feelings and prejudices regarding the subject. Thus, an individual's attitude toward mathematics is all that he feels and thinks about it.

Attitude Difference: Attitude difference is measured by the total score and the subsets of scores utilizing results obtained from the "Ideas and Preferences Inventory, Form 121B."

Degree of Attitude Difference: The degree of attitude difference is derived from the type of response for each item on the inventory. It ranges from 1 for the most negative reply to 4, 5 or 6 (depending upon the number of response choices) for the most positive opinion.

Computerized-Managed Program: The computerized-managed program in geometry utilizes the computer as a mechanical device to transmit information to the students and to fulfill specific instructional objectives. In addition, this program was intended to be used by the students as a self-paced one and consequently became more student-oriented in the instructional process.

Teacher Oriented Program: The teacher-oriented program in geometry follows a more traditional instructional approach and classroom environment. While audio-visual materials were in use, the computer as a mechanical aid was excluded. The instructional process was directed primarily by the teacher.

Observable Classroom Activities: Observable classroom activities were behaviors exhibited by both the students and the teachers at fifteen-second intervals during a fifty-minute class period. Thirty observations were made for each class.

Description of Population and Program

Severna Park Senior High School is a large secondary school of approximately 2,000 students in grades ten, eleven and twelve. The school has been on split-sessions for the past several years; and although additions to the building are currently under construction, the student body will again be divided during the 1972-1973 school term. There were twelve sections of students in the multi-media area and four classes in the traditional approach.

The computerized-managed classes used the Moise and Downs' textbook Geometry and Programmed Instruction (P.I.), which utilized film (MP), filmstrips (FS), film loops (ML), slides (TS), tapes (RT) and slide-sounds (TS - RT). Two instructors were team-teaching in this program; both held the Advanced Professional Certificate issued by the Maryland State Department of Education. One of the teachers had both the Bachelor's and Master's degrees, with six years of teaching experience, the last four in Anne Arundel County. The other teacher held a Bachelor of Arts degree and had taught in the county's school system since 1955.

A beginning teacher, who held a baccalaureate degree and a Standard Professional Certificate issued by the Maryland State Department of Education, taught the other four geometry classes with the Dolciani book Modern Geometry as the text in his classes. Both the teacher and the students in these sections used the overhead projector and the traditional chalkboard.

It appears that the teacher-control factor may contribute to some variation in this research study. All three teachers were rated equally by their supervisors and met the criteria for competence. It could therefore be assumed that the teachers were equally competent. In addition, the State of Maryland has specific certification requirements; the three instructors had satisfied the professional certification standards of Maryland, as noted by their teaching certificates.

The sixteen geometry sections at this school were scheduled into their classes by a computer; therefore, a random distribution was assumed. This investigator selected seventy-five cases from each of the programs to act as subjects of the research. Most of the geometry students at the senior high school level were tenth- and eleventh-graders and had the first year of algebra in their mathematics sequence. The highest ability students, the so-called "accelerated" ones, who were taking geometry in the ninth grade at Severna Park Junior High School, were not included in this investigation. There were some twelfth-grade students in all the sections; they were likewise not under consideration in this study.

Limitations of the Study

It seems that two major factors limit the validity of the conclusions which may be drawn from this investigation. One of these factors refers to the nature of the study group and deals with interpretations based upon results from one high school. Although this research was purposely limited in this manner, the question arises as to external validity and whether these students are representative of geometry students throughout the nation. Actually, the findings of this study may be applicable only to students attending this particular high school.

Other factors which may relate to the above-mentioned limitations follow:

1. The sample contained a disproportionate number of tenth-grade and female students.

2. Because of the sequence of mathematics courses (i.e., algebra I, geometry, algebra II, etc.) in which most students took algebra I in the ninth grade, there was no provision for the highest ability students to be included in the research. They took geometry in the junior high school, where only the traditional instructional program was offered.

3. There were no provisions for determining whether the self-pacing program in the multi-media sections caused a lowering of the interest level toward mathematics. A psychological effect may have been present due to the maturity of the students involved in such an offering.

The second factor deals with a concern of the attitude-assessing instrument. The results of the study are therefore valid internally only in the degree to which the inventory measured what it purported to measure. This study must, consequently, be interpreted within the limits of the instrument used.

Certain factors relating to internal validity are listed below:

1. A more positive attitude toward mathematics may have occurred as a result of an inventory bias.

2. Improvement in attitude toward mathematics may have occurred as a token of the "desire-to-please" syndrome, an uncontrolled variable.

3. Attitude changes in either direction may have been the result of some variables completely foreign to the design of this investigation (e.g., personality characteristics, socio-economic factors, "transients," etc.).

4. There was no open-ended portion of the attitude scale. Respondees were required to answer within the confines of the instrument.

5. Some researchers have found that attitudes are formed much earlier in life than at the secondary school level. No attempt was made by this investigator to study the development of individual attitudes.

Organization of the Remainder of the Report

Chapter II presents a review of selected literature concerning students' attitudes and the role of the computer in educational technology.

Chapter III presents a discussion of the procedures used and their limitations. Included are a description of the instrument, the sources of data, the administration of the inventory, the design of observations of classroom activities and the treatment of the data.

Chapter IV includes the findings and the analysis of this investigation. It presents some descriptive statistics, reliability involving split-half coefficients, the multivariate factorial analysis of covariance, homogeneity of regression tests, comparisons of selected subgroups of items of the inventory and the results of observable classroom behaviors.

Chapter V gives the summary of the experiments, the results and conclusions, and classroom implications and recommendations for future studies.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

Since educators endeavor to improve all phases of the instructional program to offer a better curriculum to their clientele, research dealing with attitudes and their effects on the total educational process is relevant to this study. Prescott stated this viewpoint as follows:

> The development of attitudes, ideals, loyalties, purposes, accomplished by assisting the individual with the organization of his experience, has always been recognized as an ultimate aim of educators.[1]

A review of the research and literature reveals a prolific amount of material on the subject of attitudes and a much smaller amount related to the computer as an aid in the learning process. The commentary in this chapter is organized into portions. One of these parts deals with studies of attitudes and includes their definitions, their correlation with similar terms (e.g., habits, opinions, tastes or preferences, values and beliefs), their related human factors (e.g., teachers and parents), their formation, their assessment in change and their measurement

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[1]D. A. Prescott, Emotions and the Educative Process (Washington, D.C.: A. C. E., 1938), p. 4.

scales. The second component discusses the role of the computer as a tool or as a contributing teaching aid in mathematics instruction. Included in the discussion are the effects of the self-pacing approach and the issue of the relation between technology and people.

Definitions of Attitudes

In attempting to study the behavior of human beings, the researcher must consider attitudes as one of the most important variables. In order to clarify the topic, attitudes should be defined as to what they are and what they are not. Manifestations of the various definitions show uniqueness, on the one hand, and mutuality, on the other hand.

According to Mouly, "Attitudes may be thought of as learned patterns of behavior which predispose the individual to act in a specific way when confronted with a given situation."[2]

A more comprehensive interpretation was proposed by Allport in 1935 when he defined attitudes as:

> . . . a mental and neural state of readiness organized through experience, exerting a directive and/or dynamic influence upon the individual's response to all objects and situations with which it is related.[3]

Sherif and Cantrel concurred with Allport and appeared to give a more abbreviated version by saying, ". . . an attitude denotes a

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[2]George J. Mouly, <u>Psychology for Effective Teaching</u> (New York: Holt, Rinehart and Winston, Inc., 1960), p. 343.

[3]William James Purcell, "Some Factors Affecting Attitudes of Prospective Teachers Toward Elementary Mathematics," (Doctoral Dissertation, Columbia University, New York, 1964), p. 24.

state of readiness which determines how the individual will react to certain stimuli."[4]

Newcomb, Turner and Converse further shortened the characterization of attitudes in their book, Social Psychology, as ". . . generalized states of readiness for motivated behavior."[5]

Krech and Crutchfield said that an attitude is "an enduring organization of motivational, emotional, perceptual, cognitive processes with respect to some aspect of the individual's world."[6]

In his volume Personality and Social Psychology Cattell seemed to offer a mathematical explanation. He affirmed ". . . an attitude is a vector, definable by direction as well as magnitude, and further by point of application (object) and stimulus situation."[7]

Sherif, Sherif and Nebergal collaborated on the following exposition of attitudes in their book Attitude and Attitude Change:

> Attitudes refer to the stands the individual upholds and cherishes about objects, issues, persons, groups, or institutions. The referent of a person's attitudes may be a 'way of life,' economic, political, or religious institution; family, school or government.[8]

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[4]Muzafer Sherif and Hadley Cantrel, "The Psychology of Attitudes," Psychology Review, 52 (November, 1965), p. 301.

[5]Theodore M. Newcomb, Ralph H. Turner and Philip E. Converse, Social Psychology (New York: Holt, Rinehart and Winston, Inc., 1948), p. 184.

[6]David Krech and Richard S. Crutchfield, Theory and Problems of Social Psychology (New York: McGraw-Hill Book Co., Inc., 1948), p. 184.

[7]Raymond B. Cattell, Personality and Social Psychology (San Diego, California: Robert R. Knapp, Publisher, 1964), p. 184.

[8]Carolyn W. Sherif, Muzafer Sherif and Roger E. Nebergal, Attitude and Attitude Change (Philadelphia: W. B. Saunders Co., 1965), p. 4.

Remmers and Gage stipulated that attitudes are "feelings for or against something."[9] These authors further explained "feelings" in the following manner:

> The term "feeling" points to the difference between attitudes and detailed, rational, intellectual, cognitive mental operations. Attitudes are linked to the emotions; pleasant and unpleasant associations - fear, rage, love, and all the variations and complications in these emotions brought about by learning - play a part in attitudes.[10]

Dutton's research dealing with attitudes of prospective teachers toward arithmetic agreed with Remmers and Gage when he defined attitudes ". . . as the emotionalized feelings of students for or against something."[11]

Dutton related that a more complete description of attitudes as "pros and cons" of feelings was given in a statement by Anderson:

> The term "attitudes" includes not only the negative attitudes, such as prejudice, bias, and the like, but also positive attitudes (sometimes called sentiments) which include our attachments and loyalties to persons, objects, and ideals. An attitude then, is a system of ideas with an emotional core or content . . . you can be sure that the normal nine-year-old boy will learn that "two plus two" equals "four" and rattle it off without difficulty. But you cannot be quite so sure whether he will like or dislike arithmetic or will like or dislike his teacher.[12]

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[9]H. H. Remmers and N. L. Gage, Educational Measurement and Evaluation (revised edition; New York: Harper and Brothers, Publishers, 1955), p. 361.

[10]Ibid., pp. 361-362.

[11]Wilbur H. Dutton, "Attitudes of Prospective Teachers Toward Arithmetic," The Elementary School Journal, 52 (October, 1951), p. 84.

[12]John E. Anderson, The Psychology of Development and Personality Adjustment (New York: Henry Holt and Co., 1949), p. 283.

Kerlinger postulated that attitudes should be considered an integral part of the personality. He stated that an attitude ". . . is a predisposition to think, feel, perceive, and behave toward a cognitive object."[13] He added that ". . . one has an attitude toward something 'out there'."[14]

An analysis of these authors' views yields several points, which attest to the universality of the definition of the term attitudes:

1. They are learned patterns of behavior and, as such, should be included in the instructional program. They have been acquired through the individual's prior experiences; therefore, they will be germane to the classroom situation. They are not based upon heredity factors, but are formed through the individual's environment. This carries the implication that attitudes can be changed.

2. They become "catalytic agents," rather than actions, themselves. They represent a readiness to act or predispositions to respond. One's attitude influences one's response to a stimulus; hence, attitudes are intervening factors between stimuli and responses.

3. They are closely allied with emotional, perceptual, motivational and cognitive processes in the person's environment. They denote authentic feelings (perceptions, performances or thought patterns) of individuals and are always present in the classroom, either overtly or covertly.

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[13] Fred N. Kerlinger, Foundations of Behavioral Research (New York: Holt, Rinehart and Winston, Inc., 1964), p. 483.

[14] Ibid., p. 483.

Related Terms

Some authors feel that other terms, which are related and sometimes confused with attitudes, should be considered in such a study as this and that comparisons be drawn. Words included in this category are habits, opinions, tastes or preferences, values and beliefs.

> Habits are automatic responses to stimuli. They are a necessary part and an important function of daily life. Habits are the routine actions of people which become automatic and exist without direct involvement of the conscious thought process of the individual.[15]

The differences between habits and attitudes were pointed out by Pitkin in his doctoral thesis:

> Habits and attitudes differ in that an attitude is a readiness to act and not an action. An attitude may be acquired vicariously where a habit may not. Also an attitude may be acquired by just one experience rather than a great many, such as a habit requires. Instead of being an automatic response as is a habit, an attitude involves conscious thought.[16]

An opinion implies expectation or prediction, not merely a pre. ence for something, and can always be put into words. Hilgard remarked that ". . . attitudes grade into opinions, and there is no sharp difference between them."[17]

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[15]Marland K. Strasser, James E. Aaron, Ralph C. Bohan and John R. Eales, Fundamentals of Safety Education (New York: The Macmillan Company, 1964), p. 77.

[16]Tony Ray Pitkin, "A Comparison of the Attitudes Toward Mathematics and Toward Pupils of Selected Groups of Elementary School Teachers Who Had Different Types and Amounts of College Education in Modern Mathematics," (Doctoral Dissertation, University of South Dakota, 1968), p. 24.

[17]Ernest R. Hilgard, Introduction to Psychology, 3rd edition (New York: Harcourt, Brace and World, Inc., 1962), p. 568.

In a comparison of tastes or preferences, values and attitudes, there is evidence that tastes are the most temporary, values the most permanent and attitudes somewhere between. Values are associated with large spheres of experiences, while tastes are rather specific in area and may be indicated by a preference for a particular style of automobile or design of a house. Again, Hilgard gave a meaningful description: "We may think of a taste as applying to a specific arrangement of a musical composition, an attitude is acceptance or rejection of certain categories of music such as sacred, classical, or jazz, and a value is the entire scope of music in the life of the individual."[18]

To clarify these terms further, tastes may be interpreted as viewing external objects, as to likes or dislikes. "Values more intimately inhere within the individual,"[19] whereas attitudes denote a relationship between the person and an object.

Pitkin remarked that "Tastes, values and attitudes affect the 'self' to varying degrees. Changes in taste affect the 'self' very little. They are quite peripheral and can be readily changed. Attitude change is more difficult and will make a considerable difference to the 'self.' Values are very difficult to change; when change occurs, the basic personality is altered. As far as the effect on society, changes in taste have little, attitude changes take on more importance, and value changes are of great importance."[20]

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[18] Ibid., p. 344.

[19] Ibid., p. 344.

[20] Pitkin, p. 26.

Finally, Purcell remarked that belief ". . . is that part of an attitude which deals with the perceptual and cognitive parts. They are in this sense, nondynamic and not a predisposition to act. They are either true or not true and do not tend to arouse reactions in the individual."[21]

Thus, the selection of these related terms--habits, opinions, tastes or preferences, values and beliefs--from the literature reveals that they are often used synonymously by lay people, while many authorities tend to make a distinction between these words and attitudes.

Development of Attitudes Toward Mathematics

The development of the "right" attitude toward any subject area appears to be one of the major influences which can aid in the learning process of the "whole" child. Abrego remarked that "Home environment, school environment, heredity, and good health--physical and mental--have played their part in the maturation of the student. All of these influences can aid learning, but without the right attitude the child's full potential of growth in knowledge cannot be realized."[22]

In the conclusion of her investigation, Abrego found a similarity between the ranking of traditional arithmetic and modern mathematics in subject preference of fourth-grade students at the Anza School in El Cajon, California. Another significant finding of her research,

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[21]Purcell, p. 26.

[22]Mildred Brown Abrego, "Children's Attitudes Toward Arithmetic," The Arithmetic Teacher, 13 (March, 1966), p. 206.

which is to be included for correlative purposes in this writer's work, is that students who liked traditional mathematics also liked the modern mathematics, even though it was quite different.[23]

There have been a few studies of the priority given to various school subjects by the students themselves. While it would be difficult to generalize about children's attitudes toward mathematics from these limited writings on preference, elementary school pupils have appeared to rate arithmetic rather high in comparison with other subjects.

Rowland and Inskeep[24] and Mosher,[25] in two separate undertakings, reported that pupils at the intermediate grade level tended to rank arithmetic in first place. In two other separate studies, Chase[26] and Sister Josephina[27] have reported that children at the elementary level rated arithmetic as the second best-liked subject. It is interesting to note, on the other hand, that Sister Josephina[28] found that arithmetic

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[23] _Ibid._, p. 208.

[24] Monroe Rowland and James Inskeep, "Subject Preferences of Upper Elementary School Children in Cajon Valley Union School District," _California Journal of Educational Research_, 14 (September, 1963), p. 189.

[25] H. M. Mosher, "Subject Preferences of Girls and Boys," _School Review_, 69 (January, 1952), pp. 34-38.

[26] Linwood W. Chase, "Subject Preferences of Fifth Grade Children," _Elementary School Journal_, 50 (December, 1949), pp. 204-211.

[27] Sister Josephina, "A Study of Attitudes in the Elementary Grades," _Journal of Educational Sociology_, 33 (October, 1959), pp. 56-60.

[28] _Ibid._, p. 58.

ranked first on the list of least-liked subjects, while Rowland and Inskeep[29] noted it was rated fifth.

In the junior high school area, Mosher found that mathematics was the best-liked subject; yet, it had been relegated to third place by the time the student was involved in courses at the high school level. Mathematics placed third on the list of disliked school subjects at both the junior high and the senior high school levels.[30]

Numerous studies have indicated that as early as the third and fourth grades individuals have developed distinct attitudes toward mathematics. This topic poses a resolute problem to educators, since studies reported that changes in attitude occur rather slowly as far as chronological age is concerned.

Dutton (1951, 1954, 1956, 1962)[31, 32, 33, 34] developed scales to measure attitudes of prospective elementary school teachers and children toward arithmetic. Dutton found in 1954[35] that feelings toward

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[29] Rowland and Inskeep, p. 189.

[30] Mosher, p. 37.

[31] Dutton (1951), p. 84.

[32] Wilbur H. Dutton, "Measuring Attitudes Toward Arithmetic," Elementary School Journal, 55 (September, 1954), pp. 24-31.

[33] Wilbur H. Dutton, "Attitudes of Junior High School Pupils Toward Arithmetic," School Review, 64 (January, 1956), pp. 18-22.

[34] Wilbur H. Dutton, "Attitude Change of Prospective Elementary School Teachers Toward Arithmetic," The Arithmetic Teacher, 9 (December, 1962), pp. 418-424.

[35] Dutton (1954), p. 30.

mathematics were developed in all of the grade levels of elementary school--the most crucial spots were reported from grade three through grade six. In the same article, he later recounted that certain students develop definite attitudes toward mathematics even in the junior high school.

In 1956, Dutton published the following table on when 459 junior high school pupils developed their attitudes toward arithmetic:[36]

Grade Level	Number of Responses
All grades	12
I	18
II	13
III	43
IV	48
V	74
VI	53
VII	79
VIII	28
IX	5
No response	86
Total	459

He made the deduction that "Apparently, lasting attitudes toward arithmetic are developed at each grade level. The grades with a pronounced number of responses are V and VII. Grades III through VIII also are important in attitude development, according to these pupils"[37]

Dutton's investigation in 1962 revealed that the most critical years of growth of students' attitudes toward arithmetic occurred in

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[36]Dutton (1956), p. 21.

[37]*Ibid.*, p. 21.

grades four through eight. He remarked that this finding was in agreement with the 1954 research.[38]

An investigation in 1965 showed a direct variation regarding attitude and comprehension of the subject. This factor is demonstrated by his conclusion that "Student attitudes toward arithmetic reflected a growing appreciation of the subject as they increased their understanding of the subject. The general attitude of about 75 percent of the students toward arithmetic was quite favorable--varying from 6.0 to 9.5. The lowest 25 percent of the students in this study had unfavorable attitudes toward arithmetic--2.0 to 5.5. Many students have ambivalent feelings toward arithmetic."[39]

Smith[40] concurred with Dutton that feelings toward mathematics are developed in all stages of the school program. More than one-half of the students in Smith's survey named the elementary school years as the period in which their attitudes (positive or negative) toward arithmetic developed.

Fedon was also inspired in his investigation by Dutton's previous studies. He concluded that "It would seem apparent that very

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[38]Dutton (1962), p. 42.

[39]Wilbur H. Dutton, "Prospective Elementary School Teachers' Understanding of Arithmetical Concepts," The Journal of Educational Research, 58 (April, 1965), pp. 362-364.

[40]Frank Smith, "Prospective Teachers' Attitudes Toward Arithmetic," The Arithmetic Teacher, 11 (November, 1964), pp. 474-477.

definite attitudes are being expressed, both for and against arithmetic as early as third grade."[41]

Stright also agreed that definite attitudes in students toward mathematics were formulated by the third grade.[42] Her summary of the attitudes of all the students in grades three, four and six in one particular elementary school produced the following conclusions:

1. Only nine percent of the children checked felt that arithmetic was a waste of time.

2. Seventeen percent felt they got too much arithmetic.

3. Twenty percent thought arithmetic uninteresting.

4. Fifty-eight percent said it was the best subject in school.

5. Sixty-six percent wished they had more arithmetic.

6. Sixty-nine percent liked to do extra arithmetic just for fun.

7. Eighty-one percent said they really enjoyed math.

8. Eighty-six percent classified arithmetic as the most useful subject in school.

9. Eighty-seven percent felt that arithmetic taught them to be accurate.

10. Ninety-five percent of all the children felt that arithmetic would help them in their daily lives.[43]

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[41] J. Peter Fedon, "The Role of Attitude in Learning Arithmetic," The Arithmetic Teacher, 5 (December, 1958), pp. 304-310.

[42] Virginia M. Stright, "A Study of the Attitudes Toward Arithmetic of Students and Teachers in the Third, Fourth, and Sixth Grades," The Arithmetic Teacher, 7 (October, 1960), pp. 280-286.

[43] Ibid., p. 285.

Reys and Delon reported a slightly different interpretation regarding when attitudes toward mathematics were formulated. They said, "The greatest percentage of students indicated that their present feelings toward arithmetic were developed in the junior high grades."[44] Slightly fewer than half of the students in the previous survey stated that feelings toward mathematics developed in the elementary grades; of those who did, a majority indicated that attitudes occurred in the intermediate grades rather than in the primary ones.

Sex Comparisons Regarding Attitude

Since a subordinate problem was previously proposed that the sex of the pupil may accou t for a difference in attitude toward the subject matter, a few references to this possibility were extracted for explanation. Capps and Cox determined that there was not a significant difference in the assessing of attitudes between boys and girls at grade five. An additional statement by these writers concluded that there was a chance that some unidentified and undetermined factors may influence girls more strongly than boys in a favorable attitude toward arithmetic at or before the fourth grade.[45]

Wozencraft challenged the assumption made by some researchers that boys are better in arithmetic than girls and may have more positive

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[44]Robert E. Reys and Floyd G. Delon, "Attitudes of Prospective Elementary School Teachers Towards Arithmetic," The Arithmetic Teacher, 15 (April, 1968), pp. 363-366.

[45]Lelond R. Capps and Linda S. Cox, "Attitude Toward Arithmetic at the Fourth- and Fifth-Grade Levels," The Arithmetic Teacher, 16 (March, 1969), pp. 215-220.

interests, particularly at the secondary and college levels. A semantic approach would be clearer--i.e., one should stress the need to be specific about the referent when making generalizations. Actually, the prior assumption depends upon which boys and which girls are mentioned. Wozencraft finally said, "If any conclusions are to be drawn from these figures, they might be in respect to the necessity for a very broad program of work which allows pupils to work at their own levels of ability. These considerations are of more value for the arithmetic program than sex differences."[46]

Mosher attempted to study subject preferences of girls and boys and introduced another variable, rural versus urban environment. He declared that sex differences in subject preferences grow progressively greater in number and in variety as girls and boys reach different levels of maturity. In addition, he found little significance in the slight variations of the subject preferences of girls and boys with respect to their school communities, whether urban, rural or mountain.[47]

Related Human Factors

If, as some writers have indicated, mathematics is a much disliked course at any grade level, the influence of teachers and parents in the formation of such attitudes may be significant to this study. Statements such as these have appeared in journals: "It is only too

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[46] Marian Wozencraft, "Are Boys Better Than Girls in Arithmetic," The Arithmetic Teacher, 10 (December, 1963), pp. 486-490.

[47] Mosher, p. 38.

certain that today's mathematically ill-prepared teachers, many of whom are ill-disposed toward the subject, are infecting too large a number of our boys and girls with an enduring fear and hatred of mathematics, which can rarely be overcome later on in high school"[48] and "Our problem is further complicated by attitudes of many parents and teachers who feel that anything quantitative or numerical is extremely difficult or unimportant."[49]

Poffenberger and Norton did a comprehensive study on factors which dominate students' attitudes toward mathematics and proposed this seemingly relevant summary:

> The research findings in this paper give evidence that the present lack of interest in mathematics is largely a cultural phenomenon pervading not only the educational system of the country but also the family as an institution that conditions the attitudes of children. The hypothesis developed as a result of an analysis of data in the present study is that attitudes toward mathematics is a culmi·ative phenomenon, one experience building upon another. Attitudes are developed in the home in some cases before the child enters school. In the first and second grades he is effected not only by his teacher and his readiness to deal with numbers, but also by the attitude of his parents toward the subject matter. He carries into his high school mathematics classes attitudes that are long in building and difficult to change. Certainly it is logical to expect that the student who goes into a class with the thought "Here is another lousy math class," is severely handicapped.[50]

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[48] Marshall Stone, "Fundamental Issues in the Teaching of Elementary School Mathematics," The Arithmetic Teacher, 6 (October, 1959), p. 179.

[49] Warren G. Findley, "The Ultimate Goals of Education," School Review, 64 (January, 1956), p. 14.

[50] Thomas Poffenberger and Donald Norton, "Factors in the Formation of Attitudes Toward Mathematics," Journal of Educational Research, 52 (January, 1959), pp. 171-175.

Poffenberger and Norton noted that nearly half of the total student population of their study believed that their high school mathematics teachers had no effect on their attitudes at all. It appeared that these teachers were neither good enough nor poor enough to change attitudes toward mathematics in one direction or the other. "Students negatively conditioned by their parents and often by their schools, in turn raise their children in the same mold. Not only must we prepare more adequate teachers, we must also do a better job as parents in helping our children think of arithmetic and mathematics as an interesting and very worthwhile subject matter area."[51]

Banks stipulated that there is much evidence to support the fact that a positive correlation exists between attitudes teachers hold and the attitudes that their pupils develop.[52] Collier was an earlier investigator in this realm, although he felt that the problem of teachers' attitudes and their effects on the learners' interests needed more research.[53] Dutton proposed that prospective teachers reflected the attitudes developed in a traditionally oriented mathematics program.[54] Furthermore, Kane related that the most impressive general conclusion

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[51] Ibid., p. 175.

[52] J. Houston Banks, Learning and Teaching Arithmetic, (2nd edition; Boston: Allyn and Bacon, 1964), p. 19.

[53] Calhoun C. Collier, "Blocks to Arithmetic Understanding," The Arithmetic Teacher, 6 (November, 1959), pp. 262-268.

[54] Dutton (1962), p. 424.

obtained from his research was that the attitude of prospective teachers toward mathematics was relatively high.[55]

Aiken and Dreger referred to Gough's term mathemaphobia,[56] or pronounced fears in the presence of arithmetic and mathematics, when they attempted to explain negative attitudes of students toward mathematics. Their statement further appears to define pupils' attitudes and their subsequent development: ". . . such reactions result from experiences specific to the learning of mathematics, in particular that the manner in which significant others, viz., teachers and parents, instruct children in mathematics is the primary determinant of their attitudes toward this subject referred to here as 'math attitudes'."[57]

Lerch investigated the criticism that educators' organizational procedures of grouping or individualizing instruction for mathematics has an adverse or unfavorable effect on students' attitudes toward mathematics. His research revealed "The child's successes in arithmetic and his attitudes toward arithmetic are more basically dependent upon his teachers' attitudes and the methods they employ than they are upon classroom organization."[58]

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[55]Robert B. Kane, "Attitudes of Prospective Elementary School Teachers Toward Mathematics and Three Other Subject Areas," The Arithmetic Teacher, 15 (February, 1968), pp. 169-175.

[56]M. F. Gough, Mathemaphobia: Causes and Treatments, 28 (Clearing House, Publishers, 1954), pp. 200-204.

[57]Lewis R. Aiken, Jr. and Ralph M. Dreger, "The Effect of Attitudes on Performance in Mathematics," Journal of Educational Psychology, 52 (February, 1961), pp. 19-24.

[58]Harold H. Lerch, "Arithmetic Instruction Changes Pupils' Attitudes Toward Arithmetic," The Arithmetic Teacher, 8 (March, 1961), pp. 117-119.

In summarizing the portion of Chapter II which deals with definitions, related terms, development of attitudes, comparison by sex and related human factors, it seems appropriate to conclude that attitude implies different meaning in various research, although some amount of commonality exists throughout. The definitions can best be understood in the context of the literary setting of the study. This researcher conceives attitude as a generalized, emotionally-toned opinion that is learned and supported in varying degrees either for or against some particular object that is meaningful to a specific individual.

It appears that studies of attitudes should be done, since there is value and worth in understanding the etiology of such a factor as a student's attitude toward mathematics. Definite attitudes (positive or negative) have been found to occur in individuals as early as the third and fourth grades; therefore, the contribution of parents and teachers in the development of attitudes cannot be overestimated. The majority of investigators, when dealing with differences in pupils' attitudes toward mathematics as far as sex of the individual is concerned, indicate that a very large percentage of both boys and girls like mathematics and feel it is a useful subject.

Acquisition and Modification of Attitudes

Brown and Kinsella reported that the top priority problem in mathematics education at the time of their study was identifying the most effective methods of altering students' attitudes toward mathematics.[59]

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[59] K. E. Brown and J. J. Kinsella, Analysis of Research in the Teaching of Mathematics - 1957 and 1958 (U. S. Department of HEW Bulletin, 1960, Number 8 OE 29007), p. 3.

Leake, in a more recent publication, stated ". . . it does appear that change in interest is related to instructor factors. Much more research is needed in this area to ascertain whether or not techniques of teaching can be developed which are applicable for most instructors, or else changing a student's interest may remain an art which only certain instructors possess."[60]

Allport (in 1935) announced four main ways in which attitudes are acquired:

1. By integration of specific responses, organized from sensation, perception, and feeling. The child who is a bit of a "roughneck" may acquire an attitude of politeness in social situations because he has been to a children's party, because his teacher suggests certain standards, because he has visited a friend's home where certain forms of etiquette are observed--not because he is, in general, becoming more concerned with his status in the group.

2. By differentiation. Although the child has originally a vague and diffuse attitude toward the Chinese, he begins to distinguish among Chinese individuals in terms of their characteristics as persons, their occupations, or their friendliness to him.

3. By trauma. The child has experienced a highly emotional reaction in relation to lightning and thunder, or to being chased by a cow in a field, and develops an attitude toward electric storms or toward cows in general.

4. By imitation of ready-made attitudes. The child rather unconsciously adopts his parents' views regarding labor unions or religion or borrows the ideas expressed by a close friend in regard to a summer camp or by an author of a series of juvenile books.[61]

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[60] Charles R. Leake, "Interest Changes in Mathematics of Selected College Students in New York State" (Doctoral Dissertation, New York University, 1969).

[61] David H. Russell, Children's Thinking (Boston: Ginn and Company, 1956), p. 179.

Once attitudes are formed, they are relatively difficult to change, since they are so closely related to the total personality of an individual, his needs and his self-concept. Many authors have expressed the theory that attitudes are learned; therefore, it is assumed that they are changeable. Two major objectives of educators then become (1) an attempt to form acceptable attitudes and (2) the changing of non-acceptable attitudes, which were previously developed.

Krech and Crutchfield reported "Despite the significant influences of cultural factors on the development of beliefs and attitudes, despite the deep-rooted functional nature of many beliefs and attitudes, and despite the inherent tendency of beliefs and attitudes to preserve themselves, beliefs and attitudes can be changed."[62]

Investigation has demonstrated the alterability of attitudes. Murphy, Murphy and Newcomb commented that ". . . the prestige of the persons and symbols used in the relearning process are highly important in the eyes of the person whose attitudes one is trying to change."[63] An important variable in this change process appears to be age and even maturity of the individual. The older individual tends to undergo change in his attitudes with more difficulty than the younger one. Dewey said, ". . . with the young, the influence of the teacher's personality is intimately fused with that of the subject; the child

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[62]Krech and Crutchfield, p. 179.

[63]Gardner Murphy, Lois B. Murphy and Theodore M. Newcomb, Experimental Social Psychology (revised edition, New York: Harper and Brothers, Publishers, 1937), p. 979.

does not separate or even distinguish the two."[64] Bird dealt with the maturity factor in this passage: ". . . at the older ages, mankind is not as modifiable as at a period of earlier maturity."[65]

In summary, it appears that acquisition and change of attitudes are so intertwined that one can hardly be discussed without mentioning the other. This emphasizes the fact that educators should be concerned with individuals who come to them with various degrees of attitudes and with individuals, some of whose attitudes they have molded.

Attitude Measurement

Since there is a concern about the teaching of attitudes, this researcher will need to give priority to some methods of their assessment. It has already been established that attitudes are important, have complex natures and diverse interpretations, and that assessment of changes in attitudes is necessary for the investigator dealing in educational reform.

Subjective evaluation of attitudes has been accomplished by anecdotal records of behavior and expressed opinions by the students. This study employed a check list of observable classroom behaviors; a narrative description of these and their reliability appear in Chapter IV.

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[64]John Dewey, How We Think (Boston: D. C. Heath and Company, 1933), p. 59.

[65]Charles Bird, Social Psychology (New York: Appleton-Century Company, Inc., 1940), p. 447.

Edwards has described three general approaches to measuring attitudes: (1) direct questioning, (2) direct observation of behavior and (3) indirect measurement by utilizing attitude scales.[66]

Direct questioning is a technique which originally held the logical assumption that if one wanted to know how individuals feel about some particular psychological object, the best procedure would be to ask them. Individuals may then be classified into three groups as a result of this method: (a) those with favorable attitudes, (b) those with unfavorable attitudes and (c) those who respond by saying they are doubtful or undecided about their attitudes toward the object. The latter group is responsible for giving the method of direct questioning its unreliability. Individuals often are reluctant to disclose their feelings on controversial or possibly threatening issues. In addition, our attitudes about a psychological object are sometimes so mixed and confused that it is difficult for the person to make an evaluation by introspective methods.

Direct observation makes use of observing behavior of people with respect to a psychological object, rather than asking direct questions about how they feel about the object. This approach also has its limits, since there is usually no necessary one-to-one correspondence between overt behavior and attitudes. Attitudes, as vectors of influence on behavior, may be one of many such factors determining an individual's actions, and not necessarily the most powerful. The

[66] Allen L. Edwards, Techniques of Attitude Scale Construction (New York: Appleton-Century-Crofts, Inc., 1957).

technique of direct observation may prove more reliable if repeated observations are made over a longer period of time.

The literature actually concentrates upon the method of indirect measurement, since better reliability can be obtained and it is a quick and convenient assessment of attitudes that can be used with large groups. In addition, attitude scales provide the researcher with a means of obtaining a measurement of the effective degree to which individuals may associate with some psychological object.

The construction of adequate attitude scales involves the employment of a number of items, or statements, that require careful editing and selection. In fact, this selection should be accomplished with certain criteria just as those items in any standardized psychological test. Edwards has accumulated various suggestions of investigators as to the informal criteria for editing statements to be used in the construction of attitude scales.

1. Avoid statements that refer to the past rather than to the present.

2. Avoid statements that are factual or capable of being interpreted as factual.

3. Avoid statements that may be interpreted in more than one way.

4. Avoid statements that are irrelevant to the psychological object under consideration.

5. Avoid statements that are likely to be endorsed by almost everyone or by almost no one.

6. Select statements that are believed to cover the entire range of the affective scale of interest.

7. Keep the language of the statements simple, clear, and direct.

8. Statements should be short, rarely exceeding 20 words.

9. Each statement should contain only one complete thought.

10. Statements containing universals such as "all, always, none, and never" often introduce ambiguity and should be avoided.

11. Words such as "only, just, merely," and others of a similar nature should be used with care and moderation in writing statements.

12. Whenever possible, statements should be in the form of simple sentences rather than in the form of compound or complex sentences.

13. Avoid the use of words that may not be understood by those who are to be given the completed scale.

14. Avoid the use of double negatives.[67]

Attitude scale construction has been organized according to the items comprising the series. Edwards' book considered five such types of instruments: (1) the method of paired comparisons, (2) the method of equal-appearing intervals, (3) the method of successive intervals, (4) the method of summated ratings and (5) the method of scalogram analysis.[68] In comparison, Kerlinger devoted a chapter in his volume to three major types of attitude scales: (1) summated rating scales (also called Likert-type scale), (2) equal-appearing interval scales (devised by Thurstone) and (3) cumulative (or Guttman) scales.[69] This third category approximates the one referred to by Edwards as "the method of scalogram analysis."

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[67] Ibid., pp. 13-14.

[68] Ibid., pp. 13-14.

[69] Kerlinger, P. 483.

Bird[70] gave the name of the method of summated ratings to Likert's[71] method of scale development. This type of inventory consists of (1) the collection of items by means of interviews, essays and/or informal open-ended questionnaires; (2) the use of these responses from subjects in any one of five categories: strongly agree, agree, undecided (or don't know), disagree or strongly disagree; (3) the weighing of each response as 4, 3, 2, 1 or 0, depending upon the degree of favorable response toward the item; (4) the summation of these scores obtained from individual statements to yield a total general attitude score; (5) the analysis of the various items and (6) the acceptance of the final scale which significantly differentiates individuals as to their favorable or unfavorable disposition toward the area of concern. With reference to the current study, an example of this type of attitude scale, reported in Chapter IV of this paper, is the "Ideas and Preferences Inventory, Form 121B."

The Thurstone equal-appearing interval scales were formulated with different principles. The ultimate product remains a set of attitude items which can be utilized in a similar area of assigning individuals interest scores or places along the continuum of agreement and disagreement. In addition, the equal-appearing interval scales accomplish the important purpose of assigning values to the attitude statements. The most desirable psychometric feature of this instrument is

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[70] Bird, p. 159.

[71] R. Likert, "A Technique for the Measurement of Attitudes," Archives of Psychology, No. 140, 1932.

that the items of the final scale to be used are so selected that the intervals between them are equivalent. The usual procedure for determining the scale values of the items is obtained from Thurstone and Chave's scale.[72]

Kerlinger's third method of assessing attitudes is the cumulative or Guttman scale.[73] This inventory consists of a relatively small set of homogeneous statements that are unidimensional, or nearly as one-faceted as possible in the development of the instrument. A unidimensional scale is intended to measure one variable only; the scale derives its name from the cumulative relation between items and the total scores of individuals.

It seems obvious that these three ways of constructing attitude scales are quite different. The summated rating scale emphasizes the subjects themselves and their places on the continuum. The equal-appearing interval scale focuses on the items themselves and their places on the scale. Cumulative scales converge on the scalability of sets of statements and on the scale positions of individuals.

When behavioral research is conducted, it appears that the summated rating scale is the most useful of the three types mentioned in this review. Its ease of development is a primary factor here, since the results, as far as reliability is concerned, are approximately the same as the more laboriously constructed, equal-appearing interval scale.

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[72]L. Thurstone and E. Chave, The Measurement of Attitude (Chicago: University of Chicago Press, 1929).

[73]Remmers and Gage, pp. 392-400.

Cumulative scales seem to be less useful and less generally applicable, although they have been utilized in certain areas of psychological assessment. "If one clear-cut cognitive object is used, a short well-constructed cumulative scale may yield reliable measures of a number of psychological variables: tolerance, conformity, group identification, acceptance of authority, permissiveness, and so on."[74]

Other methods of assessment of attitude and personality have been formulated and should be mentioned in this review of the literature. These include forced-choice, rank-order, rating and factor analytic. But the problem of real validity exists more in these types than in the previously-mentioned methods.

Finally, it appears that the reliability and the validity of the instrument used in this study to assess change of attitude are of major consideration. Kerlinger said, "After assigning numerals to objects or events according to rules, an investigator must face the two major problems of reliability and validity. He has devised his measurement game and has administered the measuring instrument to a group of subjects. He has a set of numbers, the end product of the measurement game. He must now ask and answer the questions: What is the reliability of the measuring instrument? What is its validity?"[75]

A few synonyms for reliability are dependability, stability, consistency, predictability and accuracy. Psychological and educational

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[74]Kerlinger, p. 487.

[75]*Ibid.*, p. 429.

measurements, then, are reliable if one can predict with accuracy and if one can depend upon their stability and consistency.

There are three ways to approach the definition of <u>reliability</u>:

1. Will we get the same or similar results if we duplicate the same or comparable measuring instrument to assess the same set of objects? (This interpretation tends to utilize stability, dependability or predictability as definitions of reliability.)

2. Are the results given by the measuring instrument the "true" assessments of the property measured? (This definition uses accuracy as the determiner of reliability.)

3. What is the amount of "error of measurement" found in a measuring instrument? (These errors are self-compensating ones and are random in nature. "They are the sum or product of a number of causes: the ordinary random or chance elements present in all measures due to unknown causes, temporary or momentary fatigue, fortuitous conditions at a particular time that temporarily affect the object measured or the measuring instrument, fluctuations of memory or mood, and other factors that are temporary and shifting."[76])

While it is possible to determine reliability without inquiring into the meaning of the variables whose reliability measurement is under study, it is not possible to study validity in this same manner. Sooner or later, in validity checks, one must inquire into the nature and the meaning of the variables.

When validity is assessed, the question is usually raised as to whether the instrument measures what it is intended to measure. Validity concentrates on "what" is being measured.

Four types of validity are presented: predictive, concurrent, content and construct. Each of these will be discussed briefly; however,

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[76] *Ibid.*, p. 430.

it appears that the construct type bears the most emphasis, since it is probably the most important form from the scientific research point of view.

Content validity refers to ". . . the representativeness or sampling adequacy of the content--the substance, the matter, the topics--of a measuring instrument."[77] This type is actually guided by the following question: Is the substance or content of this measure representative of the content or the universal nature of the content of the property being measured? Content validity is basically judgmental and each item of the inventory must be judged for its presumed relevance to the property being measured.

Predictive validity and concurrent validity have been found to be quite similar. They are usually considered the same in investigations and differ only in the time dimension. Prediction is normally associated with a future kind of outcome; but tests such as aptitude, achievement and intelligence are also concurrent with some present state of affairs of the individual. The major problem of predictive validation is the criterion. Obtaining possible criteria may be difficult; often criteria do not even exist, or their validity may be doubtful. For example, what criterion should supervisors use to validate a measure of teacher effectiveness, or what criterion should be utilized to test the predictive validity of a musical aptitude test?

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[77]"Technical Recommendations for Psychological Tests and Diagnostic Techniques," Psychological Bulletin, 51 (Supplement, 1954), p. 13.

Construct validity is a significant advancement of modern measurement theory and practice, since it unites psychometric suppositions with scientific theoretical ones. The prime feature in this type of validity is stated by the factors or constructs which account for variance in test performance. The measurement expert may specifically ask: "Does this test measure verbal ability? Does it also 'measure' social class membership? He is asking what proportion of the total test variance is accounted for by the constructs: verbal ability, abstract reasoning ability, and social class membership. In short, he seeks to explain individual differences in the test scores of a measuring instrument. His interest is more in the property being measured than in the test itself."[78]

Construct validation in assessment differs from empirical approaches, which only define the validity of a measure by its success in predicting a criterion. An example of an empiric tester would be one who assumes a test is valid if it efficiently distinguishes individuals high and low in a certain trait. Construct validation, on the other hand, attempts to determine why the test succeeds in separating the subsets of a group.

In summary, this portion of the chapter indicates that psychologists and educators are very much concerned with the problems of attitude measurement. This concern is emphasized by the scope of literature devoted to the topic and by the many attempts to devise adequate reliability and validity standards.

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[78] Kerlinger, p. 448.

It seems that the criticisms of psychological and educational assessment, by professionals and laymen alike, center on validity. Actually, the achievement of reliability is to a large extent a technical matter, but validation of an instrument involves more than just technique. The researcher must delve into science itself and philosophy for validity information. Construct validity is given priority, since it is concerned with the nature of reality and the nature of the properties being measured.

Relationship of the Computer to Education

Prior to the initiation of this investigation, nearly all of the literature related to computer-implemented mathematics instruction was descriptive and speculative. Researchers began publishing their findings toward the mid-1950's and much of the earlier work was tied in with programmed instruction. In addition, there has been a decided emphasis upon the relationship of Computer Assisted Instruction (henceforth, this shall be reported as CAI) to achievement in mathematics education. It appears that this type of sequence is the natural orientation of writers when dealing with such innovational techniques.

The effect of CAI on the attitude of students was generalized by Bundy when he said "Students are generally interested in and like the CAI form of instruction."[79] He reached this conclusion based on information obtained in his study and from the following investigations:

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[79]Robert Bundy, "Computer-Assisted Instruction - Where Are We?" Phi Delta Kappan, 49 (April, 1968), p. 425.

Mitzel and Wodke stated that "Student attitude toward CAI generally relates directly to personal performance."[80] Wilson reported "Appropriate pacing of materials presented and time-out limits can keep the concentration of even very young children at a relatively high level in a CAI system."[81]

Bundy, in his interpretation of the positive influence between computers and interest, cautioned that ". . . students often feel the need for shorter sessions with more discussion and teacher interaction."[82]

Computer management systems at the secondary school level have been termed useful in at least three ways by Hoffman et al.:[83] by pupils in conjunction with courses, by pupils in vocational training programs and by the school administration for data processing. The authors substantiate the attitude development feature by the following quote: "In addition to the obvious motivational advantage, students who write computer programs acquire a better understanding of the mathematical concepts involved."[84]

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[80]Harold E. Mitzel and Kenneth H. Wodke, "The Development and Presentation of Four Different College Courses by Computer Teleprocessing" (University Park, Pennsylvania: CAI Laboratory Interim Report, 1965).

[81]H. A. Wilson, "Computer-Assisted Instruction: A Tool for Teaching and Research" (Discussion of Stanford-Brentwood CAI Project, no date).

[82]Bundy, p. 425.

[83]Walter Hoffman, Robert L. Albrecht, William F. Atchison, Sylvia Charp and Alexandra Forsythe, "Computers for School Mathematics," The Mathematics Teacher, 58 (May, 1965), pp. 393-400.

[84]Ibid., p. 395.

Price's article "Progress in Mathematics and Its Implications for the Schools" emphasized the introduction of the large-scale, high-speed, automatic digital computing machine as one of the causes of the "revolution in mathematics." His assumptions were made because calculations can be accomplished more rapidly than heretofore and computations which were formerly completely impossible can now be made quickly and efficiently.[85]

Atkinson and Wilson attributed the rapid development of CAI ". . . to the rich and intriguing potential of CAI for answering today's most pressing need in education--the individualization of instruction."[86] The authors stipulated that individualized instruction took its beginnings from the development of programmed instruction primarily from the work of Skinner.[87] "Even though the actual results of programmed learning fell somewhat short of the glowing predictions of its early prophets, it left educators in a state of 'rising expectations.' The feeling remained that somehow through the use of science and technology the instructional process might eventually be tailored in a meaningful way to match the already known differences in motives and abilities among students."[88]

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[85] G. Baily Price, "Progress in Mathematics and Its Implications for the Schools," The Revolution in School Mathematics (Washington, D.C.: A Report of Regional Orientation Conferences in Mathematics, National Council of Teachers of Mathematics, 1961), p. 4.

[86] R. C. Atkinson and H. A. Wilson, "Computer-Assisted Instruction," Computer-Assisted Instruction, A Book of Readings, edited by R. C. Atkinson and H. A. Wilson (New York: Academic Press, Inc., 1969), p. 3.

[87] B. F. Skinner, The Technology of Teaching (New York: Appleton-Century-Crofts, 1968).

[88] Atkinson and Wilson, p. 3.

Hickey, the editor of a survey of the literature on CAI, related that an important part of the justification for computerized programs is their significance in individualized instruction. He reasoned "The study of individual differences therefore assumes some importance. For example, what kind of individual prefers independent learning to more traditional classroom learning?"[89] He recounted a four-year comparison by Ingersoll of medical students at Ohio State University, some of whom had elected an independent learning approach and others who had preferred a traditional approach. Ingersoll's research appears to be relevant to this study; he found little difference, if any, in the two subgroups on general information scores and on performance, but significant differences occurred in the following measures of personality:

1. The independent learner had higher scores on creative personality, intellectual quality, humanity interest, social-science interest, and physical-science interest.

2. The traditional group had significantly higher scores than the independent learner section in reserved versus outgoing, stable, conscientious, tough-minded, and group-tied, and had higher anxieties; while the independent section is described as more intelligent, venturesome, imaginative, placid, experimental, and creative, with higher leadership.

3. The independent group scored significantly higher on thinking intraversion, theoretical orientation, asetheticism complexity, autonomy, religious liberalism, and impulse expression.[90]

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[89] Albert E. Hickey, editor, Computer-Assisted Instruction: Survey of the Literature, 3rd edition, Technical Report No. 8 (Newburyport, Mass.: ENTELEK, Inc., October, 1968), p. 70.

[90] *Ibid.*, p. 70.

Sweet used a unit in a class of ninth graders studying School Mathematics Study Group geometry and reported that there was as much enthusiasm, or more, on the part of the class for the particular unit as there was for any other topic. "The students seemed to assimilate the programming language with no more difficulty than in learning other junior high subjects. The resulting conclusion is that such a unit is neither too difficult for junior high students of high ability nor is it hard to teach. The main difficulties are in finding instructors for such a course, in securing enough available class time, and in locating machine time that would be available on a permanent basis."[91]

In summary of this portion of the commentary, Sharpes' testimony on the value of the computer in the area of education seems to be appropriate.

> Educators can assume various stances to the rapid thrust of computer technology into elementary and secondary education. They can conservatively reject it as a forced encroachment on standard procedures and on traditional ideologies, or reject it as a passing fad. They can remain insouciant and disengaged until convinced that computer technology has demonstrated its perfection in corporate industry. Or educators can endeavor to shape, develop, and direct it--anticipating educational needs, and making long-range plans for its adoption.[92]

Computer-Reinforcement to Learning

It appears that the major value of computer facilities in the educative process is not that they enable schools to teach computer

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[91] Raymond Sweet, "High Speed Computer Programming in the Junior High School," The Mathematics Teacher, 56 (November, 1963), pp. 535-536.

[92] Donald K. Sharpes, "Computers in Education," The Clearing House, 43 (November, 1968), p. 136.

science courses, but that they provide the school with a valuable and motivating teaching aid which can be used in teaching the existing mathematics curriculum.

Sharpes informed the system that "Experimental techniques have been developed and are even now being tested which might in the future prove to be valuable aids to instruction."[93] Forsythe terms the computer's assistance in mathematics instruction a "betrothal" in the following remark:

> But this is precisely what a computer does; it carries out algorithms to solve a class of problems. This experience in application seems to me to be the important thing which computing can contribute to the training of mathematics students. It is this marriage of mathematics and computing which appears so hopeful. Since it is only a promised wedding, I call it a betrothal.[94]

Harvey found that a unit in computer organization helped seventh grade students in computational concepts. He remarked "From the experience with the class, it appears completely feasible to teach Junior High School students (Grade 7) to program and operate a computer in a simple way."[95]

Pierson mentioned a fusion of applied and pure "modern" mathematics by means of computerized instruction, so that a curriculum could

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[93]*Ibid.*, p. 137.

[94]Alexandra Forsythe, "Mathematics and Computing in High School: A Betrothal," The Mathematics Teacher, 57 (January, 1964), p. 7.

[95]R. B. Harvey, "Grade Seven and a Computer," School Science and Mathematics, 68 (February, 1968), pp. 91-94.

be developed and stimulate the students for both achievement and interest purposes.[96]

Austin discovered that the computer gave much aid in the learning process of sixth graders in Norwalk, Connecticut, because of the tremendous amount of interest, motivation and attention it generated. He talked about the challenge of the future in relation to the multi-media program.

> The sixth-grade program was just one by-product of what had been planned as a junior and senior high school experiment in using computers as instructional tools not only for math, but for science, business education, and any other areas where accurate analysis of data is vital. Another by-product was the interest emanating from nearby communities: student and faculty groups from neighboring towns soon began taking their turns at the console. As a result of all this interest, Monroe has decided to leave the computer where it is for an indefinite period.[97]

Charp[98] reported that most content areas have problems or projects in which a computer can serve as an aid in the learning program. The computer can be utilized in various types of classes for the solution of problems heretofore impossible because of the extensive use of computation involved.

Zinn actually gave an appropriate summary to this section of the thesis when he urged the use of computer aids for instructional management.

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[96]Elliot Pierson, "Junior High Mathematics and the Computer," The Mathematics Teacher. 56 (May, 1963), pp. 298-301.

[97]Malcolm Austin, "What! Sixth-Graders Run a Computer," Grade Teacher, 84 (September, 1966), pp. 132-138.

[98]Sylvia Charp, "Computers Solve Math Instruction Problems," Nation's Schools, 78 (October, 1966), p. 79.

> Well designed computer systems will significantly augment the capabilities of classroom teachers through semi-automated handling of records and instructional materials. Management applications can be implemented on a large scale sooner than tutorial uses of computers by individual students, and at much less expense per unit of instruction accomplished. Furthermore, knowledge about assessment of performance and sequencing of material in management systems will contribute to effective implementation of conversational tutorial uses of computers by students.[99]

Self-Pacing Approach

This investigator anticipated that the literature would reveal some studies of the computer's effect in a self-pacing program on students' interest toward subject matter; however, no information was found on the foregoing topic. Perhaps some knowledge will be obtained from this research, although no provisions for this effect were incorporated in the instrument. In an explanation of the classroom observations anticipated for Chapter IV, some conclusions may be drawn.

A clue to the interpretation of the self-pacing approach may lie in the student's option of the instructional program. Rather than having the type of program selected for the pupil, it might be preferable to allow him to select the approach which would most adequately satisfy his particular needs. Ryan assumed the rationale for her study from a set of theories supported by other research. Some of her major assumptions were as follows:

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[99]Karl L. Zinn, "Computer Technology for Teaching and Research on Instruction," Review of Educational Research, 37 (December, 1957), p. 626.

1. Instructional methods have varying effects on learners with different need patterns.

2. Different personality patterns of students in regular classroom situations determined various need patterns.

3. When students demonstrated their preferences for instructional approaches, they would select that which was commensurate with their specific needs.[100]

Computers and People

The rationale for these final remarks will encompass the influence that computers have upon human beings in general. It seems necessary therefore to discuss three major problem areas related to the application of computers to the "educational" clientele: (1) the question of facilitating man-machine communication, (2) the question of cost efficiency and (3) the question of user acceptance.

The first of these "human interest" orientations was described by Silberman in his article: "Two factors make it difficult for people to communicate with machines. First, the terminals for inputting information into the machine and receiving information from it are not appropriate for most educational applications. Secondly, the language that a computer understands isn't appropriate to the person who is attempting to communicate with the machine."[101]

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[100] Antionette Ryan, "Testing Instructional Approaches for Increased Learning," Phi Delta Kappan, 46 (June, 1965), pp. 534-535.

[101] Harry F. Silberman, "Applications of Computers in Education," Computer-Assisted Instruction, A Book of Readings, edited by R. C. Atkinson and H. A. Wilson (New York: The Academic Press, 1969), pp. 57-61.

The second problem concerns the analysis which an educational system must perform on the cost benefits of the multi-media program. A cost benefit analysis must first compare the computerized managed course with the traditional one and secondly select alternate systems that have the lowest costs and the highest effectiveness.

The most expensive financial feature is probably the development and maintenance of high quality written materials and computer software necessary to maintain the various applications. "For example, it has been estimated that an average of 100 hours of author time is involved in the development of one hour of student console time for instructional applications of computers. There doesn't appear to be any easy solution to this problem."[102]

Severna Park Senior High School has leased its computer facilities, but some schools have purchased them through National Defense Education Act Title III funds in mathematics and science and N.D.E.A. Title VIII funds in vocational and technical education. The Vocational Education Act of 1963 has also been utilized as a source of financial help.

> Another way schools can ease costs is by installing remote terminals connected to computers located elsewhere. This makes computers available to the school with no need to purchase them. Remote terminals cost approximately $6,000. They are usually leased from the manufacturer, as are telephone equipment and lines from the telephone company. Dataphone data sets, which enable the terminal equipment to communicate with a central process over regular telephone facilities, can be installed for approximately $35. In addition, a monthly rental of $32.50 is charged for each set. The terminal rent is approximately $136 a month, and computer time is approximately $12 per hour.[103]

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[102] Silberman, p. 59

[103] Charp, p. 79.

The problem of acceptance by the staff and the students, as well as the attitudes toward the computer program by the parents and the community, bear considerations. Although school personnel will not be the manufacturers of computerized systems, they should be involved in designing the systems relevant to usage in their schools. This involvement plus an effective staff training program seem to be significant prior to the installation of such a system in a school. Silberman concluded with "The critical issue in acceptance is to constantly remind the user of the human values to be served by the system and the ways in which they are incorporated in one's design and development work. Those values can all too easily be forgotten unless they are kept constantly at the forefront of our attention."[104]

In conclusion, there is evidence that students in a computerized-managed system have felt that the computer is helpful in the understanding of principles and in the actual learning process. When a gain occurs in understanding of principles, the application of these principles in realistic situations is enhanced. Cost of the computer program does appear to be high, but this may seem more reasonable when viewed on a per pupil basis and the conceived increase to the total learning process.

While some individuals, concerned with the preservation of humanistic or individualistic traditions, view computer technology in our society as a threat, others view it as a major thrust in the realm of individualization of instruction. Research has revealed that society

[104]Silberman, p. 61.

accepts the computer as a potent teaching aid and that the computer has a definite future in subsequent innovative planning in the educational system.

The ensuing chapter deals with the procedures and the design of the research.

CHAPTER III

PROCEDURES

Introduction

This study was intended to determine whether there were differences in students' attitudes toward mathematics as a result of two different treatments in a geometry program. The experimental group consisted of students in a computerized-managed classroom environment and the control group was associated with a more traditional or teacher-oriented instructional approach.

The investigation was restricted to students at Severna Park Senior High School in the Anne Arundel County public school system of the State of Maryland. Although the limitations were discussed in Chapter I, it seems appropriate to reiterate that any projections to be derived from this study must be limited to analagous student populations operating in similar school situations.

Sources of Data

The population in the study consisted of sixty-eight students from each of the two treatment groups. These are further subdivided in Table 1. The students were selected by taking every third name (computer section) and every name (regular section) from the teachers' registers in each group; the verbal and numerical skill IQ results were obtained from the guidance office. The IQ quotients for each pupil were derived from the Lorge-Thorndike, Level-5 test administered during the eighth grade to the recipients. These IQ numbers were utilized as the covariates (pre-test) for an analysis of covariance on the attitude inventory (post-test).

Table 1.--Sub-groups of the population

Grade	Computerized-Managed Program	Teacher-Oriented Program
Tenth Grade		
Boys	23	19
Girls	29	32
Sub-Total	52	51
Eleventh Grade		
Boys	5	13
Girls	11	4
Sub-Total	16	17
TOTAL	68	68

The multi-media project students were stationed in two separated, but aligned rooms of the school--each room (twenty-four by thirty-two feet in size) had an instructor in a team-teaching situation, but the two groups were treated as one section during that particular class interval. The students in one room were self-grouped at six tables and used the computer and all of the audio-visual aids which supplemented the program. The students in the other room used the classroom in a more traditional arrangement, although student individualization was rather pronounced in this setting. Individual arm chair desks were used; the students studied at their desks, sought help from the instructor at her desk or took cumulative tests (usually once a week). There was much movement between the two rooms as the individual student decided the particular locale which his work required. Appendix A includes a description of printed materials, a list of topics, texts, audio-visual items and equipment necessary for implementation of the multi-media project as approved by the Anne Arundel County Board of Education.

The control group of students, consisting of four individual sections, were seated in regular arm chair desks in the same size classroom as previously mentioned. The utilization of a more teacher-oriented program was in evidence in this environment. There was little student movement inside of the classroom, although the instructor walked around to help, particularly near the end of the period when the students were alloted time to begin their assigned work.

Description of Instrument

"The Ideas and Preferences Inventory, Form 121B" was the instrument used as the measure of attitude toward mathematics. It was administered to all the subjects in the cafeteria on May 4, 1972, durint a forty-minute period. The inventory plus an instruction sheet for administering the test and an answer sheet will be found in Appendix B. A request for permission to use this instrument was obtained from Dr. Edward G. Begle, Director of School Mathematics Study Group; School of Education - Cedar Hall; Stanford University; Stanford, California 94305. Statistical information on this test was obtained from A. C. Vroman, Inc.; 2085 E. Foothill Boulevard; Pasadena, California 91109.

The inventory mentioned above will be found in pages 13 through 22 of the National Longitudinal Study of Mathematics Abilities (NLSMA), copyright 1968 by the Board of Trustees of the Leland Stanford Junior University. The reports, No. 3, Z-Population Test Batteries, were edited by Edward G. Begle, Leonard S. Cahen and James W. Wilson.

Observable Classroom Activities

A description of the actual classroom observations is included in this study; the findings will be discussed in Chapter IV. Thirty observations were made in each program at fifteen-second intervals during the fifty-minute class period. This investigator visited both types of classes on the same day, noting thirty-two sessions during the months of April and May with a total of 960 observable activities. Prior to the selection of the final activity form, twenty-six observations were made in a pilot study during a three-week period in March.

An independent observer made ten visits to the classes as a check on agreement of the behaviors recorded by this examiner. On two occasions, individual sheet checks were recorded, so that the actual sequence of the activity was tested for agreement as well as for a determination of the total number of each activity during the fifty-minute class period.

Appendix C of this study includes an outline of each of the twenty-six items of the "Observable Classroom Activities" check list and the items themselves. Categories of activities and the included items originated from OScAR III (Wilk and Edson, "A Study of the Relationship Between Observed Classroom Behaviors of Elementary Student Teachers, Predictors and Those Behaviors, and Ratings by Supervisors," University of Minnesota, January, 1962) as adapted by Herman, Potterfield, Dayton and Amershek; "The Relationship of Teacher-Centered Activities and Pupil-Centered Activities to Pupil Achievement and Interest in 18 Fifth-Grade Social Studies Classes," University of Maryland, March, 1969. Certain of the original thirty items were deleted, while others were incorporated into the twenty-six items for coding behaviors in the classroom. The four categories mentioned in the OScAR III form were also excluded, necessitating some manipulation of the item numbers to relate to those behaviors which were, for the most part, teacher-centered and those which were pupil-initiated.

Treatment of Data

The writers of all the NLSMA tests affirm reliability by stating that over 112,000 students from 1,500 schools in forty states participated in the various studies. They cautioned that the inventories or scales should not be used to evaluate individual students, since the original design of the tests was intended to compare large groups of students. The reliability of the inventory administered in this study was measured by utilizing coefficient alpha. This is an estimate of the internal consistency reliability of the attitude scale. An additional part of the output was a cross-validation technique to obtain split-half coefficients.

Schafer developed the format in this cross-validation procedure, part of which is explained in the following excerpt:

> The examinees are randomly split into two groups, group E (experimental) and group V (validation), in the cross-validation technique. For each subtest, using the group E data, comparisons are made among all possible splits of the items into two halves, in order to determine which split yields the highest split-half reliability coefficient. This "best split" is then employed to calculate a corrected split-half reliability coefficient--using, for the purposes of cross-validation, just the data from group V.[1]

The total test utilizes a combination of the "best splits" of the individual subtests. A corrected split-half coefficient is then calculated from the partitioning of the items in conjunction with the data from group V.

The responses for each of the forty-five items of the attitude scale were assigned values ranging from one for the most negative reply to four, five or six (depending upon the number of response choices) for the most positive answer. This procedure included a "flipping" (reversal of the order of assigning values to responses) when the item stem was a negative statement. When there was no response to a particular item, a neutral value was assigned for the statement (i.e., items with 4, 5, or 6 reply choices were given the values of 2.5, 3 or 3.5, respectively). Finally, the item scores were summed to produce the total scale score.

It seems appropriate to mention here that item #16 was omitted from the inventory, because it did not pertain in any way to the relationship of students' attitudes toward mathematics. The statement reads as follows:

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[1]William D. Schafer, "A Computer Program to Generate Reliability Indices for Composite Tests Including a Cross-Validation Technique," Educational and Psychological Measurement, 32 (Autumn, 1972), pp. 793-794.

"I have:

G. no older brothers or sisters

H. one older brother or sister

J. two older brothers or sisters

K. more than two older brothers or sisters."

A multivariate factorial analysis of covariance (MANOVA) was employed as a statistical procedure to test the major hypothesis that the computerized-managed instructional program in geometry would generate differential student interest toward mathematics when compared with the teacher-oriented approach. In addition, univariate analyses of covariance were utilized to determine if other selected independent variables were affected by the program (the independent variable). The homogeneity of regression assumption was checked for each of the univariate tests. These dependent variables were described and referred to as subordinate problems in Chapter I and include:

1. Mathematics versus Non-Mathematics
2. Mathematics Fun versus Dull
3. Pro-Mathematics Composite
4. Mathematics Easy versus Hard
5. Ideal Mathematics Self-Concept.

The three independent variables were:

1. Treatment - this involved comparisons between the experimental and control groups of students.
2. Sex - this was intended to distinguish if attitudinal changes toward mathematics occurred as a result of the student's sex.
3. Class - this was designed to detect if differences existed between tenth grade and eleventh grade pupils.

Eighty-eight subjects were utilized in the MANOVA to obtain the necessary cell labels which appear in Table 2. The forty-eight remaining individuals were randomly deleted from the cells to give a balanced layout to the cells which related to treatment to the sex of the individual. The cells correlating treatment to the student's class and sex to class were arranged in an orthogonal design with a proportion of 4.5 to 1.

Summary

"The Ideas and Preferences Inventory, Form 121B," was administered to 136 students as the instrument to determine the differences in students' attitudes toward mathematics as a result of exposure to multi-media and traditional programs in geometry. If other researchers attempt to derive inferences from this investigation, they should be aware that a rather small sample size was included and that one specific student population was studied.

The statistical results found in this study will be presented in Chapter IV.

Table 2.--Cell labels of eight groups of geometry students

Sex	10th Grade		11th Grade	
	Computer	Regular	Computer	Regular
Male	23*	19*	5*	13*
	18**	18**	4**	4**
Female	29*	32*	11*	4*
	18**	18**	4**	4**

Table 2a.

Sex	Computer	Regular
Male	22	22
Female	22	22

Table 2b.

Grade	Computer	Regular
10th	36	36
11th	8	8

Table 2c.

Grade	Male	Female
10th	36	36
11th	8	8

*Refers to the 136 students originally in the ANCOVA.

**Refers to the 88 students utilized in the MANOVA.

CHAPTER IV

FINDINGS AND ANALYSIS

Introduction

In an attempt to discern whether students' attitudes differed as a result of the type of treatment in two geometry programs, this investigation used the "Ideas and Preferences Inventory, Form 121B." One part of the population included those students in a computerized-managed instructional approach and was designated the experimental group. The other portion consisted of students in a teacher-centered learning environment and was termed the control group.

The independent variables referred to the type of program administered, the sex and the grade level of the subjects; the dependent variables consisted of six subscales of the attitude measure. The subscales were listed as attitudinal comparisons of mathematics versus non-mathematics, mathematics - fun versus dull, pro-mathematics composite, mathematics - easy versus hard, ideal mathematics self-concept. Two covariates used for covariance adjustment were the verbal and numberical scores derived from the Lorge-Thorndike test, Level-5.

A multivariate factorial analysis of covariance (MANOVA) was used to determine whether differences on the dependent variables reached statistical significance. Thus, the multivariate factorial analysis of covariance included the eight variables mentioned in the preceding paragraph and the two levels of each of the three factors [cf. the eight cells in Table 2, Chapter III, page 69: treatment (experimental or control group), sex (boy or girl) and class (tenth or eleventh grade)].

Reliability Estimates of the Attitude Test

The attitude inventory used in this research yielded a total score based on forty-five items. The individual responses to the statements of the test were considered item scores and the reliability indices of the composite test were based upon the total scores of 136 examinees. Following Schafer,[1] these were then randomly divided into an experimental group of sixty-seven subjects and a validation group of sixty-nine subjects. Thus, the cross-validated split-half index, corrected for test length, was .8735; the usual coefficient alpha was .8261. These coefficients were judged acceptable for the purposes of reliability in the present study.

Multivariate Factorial Analysis of Covariance

The multivariate factorial analysis of covariance was computed

[1]Schafer, p. 794.

on a 2 X 2 X 2 layout, corresponding to the factors of treatment (T), sex (S) and class (C). The analysis included adjustment for the two covariates, verbal and non-verbal IQ scores.

The research issue behind the homogeneity of centroids test is whether two or more sample groups should be considered as originating from a single multivariate population or from two or more multivariate populations. The null hypothesis for the homogeneity of centroids test states that the sample statistics originated from two or more samplings of a single population. "The generalized means test is called Wilks' lambda (Λ) test; it determines a probability level for the null hypothesis of equality of population centroids (means vectors) on the assumption of equality of dispersion (variance-covariance matrices). The assumption is analogous to that of homogeneity of variance in the univariate F-ratio test of equality of means."[2]

The definition of the Wilks-Lambda test, which is actually a formulation of the distribution of a ratio of determinants, is represented statistically as:

$$\Lambda = \frac{|W|}{|T|}$$

where: Λ = represents the Wilks determinant ratio test statistic.

W = a partition term for the matric of squares and cross-products of deviations of subjects from their group centroids, pooled over all groups. It is the "Within-groups" term.

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[2]William W. Cooley and Paul R. Lohnes, Multivariate Data Analysis (New York: John Wiley and Sons, Inc., 1971), p. 12.

T = the matric of sums of squares and corss-products of deviations of all subjects from the grand centroid. This matric T stands for "Total."

In addition to the Wilks' lambda test of significance in this multivariate factorial analysis of covariance, canonical coefficients were produced to yield the largest product-moment correlation between the dependent variables and the covariables. The canonical correlation "is essentially a procedure for factoring two batteries simultaneously, in order to extract factors which are uncorrelated within their batteries but which provide maximum correlation of pairs of factors across batteries. That is, the first factor of each battery is located so that the canonical correlation of the first factor is maximized."[3]

Table 3 exhibits the cell-wise means of the eight variables, producing the centroids, and their standard deviations. The numerical designations of the factors of treatment (T), sex (S) and class (C) are as follow:

1 1 1 - experimental group; male; tenth grade

1 1 2 - experimental group; male; eleventh grade

1 2 1 - experimental group; female; tenth grade

1 2 2 - experimental group; female; eleventh grade

2 1 1 - control group; male; tenth grade

2 1 2 - control group; male; eleventh grade

2 2 1 - control group; female; tenth grade

2 2 2 - control group; female; eleventh grade

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[3]Ibid., p. 12.

Table 3.--Means and standard deviations

Factor T S C	Number of Observations	Variable 1	2	3	4	5	6	7	8
1 1 1	18M	131.111	108.500	116.611	19.167	12.000	33.056	28.667	22.444
	SD	13.412	9.420	12.807	5.628	4.379	4.808	3.956	6.051
1 1 2	4M	134.750	110.250	114.250	21.000	11.750	31.500	26.750	23.500
	SD	23.866	5.679	14.080	5.228	5.123	4.359	3.500	9.327
1 2 1	18M	131.667	115.611	120.444	17.222	11.389	30.611	26.889	25.333
	SD	20.594	8.886	8.827	4.797	5.271	6.060	5.676	7.013
1 2 2	4M	124.500	107.000	118.750	18.760	11.000	32.000	26.000	18.750
	SD	9.399	6.633	11.673	7.632	3.367	2.309	2.160	4.924
2 1 1	18M	136.667	111.444	123.778	20.667	13.167	32.333	27.944	25.111
	SD	16.737	9.642	10.614	3.726	5.125	6.472	4.659	5.840
2 1 2	4M	134.250	104.750	112.500	22.250	16.250	33.000	26.000	19.750
	SD	18.998	4.500	10.214	4.500	4.113	6.481	5.598	3.948
2 2 1	18M	134.389	110.333	121.778	20.167	15.667	36.111	28.833	26.444
	SD	31.420	9.406	10.367	4.528	4.665	7.020	7.270	18.128
2 2 2	4M	139.750	119.250	117.750	20.750	14.250	34.250	32.250	22.250
	SD	13.376	6.801	9.323	6.702	4.924	5.620	4.500	5.058

In addition, the variables are listed according to the following number scheme:

1 - Attitude (entire test)

2 - Verbal IQ

3 - Non-verbal IQ

4 - Mathematics versus Non-mathematics

5 - Mathematics - Fun versus Dull

6 - Pro-mathematics composite

7 - Mathematics - Easy versus Hard

8 - Ideal Mathematics Self-concept

The data in Table 4 yield the results of the tests of significance of the canonical correlations using the Wilks' lambda criteria.

Table 4.--Multivariate analysis of covariance results

Source	df Hypothesis	df Error	F	P Less Than
T (Treatment)	6	73	1.479	.198
S (Sex)	6	73	.984	.443
C (Class)	6	73	.571	.752
TS	6	73	1.617	.155
TC	6	73	.209	.973
SC	6	73	1.236	.298
TSC	6	73	1.188	.322

The results of Table 4 show that no significant differences occurred in the multivariate factorial analysis of covariance. The null hypothesis of equality of group centroids was therefore accepted. The researcher did not make use of the resultant univariate reanalyses with single criteria (attitude, mathematics versus non-mathematics, mathematics - fun versus dull, pro-mathematics composite, mathematics - easy versus hard and ideal mathematics self-concept) and two covariates.

Homogeneity of Regression Tests

The homogeneity of regression assumptions underlying each of the univariate analyses of covariance were tested and the results are presented in Table 5. The null hypothesis of homogeneity was retained for each test.

Table 5.--Homogeneity of regression results

Criterion	Source	df	SS	MS	F	P Less Than
Attitude	Among Slopes	14	8160.1836	582.8703	1.4634	.1367
Math versus Non-Math	Among Slopes	14	561.8311	40.1308	1.5517	.1045
Fun versus Dull	Among Slopes	14	280.0404	20.0029	.7798	.6888
Composite	Among Slopes	14	387.6978	27.6927	.7306	.7398
Easy versus Hard	Among Slopes	14	312.6034	22.3288	.6636	.8050
Self-Concept	Among Slopes	14	1676.6376	119.7598	1.5097	.1188

Observable Classroom Activities

The behaviors exhibited in the classroom were recorded on a check list and some differences in the degree of teacher versus pupil involvement were noted. The results of 960 observations are listed in Table 6. In analyzing the strategies of Table 6, generalizations appear evident, as follow:

1. The control classes were taught in a pronounced teacher-centered environment. This conclusion is evidenced by noting that 269 checks, or 56 percent of the recorded activities, were made on items 1, 2, 3, 10, 11, 12, 13 and 16. Only five checks, or 1 percent of the behaviors, were found with the same items in the computerized-managed classes.

2. The twelve-to-one ratio found in Item 9 bears out the fact that there was more opportunity for the students in the control sections to "verbally" question the teacher, since they were in a "lecture-type" environment.

3. Students in the experimental classes were given more of an opportunity to move around the classroom at their discretion and to determine the types of activities in which they wished to engage. There was greater pupil-oriented structure in these sections as detected by 308 checks, or 64.2 percent of the recorded activities, in items 18, 20, 21, 22 and 23. By comparison, 58, or 12.1 percent of the behaviors in the same items, were found in the control sections.

4. The programmed instructional approach of the multi-media program appears to give significance to the fact that students worked without the direct guidance of the teacher. This is evidenced by 139 checks, or 29 percent of the observable behaviors, in Item 18. This is contrasted with 9 checks, reflecting 1.9 percent of the same item in the traditional classes.

Table 6.--Observable classroom activities

Total Number of Observations: Control Group	Total Number of Observations: Experimental Group	Statement Number and Description
41		1. Teacher lectures with questions
40		2. Teacher questions - pupils answer questions
36	5	3. Teacher lectures, gives instruction or directions
12	9	4. Teacher or pupil talks to class about non-subject irrelevancies
3	7	5. Teacher talks to pupil(s) for discipline reasons
21		6. Teacher talks to pupil(s) in a humorous manner
		7. Pupil(s) recites, reports, gives prepared or unprepared talk
8		8. Pupil(s) "funs" with teacher
12	1	9. Pupil(s) questions teacher
77		10. Teacher illustrates at chalkboard - pupils listening and watching, copying
53		11. Teacher illustrates at chalkboard - pupil(s) participate verbally
10		12. Teacher illustrates with chart, book, or AV source - pupils listening, watching, copying
3		13. Teacher illustrates with chart, book, or AV source - pupil(s) participate verbally
		14. Pupil(s) illustrates or works on chalkboard
		15. Pupil illustrates with chart, book, or AV source

Table 6.--continued

Total Number of Observations: Control Group	Total Number of Observations: Experimental Group	Statement Number and Description
9		16. Teacher gives series of answers
		17. Pupils read or study at their desks
9	139	18. Pupils write and read or manipulate at their desks
43	59	19. Pupils take tests at their desks
34	70	20. Pupils get ready for another activity
14	16	21. Pupils work in small groups with discussion
1	52	22. Pupils confer with teacher at his/her desk
	31	23. Audio-visuals and/or multi-media used by students
4	5	24. Interruption by P.A. system, visitor, principal
30	67	25. Pupils participate in non-subject irrelevancies
20	19	26. Teacher walks around class helping students
Totals		
480	480	

5. Teachers in the experimental group provided opportunity for the students in their classes to confer with them as noted in Item 22. This strategy adheres to prior interpretations that the students were able to decide upon the type of activity that they wished to follow on a given day.

6. Item 25 reveals that there was more than twice as much student participation in non-subject irrelevancies in the experimental classes. This seems to give some support to an assumption that a self-pacing program at this level of chronological age and maturity may have a negative effect on the examinees involved.

7. The approximate one-to-one ratio of activities in Item 26 reveals that the teachers in each section moved around the room to offer assistance to their students. The instructor in the traditional classes was observed in this activity near the end of the period as the students began work on their follow-up assignments. In the experimental sections, the instructors walked around during all parts of the period. Some of their dialogue with students resulted in prodding them to complete a unit.

8. Items 6 and 8 indicate that twenty-nine checks, or 6 percent, were made with humorous interactions between the teacher and pupils of the control classes. A great deal of rapport between them was evidenced; this seemed to be especially significant, since the instructor was a first-year teacher. The instructors in the experimental classes appeared to be well-liked and respected by their students.

In addition to these observable activities, there were "unobservable" ones which were described by the teachers in the computerized-managed classes. Large quantities of materials (e.g., textbooks, manuals and printed papers) and equipment disappeared. Each class had a student assistant responsible for signing out materials, but there was much evidence of students helping themselves to items without permission from either the teacher or the assistant. Again, a possible interpretation for this effect might be that the students had a "freer" environment in which to operate.

An elementary school principal in Anne Arundel County who has had much experience in classroom observations acted as an independent observer to assess the reliability of these observable classroom activities. Table 7 indicates the results of ten observations made in the joint effort.

In addition, a check for observer agreement was performed in each class by using a rank for the sequence of the activity. Tables 8 and 9 show this order of the thirty observations made by both observers. When there was no agreement, there was similarity in the type of activity. For example, it was difficult to ascertain whether the teacher devoted the major portion of the fifteen-second interval to giving instructions or directions in his lecture (Item 3) or to illustrating a part of these instructions on the chalkboard (Item 10).

Summary

The reliability estimates of the instrument used in this study utilized both the coefficient alpha for the entire test (.8261) and the higher corrected split-half index (.8735). These coefficients were able 7.--Reliability checks of observable classroom activities

Item Number*	Control Group Researcher	Control Group Independent Observer	Experimental Group Researcher	Experimental Group Independent Observer
1	21	23		
2	13	16		
3	14	12		
4	4	3	2	2
5			2	2
6	3	3		
7				
8				
9				
10	23	23		
11	15	13		
12	2	2		
13				
14				
15				
16	3	3		
17				
18	4	4	69	66
19			11	11
20	13	12	24	19
21	14	15	4	9
22			4	4
23			3	2
24	1	1	1	1
25	10	11	29	33
26	10	9	1	1
Total 150	150	150	150	150

*cf. description of item in Table 6.

Table 8.--Order of observable classroom activities, control group

Order	Item Number* Researcher	Item Number* Independent Observer	Order	Item Number* Researcher	Item Number* Independent Observer
1	20	20	16	1	1
2	20	20	17	1	1
3	10	10	18	1	1
4	10	10	19	3	3
5	10	10	20	10	10
6	3	10	21	11	11
7	1	1	22	10	10
8	3	3	23	10	10
9	10	10	24	10	10
10	10	1	25	3	3
11	3	3	26	3	2
12	1	1	27	10	10
13	1	1	28	1	1
14	6	6	29	4	4
15	1	1	30	20	20

*cf. description of item in Table 6.

There was agreement on twenty-seven of the thirty observable activities, yielding a .9000 agreement between the two observers.

Table 9.--Order of observable classroom activities, experimental group

	Item Number*			Item Number*	
Order	Researcher	Independent Observer	Order	Researcher	Independent Observer
1	20	20	16	21	21
2	20	20	17	21	21
3	18	18	18	25	21
4	18	18	19	21	21
5	18	18	20	25	25
6	22	18	21	25	25
7	18	18	22	18	25
8	18	18	23	18	18
9	18	18	24	25	25
10	18	18	25	25	25
11	18	18	26	18	25
12	18	22	27	20	20
13	18	18	28	25	25
14	18	18	29	20	20
15	18	18	30	20	20

*cf. description of item in Table 6.

The agreement relationship indicated by Table 9 is .8333 (twenty-five activity orders in agreement).

indicative of acceptance for the instrument measuring students' attitudes toward geometry.

The multivariate factorial analysis of covariance yielded non-significant results with the six criteria of attitude, mathematics versus non-mathematics, mathematics - fun versus dull, pro-mathematics composite, mathematics - easy versus hard and ideal mathematics self-concept, and the two covariates of verbal and numerical IQ scores. Acceptance of the null hypothesis, therefore, indicated that no significant differences in students' attitudes occurred as a result of their experiences in a computerized-managed or in a traditional program in geometry at a specific secondary school.

The results of the observable classroom activities yielded certain differences between the experimental and the control groups. The experimental groups were in a student-centered environment with more opportunity for individualization of instruction. Audio-visual materials and the computer as teaching-aid equipment were used and there was more opportunity for the students to engage in non-subject discourses. Students tended to cluster themselves and there was much conferring with the teacher at any given stage of the program. On the other hand, the control groups were rather teacher-oriented and the students were able to question the instructor directly on a specific problem. There were small amounts of student movement in the classroom, little evidence of group work and a minimal degree of self-selected instruction.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

The primary purpose of this study was to determine whether differences occurred in students' attitudes toward mathematics as a result of two instructional approaches in geometry. One of these was labeled the experimental group and consisted of students in a computerized-managed program. This was part of the Multi-Media Project developed by the Anne Arundel County Board of Education and was under the auspices of a Title III program. The other group of students was designated the control and included individuals in a traditional public senior high school course in geometry. Most of the examinees were enrolled as tenth graders at Severna Park Senior High School in Anne Arundel County, Maryland.

A secondary purpose of this research was its possible aid in evaluation of the Multi-Media Project by instructional personnel of Anne Arundel County Public Schools. Interest toward mathematics was the dominant theme; achievement was not investigated at any level of this study.

Any other school district interested in the findings and the conclusions of this research should be cognizant that the study was limited to a specific locale and to a rather modest sample size.

The instrument utilized to measure the amount of difference in students' attitudes toward mathematics was the "Idea and Preferences Inventory, Form 121B." The major dependent variable was attitude as calculated by the score on the entire test. In addition, certain subgroups of items in the composite test were designated as dependent variables and these consisted of: mathematics versus non-mathematics, mathematics - fun versus dull, pro-mathematics composite, mathematics - easy versus hard and ideal mathematics self-concept. The major independent variables were the two types of geometry programs. A 2 X 2 X 2 multivariate factorial analysis of covariance was used, including the factors of treatment (the program), sex (male or female) and class (tenth or eleventh grade). The two covariates employed were the verbal and non-verbal results of the Lorge-Thorndike Test of Intelligence, Level-5.

The major hypothesis stated that a computerized-managed program in geometry would generate more student interest toward mathematics than a traditional instructional approach.

Summary of the Experiments

Two types of statistical procedures were used in an effort to determine the differences in students' attitudes toward mathematics in response to the two instructional approaches. A 2 X 2 X 2 multivariate factorial analysis of covariance was performed to indicate whether significant differences resulted in the attitudes of the examinees. This analysis used the factors of treatment, sex and class. The estimates were adjusted for the two covariates, verbal and numerical IQ scores.

The multivariate factorial analysis of covariance was actually a homogeneity of centroids test. The research issue judged whether two or more sample groups could be considered as originating from a single multivariate population or from two or more multivariate populations. The homogeneity of centroids test utilized the Wilks' lambda and canonical coefficients for correlation purposes.

In an effort to distinguish differences in attitude based upon three contrasts (treatment, sex and class) and six criteria (attitude, mathematics versus non-mathematics, mathematics - fun versus dull, pro-mathematics composite, mathematics - easy versus hard and ideal mathematics self-concept), eight cells of eighty-eight subjects were produced. This necessitated a random deletion of forty-eight individuals from the original 136 to form a balanced layout to the cells relating treatment to the sex of the individual. The cells relating treatment to the student's class and sex to class were arranged in an orthogonal design with a proportion of 4.5 to 1.

The coefficients of reliability used in this study were the coefficient alpha and the cross-validation technique to obtain split-half indices. The reliability of the inventory was judged acceptable.

Results and Conclusions

No significant differences occurred between the experimental and control groups in relation to difference in attitude toward mathematics; therefore, the major hypothesis was rejected and a null hypothesis, that treatment of examinees in a computerized-managed program of geometry did not produce more interest toward mathematics than treatment in a traditional instructional approach, was accepted.

Other findings which deal with the statistical interpretation of the instrument and the observed classroom activities are listed below:

1. The coefficient alphs for the entire test was .8261 and the corrected "best-split" index was .8735. These coefficients were indicative of reliability for the instrument utilized to measure students' attitudes toward mathematics.

2. The computerized-managed program lent itself to a student-centered environment with a great deal of movement within and between the classrooms. Individualization of the instructional program was in evidence; yet, there was more of an opportunity for the students to engage in group work as well as non-subject irrelevancies.

3. The control group of students was taught in a pronounced teacher-oriented environment with a "lecture" theme predominant. There was more opportunity for the students to question the instructor directly about the problem at hand. There was little evidence of group activity or of student movement in the classroom.

Recommendations for Future Studies

Certain recommendations for future studies are projected below as a result of the findings and conclusions of this study:

1. The scope of this dissertation was limited to students' interest in mathematics as a result of treatment with the two types of geometry programs. A future study might apply or correlate attitude with achievement.

2. Other school districts might repeat this study with randomly selected samples in secondary schools.

3. Other investigations might try to determine, within the reliability and validity of the instruments used, whether teachers' attitudes had any significant effect on students' attitudes and achievement in mathematics or whether the participating teachers had experienced a significant change in their personal attitudes toward mathematics.

4. Research might reveal the degree of competency in mathematics of elementary versus high school teachers and its effect upon their students' attitudes toward mathematics. It appears that secondary school teachers are better trained in mathematics; yet, the literature states that a lowering of interest occurs in students in high school mathematics. Could it be that the subject matter in the latter-mentioned environment is too difficult?

5. Another study might repeat this research in other subject matter fields to compare the transfer effects of utilizing the computer-managed approach to data organization and decision-making.

6. An investigation might relate students' attitudes with socioeconomic class, parental attitudes and community interests.

7. Some research could be utilized to determine the effects of a self-paced program on the change of students' attitudes toward mathematics. In accordance with this suggestion, recommendations could

be made for dealing with those students who complete the units earlier in the school term and those who fail to finish the course in the allotted time.

8. Another study might demonstrate how the self-pacing approach in all classes would affect the students' interest. If the individual student could select the approach, would this change his attitudinal level?

9. A study could be implemented to compare attitudes toward mathematics of college-bound students versus those in a general or vocational program.

10. Another recommendation for a study would be to determine if the computerized-managed students' attitudes toward mathematics would be changed if they had a better understanding of multi-media equipment and the procedures involved.

Implications for Education

The study of attitudes discloses that there are fertile areas for improving the learning process. The review of literature presents evidence that positive relationships exist between attitudes teachers possess and the attitudes their students acquire.

This research concluded that no significant differences existed in students' attitudes toward mathematics as a result of two instructional approaches in geometry. It follows that geometry teachers should be included in pre- and in-service programs; the implications are that these workshops will include computer technology as both remedial and enrichment resources. In addition to participation in the programs, the teachers should become key personnel in planning activities for these endeavors.

Observations for Educators

The writer, with some degree of confidence, offers the following observations for educators:

1. Attitudes are real and constitute a permanent aspect of one's learning.

2. Attitudes tend to spread out to other learning situations and become potent factors in the molding of the learner's personality.

3. Attitudes become important determiners in the learner's attainment of success or failure. It is imperative in the educational process that the student experience success more often than failure and that the majority of the child's goals should be attainable.

APPENDIX A

BRIEF OVERVIEW OF
COURSE MODELS

Multi-Media Geometry[1]

In the geometry model, content objectives for the course are listed in behavioral terms. The list of objectives is grouped by topics and then subgrouped by concepts. Each concept group has been matched to test questions and learning activities. For each of the forty-five topics which comprise the complete course, a topic booklet has been prepared to provide the student with:

1. an introduction which tells him what the topic is about and what he will be required to do after completing the activities

2. a flowchart of activities which lists all media options for each activity

3. a list of definitions, postulates and theorems

4. enrichment activities and requirements

5. worksheets, programmed instruction, and references to texts

6. a topic review

(It might be here noted that, although no basic text has been selected for the course and students are directed to use many references, the teacher-writers have accepted the School Mathematics Study Group system of postulates as a basis for the course.)

The geometry program is computer managed. A student enters his pre-test answers and then receives appropriate prescriptions based on the pre-test diagnosis. The prescription is completely individualized for that particular student and provides him with choices as to the options he may select in completing the activities. (He keeps a progress chart listing his media choice for his activity completed.) His post-test has been prepared just for him. For each objective to be tested, at least four questions have been stored; and the computer selects at random a question from each of the concepts on which he should be tested according to his pre-test diagnosis. After the post-test answers have been entered and corrected, he again receives a prescription which might direct him to the next topic or list additional activities to be covered before he takes a second post-test. A student who has not sufficiently mastered the objectives in order to go on to the next topic as indicated by the second post-test results is directed to the teacher

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[1]Title III, Multi-Media Project, "Dissemination," Anne Arundel County Board of Education, E.S.E.A., 1970.

for help. However, at any point in this sequence, students may go to the teacher for desired assistance or consultation; and periodic student-teacher conferences are an integral part of this type of individualized instruction. Evaluation as to student progress is arrived at cooperatively in just such conferences.

The mediation provided is a blend of commercially-prepared materials and project-prepared ones, each of which has been carefully selected in relation to specific terminal objectives and in order to provide desired variety for student options. An extensive Multi-Media Geometry Classroom Library enables students to pursue special interests in further depth and to complete enrichment activities.

Description of Printed Materials

Student Manual	A 70 page student manual introduces students to flow charting, programmed instruction, instructional media and equipment and classroom routines. The manual includes progress charts on which the student lists his media choice for each activity completed.
Content Objectives	Content Objectives are listed in behavioral terms for the course. The list of objectives is grouped by topics and then subgrouped by concepts. Each concept group is matched to test questions and learning activities.
Pre-test	A pre-test is written for each topic. The questions require students to demonstrate the behaviors listed in the objectives, and are matched to the activities in the topic. The pre-test is used to determine what activities in each topic a student is to complete.
Post-test	Unlike the pre-test, the post-test is not a single test. For each objective to be tested at least four questions are listed. A student's post-test is formed by selecting the proper number of post-test questions from the total list of questions for each concept group to be tested.
Topic booklets	Each topic booklet contains a. An introduction which lets the student know what the topic is about and what he will be required to do after completing the activities. b. A flowchart of activities. The flow chart lists all media options for each activity. c. A list of definitions, postulates and theorems. d. Enrichment activities and requirements. e. Worksheets, programmed instruction, references to texts. f. A topic review

Agreement Forms	Students use the agreement forms to plan, with their teacher, for completing the topics for a selected period of time.
Student Evaluation Forms	These forms are used by students and teachers in assessing student progress.
Figure book	Because the post-test is printed by the computer, drawings required in a question are listed in a book of figures. The test questions refer to figures by numbers.
Answer booklets	Answers for exercises are usually listed in the topic booklet. Exercises that are to be corrected by the teacher are listed in the answer book.
Cumulative test	Tests are written for groups of topics. These tests are used to assess student understanding and retention of concepts and his ability to apply concepts in problem solving.
Prescription forms	This form shows the organization of objectives pre- and post-test, and topic activities for each topic. It lists the information needed in order to program the computer to give prescriptions.
Topic Covers	Cover designs have been produced for each topic which reflect graphically the content of the topic.

Management

The georetry program is computer managed. The computer is programmed to enroll classes of students and to

a. receive answers to pre-test
b. correct pre-test answers
c. write prescriptions: (1) list activities student is to complete as indicated by questions missed on pre-test. (2) send student to next topic if he passes all questions.
d. print random post-test to match each student's prescription
e. receive 1st post-test answers
f. correct 1st post-test answers
g. write prescription indicated by 1st post-test answers
   (1) list additional activities to be studied and direct student to take a second post-test: <u>or</u>
   (2) send student to next topic.
h. print random post-test to match student's prescription after first post-test

i. receive 2nd post-test answers
j. correct 2nd post-test answers
k. write prescription indicated by 2nd post-test answers
   (1) direct student to his teacher. Prevent student from re-entering program until he has been advanced by teacher.
   (2) send student to nex

The computer also contains the following programs which give teachers information concerning individual student and class progress.

a. Roster: List, by class, student's name, student number, topic in which student is working and position in that topic.
b. Help: List by class the students who are having difficulties and the concept group with which he needs help.
c. Report: List by student for pre- and post-test in each topic
   (a) No. of questions in each concept group tested
   (b) No. of questions in each concept group missed
   (c) Repeat of post-test
d. Autros: List names of students on or beyond a given topic

The programs also permit teachers to

a. enroll students
b. advance students
c. drop students
d. change student name or number (corrections)

List of Topics

Introduction: History and Development of Geometry, Application of Geometry-Why Study it, Nature of Geometry

Language of Sets
Order on the Number Line
Absolute Value
Geometry of a Line
Lines, Segments, Rays
Planes
Determination of Space
Relationship of Lines and Planes
Convex Sets
Separation
Angles
Triangles
Polygons
Reasoning
Logic
Structure of a Proof
Correspondence of Triangles
Idea of Congruence
Congruence Postulates
Congruence-Isosceles and Overlapping Triangles
Indirect Proof
Perpendicular Lines in a Plane
Auxiliary Sets
Geometric Inequalities
Perpendicularity for Lines and Planes
Parallel Lines in a Plane

Quadrilaterals in a Plane
Right Triangles and Transversals
Parallel and Perpendicular Planes
Areas of Polygonal Regions
The Pythagorean Theorem
Similarity - I
Similarity - II
Relations of Lines, Circles, Planes and Spheres
Intersecting Lines and Circles
Characterizations
Straightedge and Compass Constructions
Areas of Circles and Sectors
Solids: Their Surface and Volume I
Solids: Their Surface and Volume II
Plane Coordinate Geometry - I
Plane Coördinate Geometry - II

Reference Code

Texts: 1 - 99

Programmed instruction (P.I.), and other Printed Material: 100 - 199

Audio-Visual Aids (A.V.): 200. . .

Film - MP
Filmstrip - FS
Film Loop - ML
Slides - TS
Tape - RT
Slide-Sound - TS-RT

Texts
1. Geometry - Moise.Downs
2. Modern Geometry (Structure and Method) - Dolciani.Donnelly.Jurgensen
3. Geometry (A Unified Course) - Goodman.Vannatta.Fawcett
4. Geometry (Plane.Solid.Coordinate) - Morgan.Zartman

P.I. or other Printed Material

100. Introduction to Modern Mathematics - Hancock.Olken.Seymour
101. String, Straight Edge and Shadow - Diggins, Julie E.
102B History of Mathematics Vol. II - Smith, D. E.
103. Mathematics for Secondary School Teachers - Meserve.Sobel

A.V.

FS 200 "Postulates: Lines: Geometry"
FS 201 "Plane Figures"
ML 202 "The first Few Dimensions"
FS 203 "Introduction to Sets"
FS 204 "Intersection of Sets"
FS 205 "Union and Complementation"
FS 206 "Constructions with Compass and Straightedge"
FS 207 "Mistakes in Thinking"
MP 208 "Geometry:Indeductive and Deductive Reasoning"
FS 209 "Applying Geometric Logic"
FS 210 "Geometric Logic - Deduction"
FS 211 "Geometric Logic - Induction"

MP	212	"Angles and their Measure" part one - Defining and Naming an Angle.
FS	213	"Using the Protractor"
MP	214	"Angles and their Measure" part two - Using a Protractor to measure an Angle.
MP	215	"Angles and their Measure" part three - Using a Protractor to construct an angle and Addition of angles.
FS	216	" Angles" SVE
MP	217	"Angles and their Measure" part four (Acute, obtuse, right angles)
FS	218	"Congruence"
FS	219	"Congruent Triangles"
FS	221	"How to De ise a Proof"
FS	222	"How to Prove Triangles Congruent"
FS	223	"Proof"
FS	224	"Properties of Triangles"
MP	225	"Donald in Mathmagic Land"
MP	226	"Angles"
MP	227	"Congruent Figures"
MP	228	"Similar Triangles"
ML	229	"Intersections of Simple Geometric Sets"
ML	230	"Corresponding Lines"
ML	231	"Necessary but not Sufficient"
ML	232	"From Hexagon to Square"
ML	233	"The first four Genuses"
ML	234	"Area and Perimeter related"
ML	235	"Perimeter and Area of Rectangles"
ML	236	"Group of the Equilateral Triangle"
ML	237	"Volume of a Cube"
ML	238	"Volume of a Pyramid"
ML	239	"Area of a Triangle"
ML	240	"Circumference of a Circle"
ML	241	"Volume of a Cone"
ML	242	"Area of a Square"
FS	243	"The Parabola"
FS	244	"Louis Problems: The Circle"
FS	245	"Parollelograms and their Properties"
FS	246	"The Parallel Postulate"
FS	247	"Arc and Angle Measurement"
FS	248	"Angle Sums for Polygons"
FS	249	"The Pythagoream Theorem"
FS	250	"Similar Triangles - Experiment & Reduction"
FS	251	"Measure Proportion and Right Triangles"
FS	253	"Absolute Value"
FS	254	"An Introduction to Coordinate Geometry"
FS	255	"The Slope of a Circle"
FS	256	"Geometric Proof using Coordinates"

FS 257 "Perpendicular Lines in Coordinate Geometry"
FS 258 "Area in Coordinate Geometry"
FS 259 "Points, Lines, and Planes"
FS 260 "Distance & Betweenness"
FS 261 "Coordinate Geometry"
FS 262 "Circles and Spheres"
FS 263 "Arcs and Areas of Circles"
FS 264 "Parallelism"
FS 265 "Volumes of Solids"
FS 266 "Polygons"
FS 267 "Areas of Polygonal Regions"
FS 268 "Introduction, Angle Definitions"
FS 269 "The Polygon Family: Quadrilaterals"
FS 270 "Sets and Reasoning"
FS 271 "Area"
FS 272 "Coordinate Geometry II - Slope (5)"
FS 273 "Triangles"
FS 274 "Circles and Tangents"
FS 275 "Locus (5) (Eye Gate House)"
FS 276 "Coordinate Geometry I - Introduction"
FS 277 "Symmetry"
FS 278 "Topology"
FS 279 "Thinking in three Dimensions"
FS 280 "Similarity (5)"
FS 281 "Coordinate Geometry"
FS 282 "Vector Geometry"
FS 283 "Locus (2) McGraw-Hill"
FS 284 "Angle Measurement in a Circle"
FS 285 "Circles and Tangents"
FS 286 "Geometric Megnalities"
FS 287 "Slope of a Line"
FS 288 "Theorem of Pytnagoras"
FS 289 "Transformation of Statements"
FS 290 "Nature of Proof (5)"
FS 291 "How to Prove Proportions in Geometry (5)"
FS 292 "The Geometry of Space (5)"
FS 293 "Sets of Quadrilaterals"
FS 294 "Parallel and Perpendicular Lines and Planes"
FS 295 "Foundations of Geometry - Postulates, Triangles and Circles"
FS 296 Surface Areas of Solids I
FS 297 Surface Areas of Solids II
FS 298 "Volumes of Pyramids, Cones and Spheres"
FS 299 "Volumes of Cubes, Prisms and Cylinders"
TS-RT 300 "Nature of Geometry (Title III)"
TS-RT 301 "An Organized Logical Development of Geometry (Title III)"
MP 302 "Kites are Quadrilaterals"
MP 303 "Trio for three angles"
MP 304 "Notes on a Triangle"
MP 305 "Newton's Equal Areas"

MP 306	"Dance Squared"
MP 307	"Patterns in Mathematics"
MP 308	"Flatland"
MP 309	"Symmetry
RT 310	"Why Study Geometry"
TS-RT 311	"Determining a Line"
TS-RT 312	"Dihedral Angles"
RT 313	"Complementary Angles"
RT 314	"Supplementary Angles"
TS-RT 315	
RT 316	"(4) Intersection: Planes"
RT 317	"Absolute Value"
ML 318	"Computer Flow Charts"
ML 319	"A Device to Measure the Moon AS/9"
ML 320	"Geometry of a Circle AS/12"
ML 321	"Angles and Triangles AS/13"
ML 322	"Eratosthenes AS/14"
ML 323	"How to Build a Rangefinder AS/15"
ML 324	"How to Use a Rangefinder AS/16"

Equipment

The following pieces of equipment are being used in the multi-media classroom. Prices given are for a single item in each case. However, it must be remembered that in an individualized-learning situation, multiple stations of the same type must be provided. In the geometry classroom, it is possible to operate four similar stations simultaneously.

A.	Creative Playthings - trapezoidal tables #AF294 - 24x24x48	$ 34.78
B.	Brewster - vertical low wall loaner/joiner modified with one surface covered with lenticular screening, other with natural pegboard, and #370 coasters - #230	141.00
C.	Brewster - vertical low wall joiners 4'6x4'4" surfaced in sand-colored burlap #200	57.00
D.	Weinberg - desk screens - cork both sides - 18x24	20.00
E.	Weinberg - teacher desk screens	40.00
F.	Weinberg - desk screens for 33" desk	30.00
G.	Weinberg - library cart	200.00
H.	Weinberg - audio-visual cart with lockable sliding doors	271.00

I.	Hamilton - wood stools 24" high, 14" seat - maple	$ 7.80
J.	Weinberg - formica working surfaces #931 gray used on Garcy Hardware	13.00
K.	Audiotronics tape reader without case (to be set in table) - #110PL	101.00
L.	Wollensak Tape recorder - #1520AV	166.50
M.	Beseler overhead projector - #G-100	75.00
N.	Standard filmstrip previewer #1995	21.00
O.	Standard filmstrip projector 750A	161.00
P.	Kodak 16mm projector AV-126-TR	490.00
Q.	Hudson rear projection screen #605T	14.50
R.	Hudson caritel screen #621	36.00
S.	Standard slide viewer #22	36.00
T.	Audiotronics record player #300A	55.00
U.	Technicolor super 8 projector #8172	142.75
V.	Kodak carousel projector 300Z	165.00
W.	Kodak super 8 reel-to-reel projector	179.00
X.	Knox wall screen #65	21.00
Y.	Audiotronics listening post #HB-4	57.00
Z.	Audiotronics mike with stand #AM-10	14.90
AA.	Wollensak headset model #A-0483	12.00
BB.	Demco 6-drawer filmstrip cabinet #53-514	47.75
CC.	Douron 4-drawer file cabinet	76.10

Note: Information as to the sources used for carpeting, blinds, and Garcy hardware is available if desired.

Materials

A. For the most part, course materials for geometry have this year been reproduced at the print shop because of the quantity involved. The materials for the other courses are reproduced using the spirit duplicator. If the latter method is used, the cost would include price of paper, masters, and duplicating fluid. Most schools already have such a machine. However, another method of reproduction might be selected; and, of course, the quantity desired would affect any cost projection. Current bid prices for these materials would make the cost per item less than we have paid.

Duplicating paper per ream	$1.40
Duplicating fluid per gallon	$2.00
Spirit masters, box of 100	$4.10

B. Audio-visual materials

Tapes, slides, filmstrips, super 8 loops, etc., have been provided in multiples of five. Four copies go to the classroom, and one copy stays in the office for use by the course team here. Single copies of 16mm films have also been purchased and integrated into the course materials. Most frequently, only segments of these films are used at one time.

C. Books

Professional books, a classroom reference library, and multiple copies of several basic texts.

D. Other instructional aids

Models, games, charts, compasses, binders, rulers, posters

E. Audio tapes and empty reels

Prices would depend on size and quantity

F. Transparency materials for overhead projector

Type 127	$22.19/box
Type 888	$19.60/box
Type 129	$26.85/box

Dealer - Three M

G. Materials for 209 copier

Type 658	8 1/2 x 11 - ream $9.50
Type 657	roll intermediate $10.00

APPENDIX B

IDEAS AND PREFERENCES INVENTORY, FORM 121B

INSTRUCTIONS, INVENTORY AND ANSWER SHEET

Instructions

This is not a test. There are no "right" or "wrong" answers to any of the questions. Just answer them as honestly as you can.

The questions ask you to tell how you feel about many different things. Your answer to each question should tell how you feel about it.

Some questions ask about experiences you have had in the past. When you answer these, think back to the experiences you have had in the last year or so.

Use the answer sheet which has been provided for you. Please work carefully but quickly. Do not spend a long time on any one question. Just fill in the answer that seems best to you at the moment by putting a circle around the letter you have selected to answer the question. Please answer all the items and give only one answer for each item.

Some questions have a blank space in the middle. Four ways to fill the blank space are given beneath each sentence. Look at sample question 0.

0. I like summer _____ than winter.
   A. a lot more
   B. a little more
   C. a little less
   D. a lot less

Which one of the four ways tells how best you like summer as compared with winter: A, or B, or C, or D? You would place a circle around the one letter you have selected on the answer sheet next to question 0.

For other questions you are just to tell how you feel about each statement. You should select one of the four or five ways given beneath the statement. Look at sample question 00.

00. It is more fun to play outdoors in winter than in summer.
   G. strongly agree
   H. agree
   J. disagree
   K. strongly disagree

Which one of the ways tells best how you feel about the statement: G, or H, or J, or K? You would place a circle around the one letter you have selected on the answer sheet next to question 00.

Inventory

1. I like story books _____ than mathematics books.
   A. a lot more
   B. a little more
   C. a little less
   D. a lot less

2. I like the problem "359 - 574 + 6840 - 999 - 46937 + 9748 + 97483 = ?" _____ than the problem "Jane is half as tall as Dick. Joe is half as tall as Jane. Mark is half as tall as Joe. Dick is 60 inches tall. How tall is Joe?
   G. a lot more
   H. a little more
   J. a little less
   K. a lot less

3. I like doing mathematics _____ than doing anything else.
   A. a lot more
   B. a little more
   C. a little less
   D. a lot less

4. I like writing answers to social studies questions _____ than doing word problems in mathematics.
   G. a lot more
   H. a little more
   J. a little less
   K. a lot less

5. I like to say, "I think this is so" _____ than saying "I proved that this is so."
   A. a lot more
   B. a little more
   C. a little less
   D. a lot less

6. I like mathematics books _____ than social studies books.
   G. a lot more
   H. a little more
   J. a little less
   K. a lot less

7. I like the statement, "There are 5220 feet in a mile." _____ than the statement, "There are over 5000 feet in a mile."
   A. a lot more
   B. a little more
   C. a little less
   D. a lot less

8. I like subtracting fractions _____ than reading a story about Brazil.
   - G. a lot more
   - H. a little more
   - J. a little less
   - K. a lot less

9. I like the statement, "An octopus has many tentacles." _____ than the statement, "An octopus has eight tentacles."
   - A. a lot more
   - B. a little more
   - C. a little less
   - D. a lot less

10. I like the problem, "A yard of cloth costs 60 cents. Sally needs 2 yards of cloth to make a skirt. How much money will she have to pay?" _____ than the problem, "2 X .60 = ?"
    - G. a lot more
    - H. a little more
    - J. a little less
    - K. a lot less

11. I like the statement, "Jane is a little taller than Sue." _____ than the statement, "Jane is 2 inches taller than Sue."
    - A. a lot more
    - B. a little more
    - C. a little less
    - D. a lot less

12. I would like to teach English _____ than I would like to teach mathematics.
    - G. a lot more
    - H. a little more
    - J. a little less
    - K. a lot less

13. I think my father uses mathematics in his job.
    - A. very often
    - B. sometimes
    - C. don't know
    - D. hardly ever
    - E. never

14. I use mathematics outside of school in my games, reading, hobbies, or when watching TV:
    - G. very often
    - H. quite often
    - J. sometimes
    - K. hardly ever
    - L. never

15. Outside of school I would like to use mathematics:

A. every chance I get
B. often
C. sometimes
D. hardly ever
E. never

16. I have:

G. no older brothers or sisters
H. one older brother or sister
J. two older brothers or sisters
K. more than two older brothers or sisters

17. I wish it were easier for me to talk in front of my mathematics class.

A. strongly agree
B. agree
C. mildly agree
D. mildly disagree
E. disagree
F. strongly disagree

18. I wish I were more proud of my mathematics homework.

G. strongly agree
H. agree
J. mildly agree
K. mildly disagree
L. disagree
M. strongly disagree

19. I wish I were trying harder in mathematics.

A. strongly agree
B. agree
C. mildly agree
D. mildly disagree
E. disagree
F. strongly disagree

20. I would like to be called on in mathematics class more often.

G. strongly agree
H. agree
J. mildly agree
K. mildly disagree
L. disagree
M. strongly disagree

21. I wish I could do better in mathematics.

A. strongly agree
B. agree
C. mildly agree
D. mildly disagree
E. disagree
F. strongly disagree

22. I wish I felt less upset in mathematics class.
    - G. strongly agree
    - H. agree
    - J. mildly agree
    - K. mildly disagree
    - L. disagree
    - M. strongly disagree

23. I wish my mathematics teacher did not make me feel that I am doing poorly.
    - A. strongly agree
    - B. agree
    - C. mildly agree
    - D. mildly disagree
    - E. disagree
    - F. strongly disagree

24. I wish I were not so discouraged with my mathematics school work.
    - G. strongly agree
    - H. agree
    - J. mildly agree
    - K. mildly disagree
    - L. disagree
    - M. strongly disagree

25. The subject I enjoy least is mathematics.
    - A. strongly agree
    - B. agree
    - C. don't know
    - D. disagree
    - E. strongly disagree

26. For most jobs it is more important to be well rounded and broadly educated than to know mathematics.
    - G. strongly agree
    - H. agree
    - J. don't know
    - K. disagree
    - L. strongly disagree

27. I cannot understand how some students think mathematics is fun.
    - A. strongly agree
    - B. agree
    - C. mildly agree
    - D. mildly disagree
    - E. disagree
    - F. strongly disagree

28. Mathematics is boring.
    - G. strongly agree
    - H. agree
    - J. don't know
    - K. disagree
    - L. strongly disagree

29. Mathematics is fun.
    - A. strongly agree
    - B. agree
    - C. don't know
    - D. disagree
    - E. strongly disagree

30. My parents think mathematics is not very practical.
    - G. strongly agree
    - H. agree
    - J. don't know
    - K. disagree
    - L. strongly disagree

31. Mathematics is a subject which is less important in the modern world than softball.
    - A. strongly agree
    - B. agree
    - C. don't know
    - D. disagree
    - E. strongly disagree

32. No matter how hard I try, I cannot understand mathematics.
    - G. strongly agree
    - H. agree
    - J. don't know
    - K. disagree
    - L. strongly disagree

33. Students who are good in mathematics are looked up to by most others.
    - A. strongly agree
    - B. agree
    - C. don't know
    - D. disagree
    - E. strongly disagree

34. Mathematics is a subject which is more difficult to understand than any other subject.
    - G. strongly agree
    - H. agree
    - J. don't know
    - K. disagree
    - L. strongly disagree

35. Most mathematics is too concerned with ideas to be really useful.
    - A. strongly agree
    - B. agree
    - C. don't know
    - D. disagree
    - E. strongly disagree

36. Except for those who are going to be scientists or engineers, most students would rather take other courses than mathematics.
    - G. strongly agree
    - H. agree
    - J. don't know
    - K. disagree
    - L. strongly disagree

37. My parents think mathematics is my most important subject.
    - A. strongly agree
    - B. agree
    - C. don't know
    - D. disagree
    - E. strongly disagree

38. There is so much hard work in mathematics that it takes the fun out of it.
    - G. strongly agree
    - H. agree
    - J. don't know
    - K. disagree
    - L. strongly disagree

39. I would like mathematics better if it were not made so hard in class.
    - A. strongly agree
    - B. agree
    - C. don't know
    - D. disagree
    - E. strongly disagree

40. I can get along perfectly well in everyday life without mathematics.
    - G. strongly agree
    - H. agree
    - J. don't know
    - K. disagree
    - L. strongly disagree

41. Mathematics is easier for me than my other subjects.
    - A. strongly agree
    - B. agree
    - C. don't know
    - D. disagree
    - E. strongly disagree

42. Mathematics is so hard to understand that I do not like it as well as other subjects.
    - G. strongly agree
    - H. agree
    - J. don't know
    - K. disagree
    - L. strongly disagree

43. To do well in mathematics, you have to be smarter than you have to be to do well in reading.
    - A. strongly agree
    - B. agree
    - C. don't know
    - D. disagree
    - E. strongly disagree

44. Most students work very hard to do well in mathematics.
    - G. strongly agree
    - H. agree
    - J. don't know
    - K. disagree
    - L. strongly disagree

45. Mathematics is more of a game than it is hard work.
    - A. strongly agree
    - B. agree
    - C. don't know
    - D. disagree
    - E. strongly disagree

46. I think someone like Winston Churchill was more important to mankind than any mathematician or scientist.
    - G. strongly agree
    - H. agree
    - J. don't know
    - K. disagree
    - L. strongly disagree

Name ______________________

Answer Sheet

1. A B C D	24. G H J K L M
2. G H J K	25. A B C D E
3. A B C D	26. G H J K L
4. G H J K	27. A B C D E F
5. A B C D	28. G H J K L
6. G H J K	29. A B C D E
7. A B C D	30. G H J K L
8. G H J K	31. A B C D E
9. A B C D	32. G H J K L
10. G H J K	33. A B C D E
11. A B C D	34. G H J K L
12. G H J K	35. A B C D E
13. A B C D E	36. G H J K L
14. G H J K L	37. A B C D E
15. A B C D E	38. G H J K L
16. OMITTED	39. A B C D E
17. A B C D E F	40. G H J K L
18. G H J K L M	41. A B C D E
19. A B C D E F	42. G H J K L
20. G H J K L M	43. A B C D E
21. A B C D E F	44. G H J K L
22. G H J K L M	45. A B C D E
23. A B C D E F	46. G H J K L

(Samples)

0. A B C D	00. G H J K

APPENDIX C

OBSERVABLE CLASSROOM ACTIVITIES

EXPLANATION OF CODES
AND CHECK LIST SHEET

Items for Coding Activities

Code:

1. Teacher lectures with questions. This category is checked when questions are asked in which an answer is expected. This occurs while the teacher lectures and is either introducing the lesson or presenting the lesson.

2. Teacher questions - pupils answer questions. Typically, this is a question and answer period; e.g., a review on content already covered, correcting homework. The teacher's question may be either direct or implied. However, it must be a question for which an answer is expected; that is, the teacher must pause long enough for an appropriate answer to be given and the question cannot be rhetorical.

3. Teacher lectures, gives instruction or directions. This category is checked during the time when the class is conducted in a manner which makes no provision for active pupil participation in the lesson being presented except through some form of intrusion or pupil interruption in the teacher's presentation. The teacher may give instructions or directions, also for this category to be checked.

4. Teacher or pupil irrelevancy talks. This category is checked when the teacher or a pupil is discussing topics of non-academic nature--e.g., student council elections, reporting to guidance, etc.

5. Teacher disciplines pupil(s). This category is checked when the teacher either interrupts the class or calls out a student's name for infraction of classroom rules.

6. Teacher talks to pupil in humor. This category is checked when the teacher breaks the monotony, speaks humorously to a pupil, or even talks in a quasi-sarcastic manner.

7. Pupil recites, reports, gives prepared or unprepared talk. This category is checked when the pupil presents material learned by rote, or the pupil gives a prepared report or talk whether from memory, read from a paper, or given with the aid of note or reference cards.

8. Pupil "funs" with teacher. This category is checked when pupil(s) either initiates humor during the class or returns teacher's humor.

9. Pupil(s) question teacher. This category is checked when the pupil(s) asks questions about relevant class work. It may occur anytime during the class as long as it pertains to mathematics.

Code:

10. Teacher illustrates at chalkboard - pupils listening and watching, copying. This category is checked when the teacher uses the chalkboard as a means of facilitating, explanation, elaboration, clarification, justification, or the imparting of information. No pupil participation is provided for except through some form of intrusion or pupil interruption in the teacher's presentation. Pupils may copy from the board.

11. Teacher illustrates at chalkboard - pupil(s) participate verbally. (same first sentence as #10.) Pupil participation is provided for as teacher asks questions which are to be answered by a pupil, or otherwise encourages by his presentation, pupil opinion or thoughts.

12. Teacher illustrates with chart, book, or audio-visual source - pupils listening, watching, copying. This category is checked when the teacher uses graphs, pictorial materials, or AV materials as a means of facilitating, explanation, elaboration, clarification, justification, or the imparting of information. No pupil participation is provided for except through some form of intrusion or pupil interruption in the teacher's presentation. Pupils may copy information at their desks.

13. Teacher illustrates with chart, book, or audio-visual source - pupils participate verbally. (same first sentence as #12.) There is pupil participation here as teacher asks questions which are to be answered by a pupil, or otherwise encourages by his presentation, pupil opinion or thoughts.

14. Pupil(s) illustrates or works on chalkboard. This category is checked when pupil or pupils perform before a group or the entire class at the chalkboard. Specifically, the pupil is requested by the teacher to work a problem on the chalkboard. But pupil may use chalkboard at his own discretion--either way, working problems or illustration is used as a means of facilitating, explanation, elaboration, clarification, or the imparting of information.

15. Pupil illustrates with chart, book, or audio-visual source. This category is checked when one of these aids is used by the pupil as a means of facilitating, explanation, elaboration, justification, or the imparting of information.

16. Teacher gives series of answers. This category is checked when teacher gives a series of answers such as in correcting and/or reviewing homework, reviewing a test, etc.

17. Pupils read or study at their desks. This category is checked whenever pupils read or study at their desks, or at a location which is being temporarily used as a desk. No writing is done during this activity.

Code:

18. Pupils write and read or manipulate at their desks. This category is used whenever pupils are writing answers after reading material, or if pupils are manipulating some objects in the classroom--e.g., compasses, rulers, geometric figures, etc.

19. Pupils take tests at their desks. This category is checked whenever written quizzes or examinations are in progress.

20. Pupils get ready for another activity. This category is checked whenever pupils walk to another section of the room or between the rooms to prepare themselves for another activity. They may be waiting in line, getting or passing books and/or papers, passing in papers, or checking (or being checked) for their attendance.

21. Pupils work in small groups with discussion. This category is used whenever students are placed in small groups or organize themselves into these groups for discussion of a particular geometry topic. There may be writing in these groups by all of the pupils or by a single secretary.

22. Pupils confer with teacher at his/her desk. This category is used whenever pupils present themselves at the teacher's desk for help in the lesson, check of their work, or for any other reason which involves relevancy to geometry.

23. Audio-visuals and Multi-media used by students. This category is checked whenever the students are utilizing film, film loops, slides, computerized tapes, records, computer, etc.

24. Interruption by P.A. system, visitor, principal. This category is used for any interruption by an extraclassroom source.

25. Pupil(s) participate in non-subject irrelevancies. This category is used whenever pupil(s) engage in such non-subject irrelevancies as joking with one another, talking with one another while excluding the subject on hand, working on another subject, staring into space (daydreaming), etc.

26. Teacher walks around class helping students. This category is checked when teacher leaves his/her desk and assists students in their written work, reading, working with the multi-media, or working with geometric figures.

Ground rules:

1. If two or more activities are occurring while the total group is engaged together in an activity, the dominant activity or the activity in which most of the group is engaged only is recorded.

2. If an activity occurs which is not listed or defined on the tally sheet, write what the students are doing at the bottom of the observation sheet.

3. The smallest amount of time to be recorded with a check is 15 seconds. An activity qualifies to be recorded when it is 15 seconds or longer in length. During the 50 minute class period, approximately 30 checks will be taken and these intervals will be selected at random during the entire period.

Name ________________

Observable Classroom Activities

________ 1. Teacher lectures with questions

________ 2. Teacher questions - pupils answer questions

________ 3. Teacher lectures, gives instruction or directions

________ 4. Teacher or pupil talks to class about non-subject irrelevancies

________ 5. Teacher talks to pupil(s) for discipline reasons

________ 6. Teacher talks to pupil(s) in a humorous manner

________ 7. Pupil(s) recites, reports, gives prepared or unprepared talk

________ 8. Pupil(s) "funs" with teacher

________ 9. Pupil(s) question teacher

________ 10. Teacher illustrates at chalkboard - pupils listening and watching, copying

________ 11. Teacher illustrates at chalkboard - pupil(s) participate verbally

________ 12. Teacher illustrates with chart, book, or audio-visual source - pupils listening, watching, copying

________ 13. Teacher illustrates with chart, book, or audio-visual source - pupil(s) participate verbally

________ 14. Pupil(s) illustrates or works on chalkboard

________ 15. Pupil illustrates with chart, book, or AV source

________ 16. Teacher gives series of answers

________ 17. Pupils read or study at their desks

________ 18. Pupils write and read or manipulate at their desks

________ 19. Pupils take tests at their desks

________ 20. Pupils get ready for another activity

__________ 21. Pupils work in small groups with discussion

__________ 22. Pupils confer with teacher at his/her desk

__________ 23. Audio-visuals and/or multi-media used by students

__________ 24. Interruption by P.A. system, visitor, principal

__________ 25. Pupils participate in non-subject irrelevancies

__________ 26. Teacher walks around class helping students

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