UNIVERSITY OF MANITOBA

A STUDY OF THE INTERESTS AND ATTITUDES OF SECONDARY STUDENTS TOWARDS SCIENCE AND MATHEMATICS

A THESIS

Submitted to the Faculty of Graduate Studies

in Partial Fulfillment of the Requirements

for the Degree of Master of Education

Department of Curriculum: Mathematics and Natural Science

Faculty of Education

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May, 1976

"A STUDY OF THE INTERESTS AND ATTITUDES OF SECONDARY STUDENTS TOWARDS SCIENCE AND MATHEMATICS"

by

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A dissertation submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

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ACKNOWLEDGMENTS

I wish to express my gratitude and appreciation to Dr. K. Slentz, chairman of my thesis committee, for his assistance and encouragement during this study; to Dr. O. Trosky and Dr. H. Williams, members of my thesis committee, for their reading and commenting upon the thesis; to my wife Sylvia, for her patience in typing the thesis; and to the administration staff and students of the Interlake School Division #21 for participating in this study.

ABSTRACT

The justification for this study was based upon: (1) the relationship of interests and attitudes of secondary school students to motivation, achievement and course selection, and (2) the importance of desirable interests and positive attitudes as outcomes of the educative process.

This study was designed to determine: (1) the interest of secondary school students in science and mathematics, (2) the attitude of secondary school students towards science and mathematics, and (3) the differences in interest and attitude towards science and mathematics which might exist at different secondary school grade levels, between girls and boys, and before and after taking science courses.

The subjects of the study were random samples of students enrolled in grades eight, nine, ten, eleven and twelve in the Interlake School Division #21. The Kuder General Interest Survey (K.G.I.S.) form E, and the Purdue Master Attitude Scale (P.M.A.S.) were administered to the subjects. Percentile scores relative to the Kuder norms were obtained using the K.G.I.S. The P.M.A.S. scores were evaluated with respect to their negative-positive dimension. The subjects were classified by grade level,

sex, and science course completed. Comparisons of K.G.I.S. percentile scores and P.M.A.S. scores were made between the various classification groups using the t-test of statistical significance.

The major findings of this study were: (1) interest of students in science was below the 40th percentile of the Kuder norm, (2) interest of students in mathematics was below the 45th percentile of the Kuder norm, (3) interest in science was lower than interest in mathematics in grades nine, ten and eleven, (4) attitude towards science was close to the point of indifference, (5) attitude towards mathematics was above the point of indifference, (6) attitude towards science was less favourable than attitude towards mathematics, (7) grade nine was the low point for interest and attitude, (8) differences in interests and attitudes between boys and girls were not statistically significant, (9) taking Science 100, Science 101, Biology 201 or Biology 201 with Physical Science 201 did not result in improved interests or more favourable attitudes.

As a result of these findings, educators were urged to give more attention to the evaluation of interests and attitudes of students and to those activities which would foster desirable interests and favourable attitudes towards school subjects.

Further investigation was suggested to provide a clearer picture of interests and attitudes of students at all grade levels, and to identify those factors which contribute to the development of greater interest and more positive attitude.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Rationale

> In general, his (student's) interests indicate the direction he should go; his abilities determine how far he can go; and his motivation ---determination---indicate how far he will go.
>
> E.K. Strong
> University of Minnesota, 1955

Educators have long recognized the significance of both interest and attitude[1] of students in the learning process. While John Dewey may have introduced a novel concept over sixy years ago[2], today few will dispute the importance of keen interest and favourable attitudes on the part of the learner for a successful learning situation. Closer examination reveals several distinct, yet related areas where interests and attitudes are significant.

One of these areas is motivation, creating an inner condition which makes one act. Here, the early literature emphasized the importance of drive-reduction,

[1]These terms, as used in this study are defined on page 9.

[2]John Dewey, Interest and Effort in Education, (Cambridge: Houghton Mifflin, 1913).

i.e., relieving of certain inner tension, in explaining motivation[1]. Since then more importance has been attached to goals, rewards, incentives and external stimuli. The attractiveness of the environment, the learner's curiosity, and the social valuation placed on environmental stimuli have been used to explain what triggers activity, in other words, motivates the individual[2]. This has been summed up very simply by DeCecco:

> The question of motivation may boil down to getting the student's attention[3].

In emphasizing the importance of the learner's attitude, Gagne advised that if we seek to produce a particular kind of behavior, we should see to it that the person wants to behave in that way[4]. Moreover, Ausubel has observed that one of the primary functions of education should be to stimulate the development of motivations that are currently nonexistent in the learner[5]. Harlow has stated that one reason why we learn or do anything is our tendency to be inquisitive about and playful with an environment which

[1] John P. DeCecco, Human Learning in the School, (New York: Holt Rinehart-Winston, 1964), p.81.

[2] Ibid., p.

[3] Ibid., p.

[4] Robert M. Gagne, Automatic Teaching: The State of the Art, E.H. Galanter, ed., (1959, John Wiley & Sons), p.13.

[5] David P. Ausubel, "Viewpoints from Related Disciplines: Human Growth and Development", Teachers College Record, vol.60(1959)p.245-54.

manages to keep us aroused[1] - a clear indication of the relation between interest and motivation in learning.

In a six year study to identify factors that relate to achievement in science and motivate students to elect courses in science, Mallinson found that high degrees of scientific and computational interest were evident among high achievers[2]. It would appear that both interest and attitude have much to contribute to motivating the learner.

More recently, through the late fifties and sixties, students' interests and attitudes have entered a new dimension with a thrust for greater student initiative in the determination of his own rate of progress in the elementary school followed by students' self-selections of courses in the secondary school. This movement, which parallels the movement toward individualized instruction or continuous progress, has had much support in educational circles in the past decade[3 4 5 6]. Thus students today are

[1]Harry F. Harlow, "Mice, Monkeys, Man and Motives", Psychological Review, vol.60(1953)p.23-32.

[2]C.G. Mallinson, Factors Relating to Achievement in Science and Motivation in Selection of Science Courses in High School (University of Western Michigan: ERIC Document ED 002 889, 1971).

[3]John I. Goodlad, "Toward 2000 A.D. in Education", N.C.E.A. Bulletin, (August 1968):p.16-22.

[4]Bruce W. Tuckman, "The Student-Centered Curriculum", Educational Technology, vol.9(Oct.1969):p.26-29.

[5]Harold E. Mitzel, "The Impending Instruction Revolution", Phi Delta Kappan, vol.51(Mar.1970):p.389-96.

[6]William M. Bechtol, Individualized Instruction and Keeping Your Sanity, (Chicago: Follet Pub. Co., 1973).

being given greater opportunity to pursue their interest in directions largely determined by their attitudes.

In the Province of Manitoba, English is the only compulsory subject that students must take each year to the end of grade twelve. Traditional subjects such as mathematics and science now compete with other electives for selection by students; in addition, there are alternatives offering different levels of difficulty and content within given subjects, e.g., grade eleven Mathematics 200, 201, 202 and 205[1].

Compounding the situation are other factors which play a part in course selection. Some factors which have been identified include parental influence[2], teacher attitudes[3], and the requirements for entry into institutions of higher learning or further training. As Gagne has observed, different motivations are determined in complex ways by experiences with parents, peers, other adults and the media[4].

[1] Manitoba, Department of Youth and Education, High School Programme of Studies 1972-73.

[2] G.E. Mowrer and J.C. Marshall, The Relation Between The Interests of High School Seniors and Their Parents Perceptions, American Personnel and Guidance Service, Washington, (ERIC Document ED 021 271, 1969).

[3] Robert B. Phillips, "Teacher Attitude as Related to Student Attitude and Achievement in Elementary School Mathematics", School Science and Mathematics, vol.73(June 1973): p.501-7.

[4] Robert M. Gagne, "A Psychologists Counsel on Curriculum Design", Journal of Research in Science Teaching, vol.1(1963):p.27-32.

During a time where there is evidence of less external restriction, students' interests and attitudes would be significant factors in course selection. E.K. Strong, noted for his work in the field of vocational interests, concluded that when students were asked why they selected a particular occupation, the most common answer was "I like it"[1]. This served as part of the rationale for the development of the widely used Strong Vocational Interest Blank. Manitoba's Committee on The Reorganization of the Secondary School (Core Committee) appeared to be in agreement with this position as evidenced by its statement that:

> Emphasis on the individual implies that the student in the secondary school should have the opportunity to make---significant decisions regarding the kinds of educational experiences which will be best for him[2].

Elsewhere there is a growing body of evidence to indicate that consideration should be given to student interest in course selection. Among the suggested uses of the Kuder General Interest Survey are helping the student decide what electives to take, and helping in planning his high school course of study[3]. At the college level, Golman found a consistent relationship between mechanical curiosity

[1] Edward K. Strong Jr., Vocational Interests of Men and Women (Stanford: Stanford University Press, 1943): p.28.

[2] Report of the Core Committee on the Reorganization of The Secondary School, (Department of Education, Province of Manitoba, 1973):p.9.

[3] G. Frederic Kuder, General Interest Survey Manual, (Chicago: Science Research Associates Inc., 1971):p.9.

of freshmen and their choice of major field of study[1]. The Department of Education, Michigan, developed a science attitude survey because it was believed that the success of a new science programme depended, at least in part, upon students' attitudes towards science classes[2]. Mallinson, in a study already cited, found that achievement in high school science courses was closely related to college plans professed at the grade nine level. Also, he found that the more science courses a student elects, the more he is likely to achieve well[3].

There appeared to be a definite relationship between interest, attitude and motivation. Ohles lends support to this relationship in the following statement:

> The relation of interest to motivation is that of any other attitude---motivation evolves from attitude and is a force that results in action---interest in school is an attitude toward school based experiences[4].

Whether or not interest is indeed an attitude itself, it seems highly probable that interest and attitude are among

[1]Roy D. Golman et al, "Sex Differences in the Relationship of Attitudes Towards Technology to Choice of Field of Study", Journal of Counselling Psychology, vol.20(Sept.1973):p.412-18.

[2]Thomas H. Fisher, "The Development of an Attitude Survey forJunior High Science", School Science and Mathematics, vol.73(Nov.1973):p.647-52.

[3]C.G. Mallinson, "Achievement and Selection of Courses", Western Michigan University (ERIC Document 002 889, 1963).

[4]John F. Ohles, "Interest and Learning," Education, vol.89(March 1969):p.249-52.

the common denominators relating motivation, course selection and achievement[1].

The decade of the seventies has seen a growing importance placed on more humanistic education which emphasizes the affective domain[2]. Courses should not only meet the needs of the student, they must also appear relevant to him. The Core Committee supported this position in its Report, with ample references to the students' needs, interests, self-fulfillment, acceptance and perception of purpose[3]. A decade after his widely accepted book, The Process of Education, Bruner made a plea for relevancy and humanism:

> In terms of a curriculum project for the seventies---I would be quite satisfied with a demphasis on matters that have to do with the structure of physics---and deal with it rather in the context of the problems that face us. We might put vocation and intention back into the process of education. The issue is one of man's capacity for creating a culture, society and technology that not only feed him, but keep him caring and belonging[4].

A suggestion for similar changes in educational strategies was also made by the noted science educator, Paul DeHart Hurd. He advocated that science be taught in the context of society with a focus on the welfare of

[1]See definition of terms on page 9.

[2]Benjamin S. Bloom, Taxonomy of Educational Objectives, Handbook II:Affective Domain (New York: David McKay Co., 1956):p.15-23.

[3]Core Committee Report, p.1, 3, 4, 8, 11, 18.

[4]Jerome S. Bruner, "The Process of Education Revisited", Phi Delta Kappan, vol.52(Sept.1971):p.21.

mankind so that better aculturalization and intellectual attitudes are achieved[1]. Elsewhere Hurd has argued for a more humanistic biology course which would take into account society and human values. "We need students coming out with commitments, appreciations and convictions about what is worthwhile"[2]. It is apparent that desirable interests and attitudes of the student have come to be considered as worthwhile ends of the educative process, and not merely as a means of encouraging the student to greater achievement during his formal education.

In summary, there are at least three major areas in education where interests and attitudes of the student are deemed to be of considerable importance:

1. Motivation
2. Determinants in course selection
3. Desirable ends in themselves of the educative process

The implications here are that if the educative process can engender keen interests and positive attitudes in the student, he will achieve more, select his elective courses more suitably, and develop more fully as a desirable citizen with worthwhile goals and commitments. Notwithstanding the many improvements in curricular materials, facilities and instructional methods, the existence of

[1] Paul DeH. Hurd, "Educational Goals for the Seventies", N.S.T.A. Conference New York (ERIC Document ED 064 118, 1972).

[2] Paul DeH. Hurd, "A Humanistic Biology Curriculum Design", American Biology Teacher, vol.33(Mar.1972):p.397-408.

favourable interests and attitudes in today's students should not be taken for granted. Only by continuously monitoring the interests and attitudes of the student population can we be certain of the nature and level of this important segment of the process of education.

Definition of Terms

There is a degree of similarity between interest and attitude which warrants some discussion as the definitions for these concepts are developed. Both are affective conditions[1]; both are emotional responses indicating varying degrees of like or dislike for a variety of items. There are, however, some important distinctions as indicated below.

Attitude

Attitude has been broadly defined as a feeling or disposition, primarily grounded in emotion, to behave either positively or negatively toward a person, group, object, situation or value[2]. Attitudes may range just as far negatively as positively from a central point of neutrality. It is possible for one to exhibit a positive attitude toward something that one has little or no interest in. For instance, a student may respect and

[1] Op. cit., Bloom, p.7.

[2] Websters Third New International Dictionary of the English Language, Ed. Phillip B. Gove, (Springfield, Mass.: G. and C. Merriam Co., 1966):p.141.

appreciate the work of a research scientist, (i.e., a positive attitude) but he may have no personal interest for that type of activity for himself. For the purposes of this study, attitude towards science and mathematics is defined as a degree of positive or negative emotional response to these aforementioned subject areas in a school context, as indicated by the Purdue Master Attitude Scale.

Interest

Interest has been generally defined as a feeling of wanting to know, see, do or take part in; a readiness to attend to and be stirred by certain objects or situations[1]. Interests range only in a positive direction from a nil starting point. A girl student may have a keen interest in science or mathematics while at school, but her attitude towards these male oriented fields may preclude her from considering these areas for her own higher education or occupation. For the purposes of this study, interest in science and mathematics will be defined as the degree of preference for scientific or mathematical activities or situations as indicated by the Kuder General Interest Survey.

Purpose of This Study

The Interlake School Division is one of several Rural Manitoba school divisions which border on the city

[1] Ibid., p.1178.

of Winnipeg. In recent years, enrollment in secondary schools of the Division has remained relatively constant at approximately one thousand students in grades nine to twelve inclusive. However, enrollment in certain science and mathematics courses has decreased markedly. The question arose: is this an indication of some underlying problems such as a lack of interest and poor attitudes of students toward these subject areas? The focus of this study was on the interests and attitudes towards science and mathematics of students in Interlake School Division. Specifically, the aims of this study were:

1. To assess the interests and attitudes on the part of secondary school students at various grade levels towards science and mathematics
2. To determine if and how these interests and attitudes change as students proceed through the secondary grades by selected course routes
3. To compare student interest and attitude in science with those in mathematics
4. To discover if there are differences between boys and girls in interests and attitudes towards science and mathematics by grade course level

Questions to be Considered

Relative to the aims of this study, the following questions were considered with respect to the Interlake School Division:

1. How does interest in science on the part of secondary school students in Interlake School Division compare with interest of the general population of secondary school students as indicated by standardized norms?
2. Where do the attitudes of these secondary students towards science lie on a continuum that ranges from strongly negative to strongly positive?
3. Is there any change in interest in science of Interlake secondary students as measured by the Kuder General Interest Survey from the time they begin to the time they complete the following courses:
   a) grade nine General Science (Thurber and Kilburn)?
   b) grade ten Science 100(I.P.S.)?
   c) grade ten Science 101 (I.M.E.)?
   d) grade eleven Biology 201?
   e) grade eleven Biology 201 with Physical Science 201?
4. Are there any significant changes in attitudes of students towards science, as measured by the Purdue Master Attitude Scale, from the time they begin to the time they complete the following courses:
   a) grade nine General Science (Thurber and Kilburn)?
   b) grade ten Science 100 (I.P.S.)?
   c) grade ten Science 101 (I.M.E.)?
   d) grade eleven Biology 201?
   e) grade eleven Biology 201 with Physical Science 201?

5. If there is a change in interest in science, what is the degree of change after having taken:
   a) Science 100 as compared to Science 101?
   b) Biology 201 as compared to Biology 201 concurrently with Physical Science 201?
6. If there is a change in attitude towards science, what is the degree of change after having taken:
   a) Science 100 as compared to Science 101?
   b) Biology 201 as compared to Biology 201 concurrently with Physical Science 201?
7. How do girls' interests in science compare with those of boys in grades nine, ten and eleven?
8. How do girls' attitudes towards science compare with those of boys in grades eight, nine, ten and eleven?
9. How does interest in mathematics on the part of secondary school students in Interlake School Division compare with interest of the general population of secondary school students as indicated by standardized norms?
10. Where do the attitudes of these secondary students towards mathematics lie on a continuum that ranges from strongly negative to strongly positive?
11. Is there any significant change in students' interests in mathematics from the time they begin to the time they complete the following courses:

a) grade nine General Science (Thurber and Kilburn)?

b) grade ten Science 100 (I.P.S.)?

c) grade ten Science 101 (I.M.E.)?

d) grade eleven Biology 201?

e) grade eleven Biology 201 with Physical Science 201?

12. Is there any change in students' attitudes towards mathematics from the time they begin to the time they complete the following courses?

a) grade nine General Science (Thurber and Kilburn)?

b) grade ten Science 100 (I.P.S.)?

c) grade ten Science 101 (I.M.E.)?

d) grade eleven Biology 201?

e) grade eleven Biology 201 with Physical Science 201?

13. If there is a change in attitude towards mathematics, what is the degree of change after having taken:

a) Science 100 as compared to Science 101?

b) Biology 201 as compared to Biology 201 with Physical Science 201?

14. If there is a change in interest in mathematics, what is the degree of change after having taken:

a) Science 100 as compared to Science 101?

b) Biology 201 as compared to Biology 201 with Physical Science 201?

15. How do girls' interests in mathematics compare with those of boys in grades nine, ten and eleven?

16. How do girls' attitudes towards mathematics compare with those of boys in grades eight, nine, ten and eleven?

17. For students who have completed grade eight, grade nine, grade ten and grade eleven, how do
    a) interests in science compare with interests in mathematics?
    b) attitudes towards science compare with attitudes towards mathematics?

It should be noted that specific reference to the 200-level science courses in grade eleven has not been included in this study. The rationale for this is that the majority of students taking 200-level courses have intentions of going on to higher learning institutions and thus select prescribed prerequisite courses. Reference to grade twelve courses has been omitted because by the time most students reach grade twelve, they have selected secondary school electives for the last time and any further changes in their interests and attitudes will have no effect in course selection. Measurement of the attitudes of grade eight students was included to determine if there was a change in student attitude attributable to the transition from the elementary to the secondary schools. The instrument used for measuring attitudes appeared to be suitable in detecting such a specific, short-range effect, whereas the instrument used for measuring interests in this study[1] was unsuitable for this purpose. Hence, interests of grade eight students were not measured.

[1]Copies of test instruments in appendix.

Importance of the Study

The anticipated value of this study is fivefold:

1. It should provide an objective measure of two important factors in the learning process - interests and attitudes of students - for a fairly typical Canadian rural education system. This should indicate how well these components of motivation are being fostered in the student population. Correspondence with the Planning and Research Branch of the Manitoba Department of Education, as well as a search of the resources of the library of the Faculty of Education, University of Manitoba revealed that such information is not available
2. It should provide information regarding changes in interests and attitudes of the above-mentioned students as they proceed through a variety of science courses in the secondary schools
3. Through comparisons, indications should be obtained as to the relative effects of taking certain science courses on the interests and attitudes of those students
4. It should indicate whether or not attitudes and interests in science correlate with similar attitudes and interests in mathematics
5. The data obtained should provide some insight into the relationship which might exist between students'

interests and attitudes and enrollment in secondary school science courses

Such information should be useful for school teachers and administrators regarding students' interests and attitudes towards science and mathematics in that it may provide a direction to improve this often neglected part of affective learning. Further, science and mathematics curriculum developers may gain new insights into the effectiveness of current course programmes in fostering desirable interests and positive attitudes. Finally, the results obtained here may serve as the basis for further study of those specific factors which determine interests and attitudes in students.

Assumptions

The validity of this study depends upon the following assumptions:

1. The random samples were indeed representative of the groups from which they were selected
2. The measuring instruments used were able to assess, with reasonable accuracy, the interests and attitudes of these students to whom they were administered
3. The subjects in the samples responded truthfully and earnestly
4. The design and execution of the study were such that the data derived would yield valid statistical results

Limitations

For reasons already noted[1], reference to students having completed 200-level science courses, and to students having completed grade twelve (300, 301 level) courses have not been included in this study. Thus the samples used were not representative of the entire student population.

While samples were classified with respect to certain science courses, this was not done with respect to mathematics courses. This might serve as a basis for another study of this type. The emphasis in this study is on attitudes and interests in science, with mathematical interests and attitudes included for purposes of comparison.

The findings of this study, while hopefully having application to other school systems, are of necessity limited by the sample size and peculiarities of the Interlake School Division.

[1] Page 15.

CHAPTER II

REVIEW OF THE LITERATURE

> Our whole policy of compulsory education rises or falls with our ability to make school life an interesting and absorbing experience to the child.
>
> Henry Suzzalo
> President, University of Washington, 1913

A great deal has been written about students' interests and attitudes as these relate to the learning process. In an attempt to classify some of the pertinent material from this large and diverse body of information, the contents of this chapter has been divided into the following major areas:

1. Theoretical basis
2. Curricula and educational practice
3. Research
4. Relevancy, humanism and affective learning
5. Measuring devices

From such an organization certain observations are made which form the basis or rationale of the study.

Theoretical Basis for Importance of Interests and Attitudes in Learning

The significance of the students' interest in, and attitude towards his school experience has been acknowledged in North American education for over half a century. Perhaps the first milestone in this area was established by the long famous educational philosopher, John Dewey, who urged, largely on theoretical grounds, that effective learning would only take place where the child was interested in the task before him[1]. Thus began a movement which was critical of American education because of its lack of emphasis on motivation of the student.

Since then, other educators have stressed the place of interests and attitudes in the learning process.

Whitehead stated that it was a fallacy to "sharpen the mind" now in preparation for future use. He emphasized that whatever mental attributes and interests educators sought to develop must be done here and now, a position which foreshadowed the emphasis on relevance many years later[2]. About the same time, Thorndike, in developing several laws of learning based upon forming psychological

[1]John Dewey, Interest and Effort in Education (Cambridge: Houghton Mifflin, 1913).

[2]Alfred North Whitehead, The Aims of Education (New York: The Macmillan Co., 1929).

connections, emphasized the importance of the learner's "set of mind" at the time of learning. This not only determined what he thinks or does, but also what he accepts or rejects[1]. Kilpatrick pointed out the importance of novelty in a learning situation with the learner being involved in an active, creative way[2]. The proponents of the gestalt school of learning theory which became widely accepted in later decades, recognized the importance of the needs and goals of the learner, as well as the will or desire of the learner to learn, as components of the learning situation[3].

Behaviorists of more recent times also are concerned with interests, attitudes and motivation. The psychologist Skinner explained such concepts as interest, incentive and motivation in terms of reenforcement of specific forms of the individuals behavior. Through positive reenforcement, an individual comes to react in a given situation[4].

[1] E.L. Thorndike, Human Learning (New York: The Century Co., 1931).

[2] William H. Kilpatrick, "A Theory of Learning to Fit the Times", Progressive Education, vol.8(1931):p.288-9.

[3] Ray H. Wheeler, Science of Psychology (New York: Thomas Cromwell Co., 1929).

[4] B.F. Skinner, Science and Human Behavior (New York: The Macmillan Co., 1953).

Gagne proposed eight kinds of learning in a series of eight heirarchies. For each of these kinds of learning he gave required conditions for that particular type of learning to take place, e.g., repetition, reenforcement, continuity and prior capabilities. In addition, there are internal and external preconditions for learning; a major internal precondition is motivation. Here, Gagne included willingness to attend school, motivation to engage in learning, motivation to continue learning, and, of extreme importance, the desire to achieve. He advised that where possible specific achievement should be related to the student's goals and interests[1]. It was important that the student got reward and satisfaction from the learning process. Gagne also introduced the concepts of the "task set" where the potential learner must be ready and willing at the outset of any learning experience, and the human tendancy to take a chance or gamble with a new situation[2]. This is somewhat similar to Harlow's interpretation of the manipulative drive: one reason why we learn or do anything is our tendency to be inquisitive about and playful with an environment that keeps us aroused[3].

In the field of education, Piaget is probably best

[1] Robert M. Gagne, The Conditions of Learning (New York: Holt, Rinehart and Winston, Inc., 1965).

[2] Robert M. Gagne, Automatic Teaching (E.H.Gallanter ed.), (New York: John Wiley and Sons, 1959).

[3] Harry F. Harlow, "Mice, Monkeys, Man and Motives", Psychological Review, vol.60(1953):p.23-32.

known for his contributions in the study of the developmental stages of human intelligence. He has proposed the existance of an invariant sequence of four major stages: sensory-motor, preoperational (or representational), concrete operations, and propositional (or formal operations). The educational implication of Piaget's theory is that it is useless to present learning experiences which are beyond the child's development stage[1]. But this is not all. Piaget has listed four factors which contribute to this intellectual development: maturation of the nervous system, experience, social transmission and autoregulation. With the first three factors, the individual is passive, while in the fourth he must be active to realize optimum development. Hence, Piaget's second educational implication is that the child be given every opportunity for active involvement in his own learning. Unless there is adequate stimulation and childfelt need or desire to engage in active learning activity, little learning takes place and the process of intellectual development is retarded[2].

Ausubel, who maintains a cognative position in learning theory where the nervous system is a data processing mechanism, stated that meaningful learning generates

[1]Edward A. Chittenden, "Piaget", Speech presented to the National Science Teachers Ass'n., Mar.1967.

[2]Eleanor Duckworth, "Piaget Rediscovered", The Arithmetic Teacher, vol.42(Nov.1964):p.496-9.

its own motivation. In our culture, learning for its own sake becomes less important with age; there is a decline in school interests as children move up the grades, with more consideration given to ego enhancement and other extrinsic rewards. Meaningful learning requires that the new material must be relatable to the learners cognative structure, and that the learner must have the intent to relate the "new" to the old, i.e., a learning set[1].

Concentrating on science education, Bruner promoted the importance of the properly structured course and learning by discovery method. One of the benefits that would follow would be the shift from extrinsic to intrinsic rewards with satisfaction derived from the learning process[2] [3]. This position was supported by Schwab who introduced the concept of learning by active inquiry rather than by passive dependance on teacher and textbook. As a result, the student would exhibit a positive active role in the search for scientific truths - something more in keeping with the true nature of a scientists work[4]. At this point it might be observed that the student could only be expected to

[1] David P. Ausubel, Psychology of Meaningful Verbal Learning (New York: Grume and Stratton, 1963).

[2] Jerome S. Bruner, The Process of Education (Cambridge: Harvard University Press, 1960).

[3] Jerome S. Bruner, "The Act of Discovery", Harvard Education Review, vol.31(Jan.1961):p.21-32.

[4] Joseph J. Schwab, The Teaching of Science as Enquiry (Cambridge: Harvard University Press, 1964).

engage in discovery and inquiry learning if by his attitudes and interests he were disposed to do so. The implication is that he will.

Mager, known for his work on behavioral objectives, maintained that favourable attitudes toward school subjects maximize the possibility that a student will willingly learn more, remember more and make more use of what he has learned[1]. The psychologist Bernard has told us that interests are built as a result of contact, experience, success and familiarity. The teacher's job, he continued is to set the stage for development of interests, and to capitalize on those already present; the problem is that the current educational system cannot function entirely on intrinsic motivations[2].

From the foregoing theoretical positions it would appear that while there is considerable agreement as to the significance of interests and attitudes of the learner in the learning process, there is a variety of positions concerning their precise nature and operation in a learning situation. A number of concepts have been suggested in an attempt to describe the complex area of motivation, of which interests and attitudes are a part. Some of these concepts are need satisfaction, drive reduction, innate

[1] R.F. Mager, Developing Attitude Toward Learning (Palo Alto: Fearon Publishers, 1968).

[2] Harold W. Bernard, Psychology of Learning and Teaching, (Toronto: McGraw-Hill Book Co., 1972).

curiosity, set of mind, task set, reenforcement, manipulative drive, intrinsic and extrinsic motivation, active developmental stages; yet there is by no means total agreement concerning their place in the total picture.

The fact remains that learning is still far from being completely understood, as evidenced by a recent statement by the National Science Teachers Commission on Professional Standards and Practices:

> We know too little yet to have much of a science of instruction: too little about how people think and learn; about how they are motivated and how their potential for creativity can be tapped; about human interactions; about the effects of attitudes and social forces on learning; about how to measure quantities that we cannot yet even define well---(we lack) fine-grained pervasive tested theories of teaching and learning[1].

In spite of this frank acknowledgement, there is a growing body of research and documentation in the area of interests and attitudes. It is presented in this chapter after the survey of literature regarding their place in school curricula.

Interests and Attitudes in School Curricula and Educational Practice

Reference to interests and attitudes can be found in numerous published works of various organizations and individuals concerned with school programmes and curricula.

[1] Commission on Professional Standards and Practices, Conditions for Good Science Teaching in Secondary Schools, (Washington, D.C.: National Science Teachers Ass'n., 1970):p.6.

The Fifty-ninth Yearbook of the National Society for the Study of Education, published in 1960 notes that objectives in science teaching have changed little in the preceding twenty-five years. This, however, represents the situation before the major impact of Sputnik. Included among these objectives were:

1. The social aspects of science
2. Appreciation of science and scientific methods
3. Attitudes regarding science[1]

The Manitoba Department of Education Curriculum Guides and High School Programme of Studies advise teachers that grade nine should help to ascertain students' interests and inclinations, while the later grades provide differentiation of studies to meet varying interests of students[2]. Among the objectives of various science and mathematics courses in the high school grades are found statements to the effect that these courses should develop interests, appreciations, willingness to apply, and favourable attitudes in the students[3]. Unfortunately, the methods of attaining these goals is not indicated. The Planning and Research Branch, in reply to a written inquiry,

[1] National Society for the Study of Education, Fifty-ninth Yearbook, Rethinking Science Education (Chicago: University of Chicago Press, 1960).

[2] Manitoba, Department of Education, High School Programme of Studies, (Winnipeg: Queen's Printer, 1972):p.1.

[3] Manitoba, Department of Education, Chemistry 200-300 (Winnipeg: Dept. of Education Printing, 1971):p.2.

reported that they have no record of any Manitoba-based study concerning the interests and attitudes of students[1]. The Guidance Curriculum Guide does authorize the use of two Kuder Preferential Records (Vocational and Personal) in grades ten and eleven[2], but local inquiry indicated that schools in Interlake School Division fail to use these.

Similarly, the use of interest measurements in secondary schools in the United States seems to be rather limited. A study conducted by the Dade County Public School System of Florida in 1970 showed that out of forty-eight large school systems from twenty-four different states, only three school systems used interest measurements in junior high grades, and only two systems used them in senior high school. On the other hand, use of achievement tests and aptitude tests were quite commonplace[3]. Without available data, one would suspect a similar situation in Canadian school systems.

On the other hand, the problems related to the affective factors of the student are not entirely overlooked. The Report of the Core Committee on the Reorganization of the Secondary School recognized the significance of the rapid changes in our technologically oriented

[1]See Appendix.

[2]Manitoba, Department of Education, <u>Guidance Grades VII-XII</u> (Winnipeg: Queen's Printer, 1966):p.11.

[3]Dade County Public Schools, <u>Survey of Large School System Achievement, Aptitude, Interest Test Usage</u> (Miami: 1970).

society, youth's changing values - the so called counter culture - and the need for continuity of education throughout one's lifetime. It recognized the importance of the immediate needs and interests felt by the students themselves, as well as the long range needs of the individual in society[1]. An essential thread which runs through many of the Committee's recommendations is the need for greater flexibility in student selection of courses and wider range of experiences in the secondary school programme[2]. "Both specialized study and exploration are considered equally worthy objectives in determining a student's programme[3]". This approach, presumably, would make the school better able to meet the needs and interests of a larger proportion of students in both the immediate and the long range categories.

The Committee on Designs for Progress in Science Education of the National Science Teachers' Association (1969) noted "a demonstrated shift in interests of students away from the sciences". This seemed to be coupled with manpower shortages in science-based fields. This Committee recommended more relevance in content and emphasized the urgency of relating science learning to human and social

[1]Core Report, p.3, 4, 5.

[2]Ibid., p.18, 22, 23, 24, 25.

[3]Ibid., p.25.

problems[1]. Among suggested requirements for learning science are student readiness, meaningful goal and frame of reference, interest in life and alertness to what is going on[2]. This would seem to imply that the present science programmes are failing to meet these requirements.

Several critics have in fact, suggested this shortcoming. Watson complained that the revisions in science curriculum have neglected the average student as new programmes have become too discipline oriented, segmented, and unrelated to student needs[3]. Hurd pointed out several weaknesses in the then current science programmes in that they did not motivate the majority of students toward an interest in science. This was because the courses lack relevance, are separated from the human context, and lack personal, practical and social aspects. As a result, science courses tend to be confined to a narrow range of students' interests and abilities[4].

In an address to the twentieth annual meeting of the National Science Teachers' Association entitled "The

[1]David P. Butts, ed., Designs for Progress in Science Education (Washington, D.C.: National Science Teachers' Ass'n., 1969):p.7,13.

[2]Ibid., p.29.

[3]Fletcher S. Watson, "Teaching Science to the Average Student", The Science Teacher, vol.34(Mar.1967): p.21-26.

[4]Paul DeH. Hurd, New Directions in Teaching Secondary School Science (Chicago: Rand McNally, 1969).

Flight From Science", Westmeyer acknowledged the recent decrease in science enrollment, along with a decline in the general image and popularity of science in North America. He admitted that science courses have become dull, difficult, uninteresting, factual and uninspiring. However, he continued though science has been accused of being inhumanistic, it is really a very human endeavor. Thus, the fault here lies not with the subject but with "our teaching of science which is inhuman"[1].

Youngpeter placed the blame for reduced enrollments and interest in science on recent pedagogical methods, particularly the process approach. This practice which emphasizes the methods of scientists is unsuitable for students in lower grades because students do not acquire a basic core of information which is necessary to understand and appreciate natural phenomena. This in turn, results in decreasing interest at a critical stage in the student's life. The object of the curriculum, he concluded, should be teaching basic sciences first, rather than producing scientists[2].

It is evident, from the foregoing references, that institutions and organizations traditionally concerned

[1] J. Westmeyer, "The Flight From Science", Address to twentieth annual meeting of the National Science Teachers' Association, Mar. 1972.

[2] John M. Youngpeter, "Has the Process Approach Taken the Wonder Out of Science?" Ward's Bulletin, vol.13 (May 1974):p.11.

with the school curriculum continue to include interests and attitudes as worthy objectives, although little has been done to indicate how these should be promoted in the schools. In summary, educators both individually and through their professional organizations have in recent years, pointed out certain shortcomings in science curricula:

1. Failure to provide for the full range of student aptitudes
2. Lack of appeal to student needs and interests
3. Lack of relevance to human and social problems

Improvement in these areas remains one of the priority needs in science education.

Research on Interests and Attitudes

Numerous studies have been carried out in the past two decades in areas related to students' interests and attitudes. These have been classified here under the following headings:

1. Background Influences, Level and Stability of Interests and Attitudes
2. Influence of Pedagogical Methods
3. Vocational Choice
4. Achievement
5. Specific Courses of Study

In many instances, it was possible to discern a common pattern in a group of studies.

Background Influences and the Level and Stability of Interests and Attitudes

A number of studies have been reported which indicate, how various factors such as media, parental aspirations, grade level, sex and personality may influence interests and attitudes for various age groups.

As one might suspect, media are significant in this area. In a study of third to ninth grade pupils, Witty concluded that their interests reflect our mechanized society and the impact of the mass media, especially television. This in turn, may have a restricting effect upon interest in other cultural or recreational areas[1]. Similarly, Feeley discovered a strong relationship between media preference patterns and interest patterns in fourth and fifth graders[2].

Several studies have investigated personality factors of boys and girls as these relate to interests in science and mathematics. Craven, based on a study of secondary school students with a high level of scientific interests as identified by the Kuder Personal Interest Inventory, listed the following characteristics of students

[1]Paul A. Witty, et al, "A Study of Interests of Children and Youth" (Northwestern University, Evanston, Ill., ERIC Document ED 002 846, 1959).

[2]Joan F. Feeley, "Interest Patterns and Media Preferences of Boys and Girls" (New York University, N.Y., ERIC Document ED 067 683, 1973).

likely to prefer science activities:

1. Active participants in their age group
2. Conforming to standards
3. Not close to one's family
4. Personal-social bonds are weak
5. Higher intelligence
6. Boys[1]

Clark investigating the commonalities of science interests by intermediate grade children found that biology was the most liked, social class and grade level had no effect, and sex was a major factor with boys more interested in pysical science and girls more interested in biology[2]. Whetjen found that in science boys are more curious, better achievers and have greater analytical skill. Hypothesis formation is greater in lower grades and in more permissive classes[3]. Feeley agreed that in middle grades sex continues to be a major determiner of interests[4].

[1]Eleanor B. Craven, The Use of Interest Inventories in Counseling (Chicago: Science Research Associates Inc., 1961):p.14.

[2]Cleveland O. Clark, "A Determination of Commonalities of Science Interests Held by Intermediate Children", Science Education, vol.56(June 1972):p.125-36.

[3]Walter B. Whetjen, "Learning and Motivation: Implications for the Teaching of Science", The Science Teacher, vol.32(May, 1965):p.22-26.

[4]Id., Joan F. Feeley, "Interest Patterns and Media Preferences", 1973.

With respect to mathematics, Cox found different attitudes in boys and girls in grade four but not in grade five. From grade four to five favourable attitudes of girls decreased while those of boys increased. Girls in both grades liked science less than boys[1]. A study by Phillips supported the opinion that the teacher's attitude to mathematics is significantly related to students' attitude, but not if only the most recent teacher is considered[2].

Mowrer found that parents' perceptions of their sons' interests were fairly valid. This would lead one to suspect that parents often exert a significant influence on the interests of their children[3]. This is in part supported by Mallinson who found that one of the most influential factors in science achievement was the aspirations and interests of parents for the education of their children[4].

Several investigators have discovered a decline in

[1]Linda S. Cox, "Attitude Toward Arithmetic at 4th and 5th Grade Levels", Arithmetic Teacher, vol.16(Mar. 1969):p.215-20.

[2]Robert B. Phillips, "Teacher Attitude as Related to Student Attitude in Elementary School Mathematics", School Science and Mathematics, vol.73(June 1973):p.501-7.

[3]G.E. Mowrer and J.C. Marshall, "The Relation Between the Interests of Male High School Seniors and Their Parents Perceptions of These Interests", American Personnel and Guidance Assoc., Washington, D.C., (ERIC Document ED 021 271, 1969).

[4]Id., Mallinson, "Factors Relating to Achievement and Motivation in Science", 1963.

favourable interests or attitudes as students proceed from intermediate to high school grades. Clark reported that attitudes toward curriculum and administration decline from grade eight to grade eleven[1]. Ryan found a decline in positive attitude toward mathematics from the start of grade six to the end of grade nine[2]. Moore discovered ninth grade students neither strongly accept positive scientific attitude statements nor strongly reject negative scientific attitude statements[3].

By the time they reach college age level, interests and attitudes appear to become more stabilized. Stewart, investigating the consistency of personality and interests, found little difference between working apprentices and enrolled college students, as well as between students and graduates[4]. Omen found that different high school backgrounds had little or no effect on attitude patterns in

[1]Cleveland O. Clark, "Commonalities of Science Interests Held by Intermediate Children", Science Education, vol.56(June 1972):p.125-36.

[2]J.J. Ryan, Effects of Modern Conventional Mathematics Curriculum on Pupil Attitudes, Interests, and Perception of Proficiency (Washington, D.C.: U.S.O.E. Bureau of Research, 1968).

[3]Richard W. Moore, "A profile of the Scientific Attitudes of 9th Grade Students" (School Science and Mathematics, vol.71(Mar.1971):p.229-32.

[4]L.H. Stewart, A Study of Certain Characteristics of Students and Graduates of Occupation-centered Curricula, (Office of Education, Washington, D.C.: ERIC Document ED 025 264, 1969).

the following two years[1]. Roberts discovered no significant difference in mathematics attitudes between the sexes, although engineering students showed more positive attitudes than terminal mathematics students[2]. Scwirian found that a 1971 sample of college students had just as positive an attitude to science as a 1967 sample[3].

Studies concerning adults indicate a generally favourable attitude toward science. Riggs concluded that more people today realize what the benefits of science are and its importance[4]. The Opinion Research Corporation of Princeton found strong public approval concerning past scientific achievement and even stronger confidence in the future[5].

[1] J.L. Omen, Relation of High School Backgrounds to Attitude Patterns Over First Two Years of College (St.Paul's College, Concordia, Md.: ERIC Document ED 034 250, 1969).

[2] Fannie Roberts, "Attitudes of College Freshmen Towards Mathematics", Mathematics Teacher, vol.62(Jan. 1969):p.25-7.

[3] Patricia M. Scwirian, "Changing Attitudes Towards Science: Undergrads. in 1967 and 1971", Journal of Research in Science Teaching, vol.9(Mar.1972):p.253-9.

[4] Virgil M. Riggs, "Change in Attitude of American Society Towards Science", Science Education, vol.53(Mar. 1969):p.115-19.

[5] Opinion Research Corp., Princeton, "Survey of Public Attitudes Toward Science and Technology", Science News, vol.104(Sept.1973):p.151-4.

The foregoing presents a picture of generally favourable attitudes and interests at the elementary school level with girls falling behind boys in science and mathematics. A general decline continues through the intermediate and high school grades, with stability reached by college level. Nevertheless, public attitude remains relatively favourable. Important influences mentioned here which operate during this time are parents' aspirations, teachers' attitude, sex roles, mass media and progress through the educational system. There are other influences closely akin to the school which are discussed in the following section.

The Influence of Pedagogical Practice on Interests and Attitudes

It has been stated in the previous section of this chapter[1] that the teacher's attitude towards mathematics is positively related to the student's attitude if more than the most recent teacher is considered. It would seem that attitudes of teachers have a cumulative effect on their students over the years.

Other findings related to pedagogical practices appear to cross many dimensions: Deady found that introduction of longer time periods for science instruction

[1] Page 35.

(from twenty to thirty-five minutes) caused attitude changes in both directions (favourable-unfavourable) in elementary school students[1], while a study by Champlin concluded that students need not have an accurate understanding of science and the work of scientists as a prerequisite to having a favourable attitude towards science and scientists[2]. Leppar showed that using children's initial interest in an activity as a means to some ulterior end undermined this intrinsic interest in the original activity[3] and Koelshe found that students using the "process approach" in science have different scientific interests than those using a traditional approach in grades four to six[4]. Strozack showed that students in both directive and nondirective instructional situations had positive correlations between attitude to course and achievement[5]. In a

[1]Gene M. Deady, The Effects of Increased Time Allotment on Student Attitudes and Achievement in Science (Chico State College, Calif., ERIC Document ED 039 126, 1970).

[2]Robert F. Champlin, The Development of an Instrument to Assess Student Attitudes Toward Science and Scientists (Ohio State Univ., ERIC Document ED 071 849, 1973).

[3]Mark R. Leppar, Extrinsic Rewards and Intrinsic Motivation in Children (National Inst. of Mental Health, Bethesda, Md.; ERIC Document ED 084 210).

[4]Charles L. Koelshe, et al, "Relation Between Certain Variables and the Science Interests of Children", Journal of Research in Science Teaching, vol.8(Oct.1971): p.237-41.

[5]Victor S. Strozack, The Effects of Directive and Nondirective Problem Solving and Attitudes and Achievement (ERIC Document ED 086 458, 1974).

study of senior high school students, Fiks observed that glamour and status were the highest sources of satisfaction in taking foreign language courses[1]. In a somewhat different vein, James found no significant differences between attitudes of three groups of student science teachers receiving three different types of supervision[2]. Also at the college level, Vlandis discovered that attitudes of college students toward certain topics were changed as a result of grades received in subjects where these topics were taken up[3]. It is apparent that a number of factors which have been investigated such as teacher's attitude, instruction, curricular approach, and grades received significantly influence interests and attitudes of students. Others, such as type of supervision and student's understanding do not seem to have any such clear cut influence. Perhaps the keynote in this area was given over a decade ago by the psychologist Ausubel:

[1] A.I. Fiks, Student Attitudes to Foreign Languages (Geo. Washington Univ., Alexandria, Va.: ERIC Document ED 028 417, 1969).

[2] Helen H. James, "Attitude and Attitude Change", Journal of Research in Science Teaching, vol.8(Apr.1971): p.351-5.

[3] John Vlandis, "Grades as Reenforcing Contingencies and Attitude Change", Journal of Educational Psychology, vol.52(Feb.1961):p.112-15.

> The current interests and desires of immature pupils can hardly be considered reliable guide-posts and adequate substitutes for specialized knowledge and seasoned judgement in designing a curriculum---in fact, one of the primary functions of education should be to stimulate the development of motivations that are currently nonexistant ---(student's needs) are not endogenous but acquired largely through exposure to provocative, meaningful and, developmentally appropriate instruction[1].

Using Interests and Attitudes in Vocational Guidance and Prediction

Probably the greatest application made of the measurement of interests and attitudes is in the field of vocational prediction. Edwards and Wilson, in a study of attitudes of high school students, concluded that there is a direct relationship between attitudes, subject interests, grades and vocational aspirations[2]. Similarly, Apostal's investigation of high school students' interests found close relationship between interests and personality in the process of choosing a vocation[3]. Golman in a study of college freshmen, discovered that mechanical curiosity was related to choice of major field for both men and

[1]David P. Ausubel, "Viewpoints from Related Disciplines", Teachers College Record, vol.60(1959):p.246.

[2]T.B. Edwards and A.B. Wilson, Attitudes of High School Students as Related to Success in School (California University, Berkeley: ERIC Document ED 002 827, 1969).

[3]Robert Apostal and Patricia Harper, "Basic Interests in Personality", Journal of Counselling Psychology, vol.19(Mar.1972):p.167-8.

women[1]. Contrary results were reported at the high school level by Holland when he found that asking the student concerning vocational preference was almost twice as efficient as using a vocational preference survey[2].

Relationships between vocational choice and other psychological factors have also been investigated. Krippner concluded that academic ability has greater influence on vocational preference at the junior high school level than mental ability. These abilities were found to be more closely tied to vocational and educational interest of boys than those of girls[3]. Holland found that the choice of a major field may be a determinant of non-academic achievement[4]. In a study of college students Nordstrom found that those who left the sciences for other disciplines were concerned with personal self-integration and maintaining a healthy spirit of inquiry, these facets not

[1] Ray D. Golman Et al., "Sex Differences in the Relation of Attitudes Towards Technology to Choice of Field of Study", Journal of Counselling Psychology, vol.20 (Sept.1973):p.412-18.

[2] J.L. Holland and S.W. Lutz, Predicting a Student's Vocational Choice (American College Testing Program, Iowa City,: ERIC Document ED 012 941, 1968).

[3] S. Krippner, A Study of Vocational and Educational Interests of Junior High School Girls and Boys (Northwestern Univ., Evanston, Ill.: ERIC Document ED 002 848, 1961).

[4] John L. Holland and J.M. Richards, Academic and Nonacademic Accomplishment in a Representative Sample (American College Testing Program, Iowa City,:ERIC Document ED 014 093, 1968).

being open to them in the science field apparently[1]. The majority of studies supported the practice of using interests and attitudes of students as an aid to vocational guidance and selection.

Interests, Attitudes and Achievement

Perhaps the most extensive study in this area was Mallinson's six year investigation where a sample from grade seven in twelve school systems was followed through to grade twelve. In this study, which was mentioned earlier[2], Mallinson drew a number of conclusions:

1. In "usual" courses in science offered in high school, achievement is closely related to college plans professed in grade nine
2. Science instruction appeared to be most effective in grade eight
3. In biology, a high degree of interest seemed to accompany success, but in chemistry and physics a low level of achievement does not seem to be accompanied with a low level of scientific interest in these fields
4. High degrees of scientific and computational interests

[1] C. Nordstrom, Why Successful Students in Natural Science Abandon Careers in Science (City University of New York: ERIC Document ED 002 936, 1962).

[2] Pages 3,6.

were evident among high achievers

5. The more science a student elected, the more he was likely to achieve[1]

Cattel concluded from a study of seventh and eighth grade students that abilities, personality traits, and motivational traits contributed about equally to scholastic achievement, and mutually overlap only about one third[2]. Similarly, Thomas investigating seven areas of instruction (including science and mathematics) supported the assumption that educational interests are related to academic success[3]. In higher education, Ellish found a significant relation between attitude and grade point average of both junior college and four-year college students[4].

There is, however, by no means full agreement in this area. Neale found in intermediate grades that positive and negative attitudes to mathematics have only a slight influence on learning mathematics. More significant were the desire to do their duty, be good, and

[1] C.G. Mallinson, Factors Relating to Achievement in Science and Motivation in Selection of Science Courses in High School (University of Western Michigan: ERIC Document ED 002 889, 1961).

[2] B.B. Cattel et al., Prediction and Understanding of the Effect of Childrens' Interest on School Achievement (Illinois University, Urbana: ERIC Document ED 002 987, 1962).

[3] Lucinda Thomas, et al., "Educational Interests and Achievement", Vocational Guidance Quarterly, vol.18 (Mar.1970:p.199-200.

[4] Arthur D. Ellish, "The Effects of Attitude on Academic Achievement", Junior College Journal, vol.39 (Mar.1969):p.120-22.

gain approval[1]. Husen on a nation wide survey (U.S.A.) concluded that attitudes towards mathematics had no correlation with achievement[2] and Knapp maintained that research shows little relation between attitude and achievement in elementary mathematics, however, this may be due to the problem of using measuring devices with younger children which at times produces questionable results[3].

Attempts to use measurements of academic interests to predict achievement have met with limited success. Samuelson found in a study of trade school students that a real relationship existed between interests, as measured by the Kuder Preference Record, and achievement significant at the one per cent level. However, the correlation was low thus forecasting achievement would not be very accurate[4]. Johnson concluded that the predictive validity of S.V.I.B. academic scales contributed significantly but modestly in predicting academic performance of freshman. These scales

[1] David C. Neale, "The Role of Attitudes in Learning Mathematics", Arithmetic Teacher, vol.16(Dec.1969): p.631-40.

[2] T. Husen, ed., International Study of Achievement in Mathematics, (New York: John Wiley & Son, 1967).

[3] Jonathon Knapp, "Are Children's Attitudes Toward Learning Mathematics Really Important", School Science and Mathematics, vol.73(Jan.1973):p.9-15.

[4] Cecil O. Samuelson, "Interest Scores in Predicting Success in Trade School Students", Personnel and Guidance Journal, vol.36(Apr.1958):p.538-41.

were somewhat more valid for use with marginal students[1]. Katz developed a scale for measuring academic interests which proved to be valid to an extent greater than ability measures in predicting achievement in four out of ten courses for boys, and eight out of ten courses for girls. However, self-ratings were nearly as valid as the scale in predicting grade twelve marks[2].

Interests, Attitudes and Specific Courses

A number of studies have been reported concerning the interests or attitudes engendered by established courses in science. In a study using fifth form students as subjects, Meyer selected one group that had two years of Nuffield O-level biology, physics and chemistry with a control group that had traditional courses. The Nuffield courses appeared to have been related to:

1. Improved scientific attitudes for girls but not boys
2. Increased interest in empiricism, and science as a leisure activity
3. Loss of interest in male physics students
4. Decline in interest in fine arts and literature[3]

[1]R.M. Johnson, The Effectiveness of Academic Interest Scales in Predicting College Achievement (Mass. Univ.; ERIC Document ED 024 085, 1968).

[2]M.K. Katz and L. Norris, The Measurement of Academic Interests (Educational Testing Service, Princeton: ERIC Document ED 052 240, 1971).

[3]G.R. Meyer, Pupils' Reactions to Trail. Editions of Nuffield O-Level Science Materials (Macquarie Univ., N. Ryde, Australia: ERIC Document ED 046 683, 1971).

Gallagher working with high school students, found that both sexes who took physics and chemistry demonstrated more favourable attitudes to science, scientists, science teachers and themselves as scientists, than those who took no science in these grades[1].

Results of other studies of science courses are less encouraging than the foregoing. Mackay found that students studying P.S.S.C. physics in grades eleven and twelve lost interest in physics, viewed scientists as more abnormal, but increased their acceptance of non-authoritarian teaching situations[2]. In a study of grade twelve biology students in the Australian schools, Luchas discovered that students with prior biology courses increased in understanding of science and science reasoning, but did not change in critical thinking and actually declined in enjoyment of biology[3]. Starr found no significant difference in attitudes toward biology between high ability grade nine biology students after being exposed to twenty random

[1]James J. Gallagher, Test Every Senior Project: Attitudes of Seniors Concerning Science (Educational Research Council of America, Cleveland: ERIC Document ED 028 088, 1969).

[2]Lindsay D. Mackay, "Changes on Affective Domain Objectives During Two Years of Physics in Victoria Schools" Australian Science Teachers' Journal, vol. 17(May 1971): p.67-71.

[3]A.M. Luchas, "Changes in Skills, Knowledge and Attitudes During Two Terms of Grade Twelve Biology Instruction", Australian Science Teachers' Journal, vol.18(Mar. 1972):p.66-74.

"invitations to enquiry" (part of the B.S.C.S. course)[1]. _The Manitoba Science Teacher_ reported a study which compared the attitudes of ninth grade students taking I.P.S. with a control group using the Thurber and Kilburn Text. No significant differences were found at the five percent level in either scientific attitudes or attitude towards science as a subject[2]. Simmons concluded on the basis of a questionnaire that an experimental group using the process approach was more positive in attitude toward science and related activities than a control group using text oriented instruction[3]. However, Yanagidate found no significant change in student attitude to science when transferred from a concept approach to a process approach[4].

Several investigators have written about the effects of special materials on attitudes. Wickline reported that a film series "Horizons of Science" resulted in changes in a few items on an attitude scale, but there was no significant

[1] Robert J. Starr, "The Use of 'Invitations to Inquiry' and Student Attitude", _Journal of Research in Science Teaching_, vol.9(Mar.1972):p.247-51.

[2] "IPS vs Thurber", _The Manitoba Science Teacher_, vol.13(Apr.1972):p.14-17.

[3] Jack Simmons and William Esler, "Investigating the Attitudes Toward Science Fostered by the Process Approach Program", _School Science and Mathematics_, vol.72 (Oct.1972):p.633-6.

[4] May D. Yanagidate, _A Study in Student Attitude Changes Resulting from Nonsequential Curriculum Modification_ (University of Texas, El Paso,: ERIC Document ED 061 040, 1971).

difference on the entire scale between the test group and the control group. There was also no difference noted on a measurement of understanding the value of science as a social institution[1]. Cosman, working with eleventh and twelfth grade students concluded that it was possible to design and teach science materials that would bring about broad changes in scientific literacy and foster several important scientific attitudes[2]. Other attempts were even more encouraging. Bingham placed underachieving junior high school students in success oriented small group activities using the discovery approach. He found that attitudes toward the school and school personnel improved[3]. In a similar vein, Milson developed science materials based on first hand experience, ease of communication, detailed teachers guide and prelab-investigation-postlab format. Using such materials with below average students resulted in significant improvement in attitude towards science[4].

[1] L.E. Wickline, Use of Films to Change Attitudes of High School Students Towards Science (West Virginian State Dept. of Education: ERIC Document ED 003 598, 1962).

[2] G.W. Cosman, The Effects of an Experimental Science Course in Fostering Literacy and Development of Scientific Attitudes, (Iowa University, Iowa City: ERIC Document ED 025 414, 1967).

[3] N.E. Binham et al., Demonstration of an Improved Science Curriculum for Underachieving Students (Florida University,: ERIC Document ED 041 730, 1969).

[4] J.L. Milson, "The Development and Evaluation of Physical Science Curriculum Materials to Improve Students' Attitudes", Journal of Research in Science Teaching, vol.9 (Apri.1972).

The findings to date, while perhaps not sufficient to be considered conclusive, nevertheless indicate that a number of the newer science programmes such as PSSC Physics, BSCS Biology, Nufield Science and the Process Approach have not been particularly successful in fostering desirable attitudes and interests in students. Greater success has been achieved in this respect with courses and materials specially designed for specific groups of students. The validity of a universal course or programme for a science subject is not supported insofar as fostering interests and attitudes is concerned.

Affective Factors and Relevancy

The proliferation of recent literature related to such aspects of education as relevancy, humanism, and affective domain indicates that a definite shift in educational priorities and strategies has occurred in the current decade. A key factor in this movement appears to be the realization that the revisions of the sixties were not working out as well as expected[1] as indicated by Ehrle:

> As we move onward into the seventies, the emphasis in science education at all levels is shifting from more-and-better-content-for-contents-sake towards more relevant learning and better teaching for the students sake[2].

[1] Jerome S. Bruner, "The Process of Education Revisited", Phi Delta Kappon, vol.52(Sept.1971):p.18-21.

[2] Elwood B. Ehrle, "If you Teach the Content, Who Will Teach the Students", Science Teacher, vol.38(Sept. 1971):p.22.

Desirable interests and attitudes must figure prominantly among the goals of this type of education. Certainly there is much that needs to be corrected in the prevailing attitude of much of our youth to the educational system. Watson observed that elementary school children today are increasingly disinclined to be manipulated by hope and fear into doing blindly what adults tell them they need to do[1]. More disconcerting is the claim of DeCecco that research shows that the lessons learned at the typical high school as now operated are "bored acquiescence or bold defiance"[2].

The relationship between affective factors and learning may shed some light on the current problems in this area. Kirchner in giving an overview of attitude research, noted that:

1. Attitudes have other dimensions besides positive and negative, namely direction, intensity, time perspective and information level
2. Attitudes are interdependant with other motivation and value factors
3. Attitude change does not rest on the basis of information itself; a more significant determinant is the

[1] Fletcher G. Watson, "Teaching Science to the Average Student", The Science Teacher, vol.34(Mar.1967): p.21.

[2] John P. Dececco, "Tired Feeling, New Lifestyles and the Daily Liberation of the School", Phi Delta Kappon, vol.53(Nov.1971):p.168-71.

nature and degree of ego-involvement[1]

In a study of informal learning by elementary school children, Howell concluded that if information is to be meaningfully absorbed it must be seen as having a direct bearing on the real life of the individual[2]. Hazen suggested that the individuals attitudes play a significant role in how he organizes information and data to make it understandable[3] while Simpson estimated that human behavior is influenced as much by how a person feels as by how much he understands[4].

Student interests have also come under scrutiny here. Wilson advised that we must teach the students the interest in what we want them to do. A teacher can help the child see the significance in what he is doing and thus engender interest in it[5]. Wyeth suggested that schools and society fail with the underachiever by failing to use the interests already there (in the learner), and by not

[1]C. Kirchner and D.S. Wilder, An Overview of Attitude Research (Adult Education Association, Washington, D.C.: ERIC Document ED 022 076, 1969).

[2]Richard W. Howell, A Study of Informal Learning (City Univ. of New York: ERIC Document ED 040 485, 1970).

[3]Michael D. Hazen, The Role of Attitudes in Prediction of Behavior (Central States Speech Ass'n., Minneapolis: ERIC Document ED 077 037, 1973).

[4]R.D. Simpson, "Evaluating Noncognative Achievement", American Biology Teacher, vol.35(Aug.1971): p.441-51.

[5]P.S. Wilson, Interest and Discipline in Education (London: Routlege and Kegan Paul, 1971).

helping students to develop others[1].

A number of writers have called for greater emphasis in areas of relevancy and humanism, many of these with specific reference to science. Scwiran has cautioned that positive attitudes towards science and its role in society are not an automatic consequence of our age; that appreciation is not equivalent to understanding[2]. Schneider advised that affective education may be a partial solution to the criticism that our society and its schools produce people who may be able to acquire skills, but who often use these skills for destructive purposes[3]. Hurd writing on educational goals for the seventies, advocates that to achieve better aculturization and intellectual attitudes, science must be taught in the context of society with a focus on the welfare of mankind[4]. Ehrle stated teachers must actively teach for favourable feelings and attitudes, and show that they care for the subject, humanity and the students[5]. Robinson has recommended a science

[1] E.R. Wyeth, "Motivation: An Empty Word", The Clearing House, vol.39(Mar.1965):p.46.

[2] Pat M. Scwiran, "On Measuring Attitudes Toward Science", Science Education, vol.52(Mar.1968:p.172-9.

[3] Donald Schneider, "The Time is Ripe for Affective Education," The Clearing House, vol.47(Feb.1972)p.106-9.

[4] Paul DeH. Hurd, "Educational Goals for the Seventies" (Address to N.S.T.A. Meeting, New York, Apr. 1972: ERIC Document ED 064 118, 1972).

[5] Elwood B. Ehrle, "If you Teach the Content, Who Will Teach the Students", Science Teacher, vol.38(Sept. 1971):p.22.

appreciation course. Its goals would be to have the student appreciate the concepts of science and the men who elucidated them[1].

Science may contribute here considerably as was outlined by the Committee on Designs for Progress in Science Education of the N.S.T.A. (1969). It advised that modern man's (youth's) dilemma involves self-identity and alienation, thus science can help by showing orderliness in nature and man's relation to the universe[2]. Similarly Howe recommended that we need to show students where man fits into nature, however, she cautioned that children are children and not scientists so that more feeling is needed in science education[3]. Kantor writing on the topic of moral science, implied that a science programme can be psychologically healthy to the learner, but this would mean abandoning analytic inquiry methods in favour of more openended holistic ones[4].

[1] Lucretia G. Robinson, "Turning the Prism", Science Teacher, vol.40(Feb.1972):p.48-9.

[2] Committee on Designs for Progress in Science Education, National Science Teachers Ass'n., (Washington, D.C.:1969).

[3] Anne Howe, "A Lost Dimension in Elementary School Science", Science Education, vol.55(Apr.1971):p.143-6.

[4] R.E. Kantor, Implications of a Moral Science (Stanford Research Institute: ERIC Document ED 061 738, 1972).

At present there appears to be considerable agreement among many writers in education that the school curriculum should be made more relevant to the students' goals and needs; more humanistic in reflecting the desirable values of our culture and society and concern with social and world problems; and more affectively oriented.

The educational pendulum, which in the sixties had swung over in the direction of greater emphasis on the subject matter and skills of the disciplines, is now well on its way back towards emphasis on the nature and needs of the learner and his society; somewhere between these positions lies the elusive happy medium- that ideal blend of the optimum in factors pertaining to the learner and that which is to be learned.

The Measurement of Interests and Attitudes

One of the clearest statements concerning the importance of measuring students' interests was given by Mehrens and Lehman:

> The important thing to remember is that because pupil interests can influence how well they learn, teachers must be concerned with interest measurement[1].

It follows that selection of suitable measuring devices is crucial. Prior to the selection of specific measuring

[1] W.A. Mehrens and I.J. Lehman, Standardized Tests in Education, (Toronto: Holt Rinehart Winston, 1962).

instruments for use in this study some pertinent items in this respect were obtained from several writers and researchers by the investigator of this study. Stephens observed that up to 1963, research on the objective measurement of attitudes towards science have been meagre[1] with Skinner pointing out that the major problem lay in scientific interest not being unidimentional and hence not easily measured[2]. Craven cautioned the users of interest scales:

1. There is a tendency to confuse interests with abilities
2. Interest scores should not be used as absolut stable entities
3. One should look for supporting behavior to verify interest test scores

She does, however, cite several advantages of using interest scales, particularly for guidance purposes:

1. It brings unconsciously acquired behavior under scrutiny
2. It predicts future occupation better than preferred interests
3. It gives evidence of cultural patterning of interests
4. Responses bear relation to ego development[3]

[1]Stephens and W.H. Dutton, "Measuring Attitudes Towards Science", School Science and Mathematics, vol.63 (Jan.1963):p.43.

[2]Ray Skinner,"Measuring Specific Interests in Biology, Physics and Earth Science", Journal of Research in Science Teaching, vol.10(Feb.1973):p.153-8.

[3]E.B. Craven, The Use of Interest Inventories in Counselling (Chicago: S.R.A. Inc., 1961).

Mehrens essentially agrees with this position, conceding, however, that interest tests are often unreliable and interests themselves unstable but recommending their use foreducational and vocational guidance, to help teachers understand underachieving bright pupils, and to help the student himself consider his future[1]. Another use for interest tests suggested by Fitzelle is to aid the teacher in gearing course content to needs and interests of students[2].

Some general advice on test selection can also be found. Campbell lists the major desirable characteristics of interest inventories as follows: items are relevant, in good taste, simple and direct, valid and stable, specific yet broad enough, tied to a theory, and that the results are clearly described[3]. Finally, it was useful to note from a study by Abrams that faking was not a significant factor in interest tests[4].

The general concensus would appear to be that while care must be taken in the measurement of interests and

[1]W.A. Mehrens, Standardized Tests in Education (Holt, Rinehart Winston, Toronto)

[2]George T. Fitzelle, "Responses to an Interest Inventory", Journal of Home Economics, vol.62(Nov.1970): p.673-5.

[3]D.P. Campbell, Some Desirable Characteristics of Interest Inventories (American Personnel and Guidance Ass'n., Washington, D.C.: ERIC Document ED 033 417, 1970).

[4]N.M. Abrams, Analysis of the Navy Interest Inventory as a Predictor of School Performance (Navy Personnel Research Academy, San Diego: ERIC Document ED 029 250, 1969).

interpretation of results, it still can be a valuable tool for guidance and education.

In summation, the following observations can be made concerning the research on interests and attitudes, particularly as these apply to science and mathematics:

1. There is a considerable although diverse theoretical basis for the importance of interests and attitudes in learning
2. Whereas curricula pay lip service to the significance of developing favourable interests and attitudes, far too little is done to indicate how this may be achieved
3. There are many diverse factors which can and do influence interests and attitudes, some of the more pertinant are parental aspirations, teachers, curricula, age and grade level, sex roll, pedagogical approaches and mass media
4. With proper care, interests and attitudes of students can be used to assist in course selection and vocational choice
5. While favourable interests and attitudes can contribute significantly to better achievement, other factors such as intellectual maturity, suitable curriculum and appropriate pedagogical methods must also be present
6. Specific courses in science and mathematics can be developed to promote favourable interests and attitudes in these subject areas

7. Favourable attitudes and interests reflecting certain values of society are a worthwhile end in themselves, and as such are a major goal of the educative process
8. Measurement of interests and attitudes is a worthwhile venture to assist the educative and guidance process, provided that due care is taken with measuring devices and interpretation of results

A major objective of this study was to discover some of the realities pertaining to interests and attitudes of secondary students towards science and mathematics in a specific Manitoba school division. Since these factors are considered to be vital in the learning process, the findings should prove useful in assessing and improving the quality of education in that particular setting as well as in other similar situations.

CHAPTER III

DESIGN OF THE STUDY

Introduction

The study was undertaken in an attempt to find answers to the following questions:

1. What are the levels of interest in science and mathematics of the secondary school students in the Interlake School Division
2. What are the attitudes of these students towards science and mathematics
3. Do interest and attitude of students change as they proceed through the secondary grades
4. How do the interest and attitude of secondary school students towards science compare with their interest and attitude towards mathematics
5. Are there significant differences in these interests and attitudes in boys as compared with girls

Answers to these questions should not only have educational value in the secondary schools of Interlake Division, but also to other similar school systems in Canada and possibly other countries as well, thus a brief description of Interlake Division is offered.

The Setting

The Province of Manitoba is divided into forty-eight school divisions. These school divisions may be arbitrarily classified as being predominantly urban, predominantly rural, far northern, and rural bordering on urban areas. The Interlake School Division is fairly typical of the latter group. Although living on farms or in small towns and villages, the residents here have ready access to the resources and influences of the city. The increasing numbers of commuters and greater mobility of these rural residents reflect their growing interdependence with the nearby urban area. While an ever more sophisticated, highly mechanized form of agriculture remains an option to some of the youth, the majority tend to seek employment, further training or residence in the city.

It is against this background that the secondary student subjects for this study were selected. There are three secondary schools of different size in Interlake School Division; Stonewall Collegiate, Teulon Collegiate and Warren Collegiate, with relatively stable combined enrollment of between one thousand and eleven hundred students from grades nine to twelve. In accordance with school board policy, instructional staffs, facilities, subject options and general operational patterns vary little among these three school. The one major exception is that one of the schools, Teulon Collegiate, has been operating on the semester system for five years. Another difference is that the smallest school, Warren Collegiate, offers fewer course options than the two larger schools.

Experimental Design

Basic Pattern

The experimental design used in this study is patterned after Campbell and Stanley's design number 12 - "the separate-sample pretest-posttest design"[1]. Here, one sample is measured prior to a treatment, while another equivalent sample is measured after presentation of the treatment, as represented in the following model.

Measurement	Population Under Investigation	
	Random Sample A	Random Sample B
Pretest	X	
Posttest		X

For example, the "pretest" could be given to a random sample of students at the beginning of grade nine while the "posttest" would be given to another random sample of students having completed grade nine. Comparison of the

[1]D.T. Campbell and J.C. Stanley, Experimental and Quasi-experimental Designs for Research, (Chicago: Rand McNally and Co., 1968).

results of the two samples would indicate changes that have occurred during ninth grade.

The alleged weaknesses of this design are the result of a failure to control for history of the samples, effects of maturation, and mortality between pretest and posttest groups. The strengths purported for this design include the following:

1. Where no control group is possible (e.g., all grade nine students take the same science course) it is the only feasible method under such circumstances
2. It moves the laboratory into the field situation, i.e., the effects of a condition or treatment are tested in the natural setting
3. There is high external validity or generalizability since representative sampling from populations specified in advance can be employed[1]

Experimental Procedures

The experimental design was translated into practice for the purpose of answering the questions using the following procedures:

1. The Kuder General Interest Survey (K.G.I.S.), form E, and the Purdue Master Attitude Scale for school subjects (P.M.A.S.)[2] were administered to random

[1] Ibid., Campbell and Stanley

[2] Sample copies are in the appendix.

samples of Interlake students early in the school year (October) as follows:

a) Grade nine - 57 students

b) Grade ten - 62 students

c) Grade eleven - 64 students

d) Grade twelve - 37 students

2. The Purdue Master Attitude Scale was also given to a random sample of 150 grade eight students near the end of the school year (June)

3. The test instruments were scored, giving raw scores in the following areas:

a) Interest in science

b) Interest in mathematics

c) Attitude towards science

d) Attitude towards mathematics

4. These raw scores were classified on the basis of grade and course taken as follows:

	Interests (K.G.I.S.)		Attitudes (P.M.A.S.)	
	Sci.	Math.	Sci.	Math.
a) Grade 8 (June)			X	X
b) Pre grade 9	X	X	X	X
c) Post grade 9 - pre grade 10	X	X	X	X
d) Pre grade 10 - I.M.E.	X	X	X	X
e) Pre grade 10 - I.P.S.	X	X	X	X
f) Post grade 10 - I.M.E.	X	X	X	X
g) Post grade 10 - I.P.S.	X	X	X	X

	Interests (K.G.I.S.) Sci.	Math.	Attitudes (P.M.A.S.) Sci.	Math.
h) Pre grade 11 - Biol.201	X	X	X	X
i) Pre grade 11 - Biol.201 with Phys. Sc. 201	X	X	X	X
j) Post grade 11 - Biol. 201	X	X	X	X
k) Post grade 11 - Biol. 201 with Phys. Sc. 201	X	X	X	X

5. Where sample sizes in these groups were sufficient, the scores were subdivided on the basis of sex of subjects.

To determine interests in science and mathematics the Kuder General Interest Survey (K.G.I.S.) was administered to random samples of students from the three secondary schools in the division. Raw scores were obtained for interests in the areas of science and mathematics. These scores were then compared to the norms (means and percentiles) of the Kuder sample groups used in standarization of the inventory. To determine attitudes towards science and mathematics, the Purdue Master Attitude Scale (P.M.A.S.) for school subject areas was given to the same random samples of students. Scores were compared with the "built in" norms of the scale itself[1]. To determine whether interests and attitudes change as students go through the secondary grades, pre and post scores were compared for samples from the different grades, as well as for a number of specific courses.

[1]The Kuder and Purdue instruments are described in more detail later in this chapter.

Scores for boys were compared with those for girls to discover if sex differences were reflected in interests and attitudes.

To compare the two subject areas, scores for interest and attitude in science were compared with scores for interest and attitude in mathematics.

Statistical treatment of results

1. Scores on the K.G.I.S. (mathematical and scientific) for the various grade level samples tested were compared with the standarized norms with respect to means percentiles and standard deviations
2. Comparisons of the scores made by grade level samples and the pre and post course samples on the K.G.I.S. were made using the t-test of statistical significance
3. From scores on the P.M.A.S.(mathematics and science) for the various grade level samples, means and percentiles were determined. These were compared with the rating scale provided for this instrument to indicate the degree of positiveness of the attitudes measured
4. Comparisons of the scores made by grade level samples, and the pre and post course samples on the P.M.A.S. were made using the t-test of statistical significance
5. Comparisons of K.G.I.S. scores with P.M.A.S. scores at the different grade levels were made using the t-test

6. Comparisons of boys' scores and girls' scores on K.G.I.S. and on P.M.A.S. were made using the t-test.

Selection of Test Instruments

The Kuder General Interest Survey, Form E

Since the early 1930's G.F. Kuder has pioneered in the development of a variety of interest measuring devices. Form E, one of the more recent of these, was designed to help younger students (grade six and up) make tentative educational and vocational plans[1]. The format of each item is a forced choice where the student indicates the sub-items he likes best and least. Separate scores in these areas of interest are obtained: outdoor, mechanical, computational, scientific, persuasive, artistic, literary, musical, social service and clerical.

Percentile norms for grades seven to twelve were developed in 1963 from stratified samples of boys and girls in U.S. schools. Validity is based on studies using earlier forms (B and C) in which scores were compared to a measure of job satisfaction seven to ten years later. McRae found:

1. Nearly two thirds of the subjects were in jobs consistent with measured interests
2. 62% of these were indeed satisfied with their work, while only 34% were not[2]

[1] G.F. Kuder, General Interest Survey Manual (Chicago: Science Research Associates, 1971).

[2] G.G. McRae, "The Relationships of Job Satisfaction and Earlier Measured Interests", Doctoral dissertation, Univ. of Florida, 1959.

Reliability (stability) data were obtained from samples of 328 girls and 311 boys tested first in grade six and seven, then retested four years later. Stability was estimated at .50 for boys and .43 for girls, which although not high, is still significant considering the ages and development stages of samples concerned. Retests given only 6 weeks later showed correlations of between .70 and .90.

Form E is a lengthy instrument and covers ten areas of interest. Among its strengths are its use of clear simple language, verification scale to detect dishonesty or carelessness in following directions, and value for research in interests of students. Alleged limitations are insufficient data on reliability and validity, and failure to investigate the impact of social desirability on the test items[1]. In addition, during one study it was found that some students tired noticeably towards the end (after an hour of concentration) while a few actually gave up making deliberate choices before finishing and responded in a random manner, thereby invalidating their scores[2]. This effect was observed in this study in a few isolated instances.

Kirk and Lohnes, quoted in the Seventh Edition of

[1]J.P. Linden and K.W. Linden, Tests on Trial (Houghton Mifflin Co., Boston, 1968).

[2]Ibid., Linden and Linden.

the Mental Measurements Yearbook have made the following critical observations concerning the Kuder form E:

1. Interpretive materials are inadequate
2. Complexities of scores may lead to misunderstanding in applying results of individual cases
3. There is a dearth of validity data

However, they also made favourable comments:

1. It is a promising instrument for research
2. For early high school years, it may be as good an instrument as exists
3. It is "psychometrically polished[1]"

On the whole this appeared to be a suitable instrument for this study.

The Purdue Master Attitude Scales

Created by H.H. Remmers, Professor of Psychology and Education at Purdue University, these scales were developed on the basis of earlier similar attempts by Thurstone to measure attitudes. These eighteen scales (nine form A and nine form B) are designed to measure an individual's attitude toward nine different items, one of which is any school subject. This scale consists of seventeen attitude statements (statistically selected from forty originally) ranging from extremely positive at the

[1] The Seventh Mental Measurements Yearbook, Oscar K. Buros, ed., (New Jersey: The Gryphon Press, 1972):p. 1421-27.

beginning to less positive and then extremely negative at the end[1]. Individuals being tested are asked to indicate which of the statements they are in agreement with. Each statement is assigned a numerical value in accordance with the degree of "positiveness" of the statement. Scoring is done by finding the scale value of the median statement in those agreed with. A similar technique was used successfully by Stephens in developing a scale to measure attitudes towards science by prospective elementary teachers[2]. The attitude statements originally come from a representative sample of individuals as their reactions to the item being tested, and are then ranked (from positive to negative) and scaled by a panel of experts in that area so that the entire attitude spectrum is represented by such a scale.

The manual for the P.M.A.S. indicates that validation has been demonstrated against Thurstone's specific attitude scales as well as in their ability to differentiate among attitudes known to differ in different groups of individuals e.g., liking for social studies v.s. science studies among high school students[3]. Reliabilities

[1]See Appendix for copy of Purdue Scale and Manual.

[2]L. Stephens and W.H. Dutton, "Measuring Attitudes Towards Science in Elementary School Teachers", School Science and Mathematics, vol.63(Jan.1963):p.42-9.

[3]Ella B. Silance, "An Experimental Generalized Master Scale: A Scale to Measure Attitude Toward any School Subject", Bulletin of Purdue University (Dec.1934): p.18-36.

of the scales for various population samples ranged from .71 to .92. The scales are designed so that the possible scores range from 1 (extremely negative attitude) to 10 (extremely positive attitude) with 6.0 being the indifference point. In this way, the manual claims, norms are not required since the individual's score gives a direct indication of his attitude level. It is for lack of norms that some criticism has been leveled, as well as for having less validity (as a general scale) than specific attitude scales[1]. Described as an instrument which did not discriminate finely, it was still recommended for use in schools[2].

In practice, this scale was found to be convenient and straightforward to administer and score. It was selected for this study in preference to some of the Likert-type scales to avoid the possible confusion and unreliability that might result from some students being faced with the wider choice of responses (e.g., strongly agree, undecided, neutral, disagree, strongly disagree) for each scale item.

Analyzing the Data

Maximum possible raw scores on the K.G.I.S. are 65 for mathematical (computational) and 62 for scientific. Raw scores of subjects tested were changed to percentile

[1] Mental Measurements Yearbook, Oscar K. Buros, ed., (New Brunswick, Rutgers Univ. Press, 1938):p.43,44.

[2] Mental Measurements Yearbook Third Edition, Oscar K. Buros, ed., New Brunswick, Rutgers Univ. Press, 1949): p.68.

values using the tables provided in the manual. This would, of course, give a range of values (percentiles) from 1 to 100 in both the mathematical and scientific areas which could now be statistically compared with each other.

The raw scores on the P.M.A.S. were multiplied by a factor of 10 which would also give a derived series of values ranging up to 100, a more convenient range to work with.

These derived values for the K.G.I.S. (mathematical and scientific) and the P.M.A.S. (mathematics and science) were entered on punch cards for computer statistical analysis as described in a previous section in this chapter[1]. Results of this analysis were tabulated and are presented in the following chapter.

For the purposes of drawing conclusions from statistical results in this study, these guidelines will be observed, with respect to t-test levels of confidence:

1. 0.05 and higher levels will be accepted as indicating a statistically significant difference between the scores concerned
2. Levels of .10 to .06 will be tentatively accepted as indicating significant differences
3. Levels of .20 to .11 will be neither accepted nor rejected. These will be considered as "borderline"

[1]Page 66.

cases which would require further investigation to establish

4. Levels below .20 will be rejected as indications of significant differences

CHAPTER IV

ANALYSIS OF DATA

Interests and Attitudes by Grades

Interest and Attitude Norms

A major question raised in this study was how the interests and attitudes of Interlake students towards science and mathematics compared with the interests and attitudes of the general population of students. As described in Chapter III[1], the Kuder General Interest Survey (K.G.I.S.) was "standardized" using samples of students throughout the United States. Since the raw score range of the individual interest scales composing the K.G.I.S. were not of the same magnitude, these raw scores could not be compared directly. Hence, the raw scores on the scientific and mathematical interest scales were converted to percentiles, using the tables provided in the manual. These percentiles, hereinafter referred to as interest scores, were presented and used in the tables in this chapter.

[1]Page 67.

The Purdue Master Attitude Scale (P.M.A.S.) for school subjects yields raw scores that range from 1.0 (extremely unfavourable, negative or hostile attitude) to 10.3 (extremely favourable, positive attitude). The indifference point is 6.0. All raw scores were multiplied by a factor of 10 which yielded scores having two digits before the decimal point, and an indifference attitude value of 60. The degree of favourability of the attitudes of a sample i.e., their negative or positive dimension, could be assessed by reference to this indifference value. There are no external standardized norms for this instrument. The P.M.A.S. scores are also referred to in this chapter as attitude scores.

Grade Eight Students' Attitudes

Only the P.M.A.S. was administered to the grade eight sample in this study. Table 1 contains the means, medians and standard deviations of the entire grade eight sample scores for attitudes towards science and mathematics. Means and standard deviations are also given for girls' scores and boys' attitude scores. As shown in Table 1, the scores for attitude towards science are somewhat above the indifference point, while the scores for attitude towards mathematics are well above (or more positive). Table 2 contains a comparison of scores for attitude towards science with those towards mathematics, including mean

TABLE 1

GRADE EIGHT

ATTITUDE STATISTICS (P.M.A.S.,[1] JUNE)

SUBJECT	ENTIRE SAMPLE				GIRLS			BOYS		
	No.	Mean	Median	S.Dev.	No.	Mean	S.Dev.	No.	Mean	S.Dev.
Science	150	71.9	78.6	15.5	84	69.9	15.1	66	74.4	10.5
Math.	150	79.8	83.8	10.7	84	79.6	15.7	66	80.1	11.1

TABLE 2

STATISTICAL COMPARISONS OF ATTITUDES (P.M.A.S. JUNE)

COMPARISON	MEAN DIFF.	CORR.	F-VALUE	T-VALUE	PROB.	DEGREES FREEDOM
Sc. & math. (entire)	-7.9	-.095		-4.95	0.000	149 *
Girls Sc. & Boys Sc.	-4.5		1.08	-1.77	0.079	148 **
Girls Math & Boys Math	-0.4		1.13	-0.24	0.812	148

* $P < .01$ ** $P < .10$

[1] Purdue Master Attitude Scale

difference, correlation, t-value, and 2-tail probability corresponding to the t-value. There are also comparisons made between attitude scores of girls and boys towards science, as well as attitude scores of girls and boys towards mathematics, including mean differences, f-values, t-values and 2-tail probabilities. Table 2 indicates that scores for attitude towards mathematics are more positive than scores for attitudes towards science, at the .01 level of confidence. Boys' scores for attitude towards science are more positive than girls at the .10 level of confidence. There is no significant difference between boys' and girls' scores for attitude towards mathematics in grade eight.

As already noted in Chapter I[1], interests were not measured in grade eight since it was felt that the measuring instrument for interests would not be appropriate to distinguish differences in subject interests of students from the end of grade eight to the beginning of grade nine.

Grade Nine Students' Interests and Attitudes

Both the Kuder General Interest Survey, form E, (K.G.I.S.) and the Purdue Master Attitude Scale (P.M.A.S.) were administered to the grade nine sample. Table 3 contains means, medians and standard deviations of K.G.I.S. percentile scores forinterests in science and mathematics for the entire sample, and means and standard deviations

[1]Page 15.

TABLE 3

GRADE NINE INTEREST STATISTICS (K.G.I.S.[1] OCTOBER)

SUBJECT	ENTIRE SAMPLE				GIRLS			BOYS		
	No.	Mean	Median	S.Dev.	No.	Mean	S.Dev.	No.	Mean	S.Dev.
Science	57	33.7	25.9	26.9	23	32.0	27.5	34	34.9	26.9
Math	57	40.3	39.1	23.5	23	38.5	20.2	34	41.4	25.7

TABLE 4

STATISTICAL COMPARISONS OF INTERESTS
(K.G.I.S. OCTOBER)

COMPARISON	MEAN DIFF.	CORR.	F-VALUE	T-VALUE	PROB.	DEGREES FREEDOM
Sc. & math entire)	-6.6	-0.111		-1.32	0.194	56
Girls Sc. & Boys Sc.	-2.9		1.05	-0.39	0.698	55
Girls Math. & Boys Math	-2.9		1.63	-0.46	0.650	55

[1] Kuder General Interest Survey, Form E

for girls' scores and for boys' scores. Table 3 indicates that mean and median scores for interest in mathematics were well below the 50th percentile of the Kuder mathematics norm, while scores for interest in science were still farther below the respective norm.

Table 4 compares science interest scores with mathematics interest scores, including mean difference, correlation, t-value and 2-tail probability derived from the t-value. It contains comparisons of science and mathematics interest scores of girls with those of boys. This table indicates a low correlation between science interest and mathematics interest. The t-value indicates a difference between science and mathematics interests significant only at the .20 level of confidence. There are no significant differences between girls' and boys' mathematics interest scores.

Table 5 is similar in format to Table 1, containing means, medians and standard deviations for grade nine attitude scores. It indicates that while scores for attitude towards science were below the indifference point on the Purdue scale, (especially for girls) scores for attitude towards mathematics were above the indifference point, this time with girls' scores slightly higher than boys.

Table 6 is similar in format to Table 2. It indicates very low correlation between attitude scores for

TABLE 5

GRADE NINE ATTITUDE STATISTICS (P.M.A.S. OCTOBER)

SUBJECT	ENTIRE SAMPLE				GIRLS			BOYS		
	No.	Mean	Median	S.Dev.	No.	Mean	S.Dev.	No.	Mean	S.Dev.
Science	57	49.8	50.2	21.6	23	46.5	21.5	34	52.0	21.8
Math.	57	73.0	80.4	18.5	23	74.4	22.5	34	72.1	15.5

TABLE 6

STATISTICAL COMPARISONS OF ATTITUDES (P.M.A.S.OCTOBER)

COMPARISON	MEAN DIFF.	CORR.	F-VALUE	T-VALUE	PROB.	DEGREES FREEDOM
Sc. & math. (entire)	-23.2	0.018		-6.11	0.000	56 *
Girls Sc. & Boys Sc.	-5.5		1.03	-0.95	0.353	55
Girls Math. & Boys Math	2.3		2.07	.45	0.654	55

* $P < .01$

science and attitude scores for mathematics, with a difference between them based on the t-value beyond the .01 level of confidence. There is no significant difference in attitude scores of girls and boys in science or in mathematics.

Grade Ten Students' Interests and Attitudes

Table 7, similar in format to Table 3, shows that in the grade ten sample, mathematics interest scores were very close to the Kuder "norm" (50th percentile), but science interest scores were well below this norm.

Table 8, similar in format to Table 4, shows a very low correlation between science interest scores and mathematics interest scores while the t-value indicates a difference beyond the .01 level of confidence. Differences between girls' and boys' interest scores are not significant for either science or mathematics, using the t-value.

Table 9 (similar to Table 1) shows that in grade ten scores for attitude towards science are very close to indifference point, while scores for attitude toward mathematics are notably higher and substantially on the positive side.

Table 10 (similar to Table 2) shows a difference between scores for attitude towards science and mathematics beyond the .01 level of confidence, with boys' attitude scores in science higher than girls' at the .10 level of confidence. There is no significant difference in mathematics attitude scores.

TABLE 7

GRADE TEN — INTEREST STATISTICS (K.G.I.S. OCTOBER)

SUBJECT	ENTIRE SAMPLE				GIRLS			BOYS		
	No.	Mean	Median	S.Dev.	No.	Mean	S.Dev.	No.	Mean	S.Dev.
Science	62	37.3	28.8	27.9	30	39.6	32.3	32	35.0	23.4
Math	62	50.2	50.6	23.9	30	53.5	25.7	32	47.1	22.1

TABLE 8

STATISTICAL COMPARISONS OF INTERESTS (K.G.I.S. OCTOBER)

COMPARISON	MEAN DIFF.	CORR.	F-VALUE	T-VALUE	PROB.	DEGREES FREEDOM
Sc. & math. (entire)	-13.0	0.027		-2.82	0.007	61 *
Girls Sc. & Boys Sc.	4.6		1.90	.65	0.521	60
Girls Math. & Boys Math	6.5		1.35	1.07	0.290	60

* P ⁄∠ .01

TABLE 9

GRADE TEN ATTITUDE STATISTICS (P.M.A.S. OCTOBER)

SUBJECT	ENTIRE SAMPLE				GIRLS			BOYS		
	No.	Mean	Median	S.Dev.	No.	Mean	S.Dev.	No.	Mean	S.Dev.
Science	62	60.7	63.5	21.8	30	55.7	24.1	32	65.3	18.6
Math.	62	79.3	84.0	13.7	30	81.3	12.5	32	77.3	14.7

TABLE 10

STATISTICAL COMPARISONS OF ATTITUDES (P.M.A.S. OCTOBER)

COMPARISON	MEAN DIFF.	CORR.	F-VALUE	T-VALUE	PROB.	DEGREES FREEDOM
Sc. & math. (entire)	-18.6	0.185		-5.26	0.000	61 *
Girls Sc. & Boys Sc.	-9.6		1.68	-1.76	0.083	60 **
Girls Math. & Boys Math	4.0		1.40	1.16	0.252	60

* $P < .01$ ** $P < .10$

Grade Eleven Students' Interests and Attitudes

Table 11 indicates that in the grade eleven sample science interest scores were well below the Kuder 50th percentile norm, while mathematics interest scores were also somewhat below this percentile level, but only for boys.

Table 12 indicates a very low correlation between science and mathematics interest scores, with mathematics interest scores higher at the .05 level of confidence. While there is no significant difference between boys' and girls' interest scores in science, girls' interest scores in mathematics are higher than boys at the .10 level of confidence.

Table 13 indicates that scores for attitude towards science in the grade eleven sample were only slightly above the indifference point. Scores for attitude towards mathematics were somewhat higher than the indifference point.

Table 14 indicates that scores for attitude towards mathematics were higher than those towards science at the .05 level of confidence. Although scores of attitude towards mathematics appear slightly higher in girls than in boys this was only significant at the .20 confidence level.

TABLE 11

GRADE ELEVEN INTEREST STATISTICS (K.G.I.S. OCTOBER)

SUBJECT	ENTIRE SAMPLE				GIRLS			BOYS		
	No.	Mean	Median	S.Dev.	No.	Mean	S.Dev.	No.	Mean	S.Dev.
Science	66	34.9	31.0	24.3	20	36.3	26.0	46	34.3	23.8
Math.	66	43.1	40.8	27.1	20	51.5	33.8	46	39.5	23.2

TABLE 12

STATISTICAL COMPARISONS OF INTERESTS (K.G.I.S. OCTOBER)

COMPARISON	MEAN DIFF.	CORR.	F-VALUE	T-VALUE	PROB.	DEGREES FREEDOM
Sc. & math. (entire)	-8.3	0.113		-1.96	0.055	65 *
Girls Sc. & Boys Sc.	2.0		1.20	0.30	0.762	64 *
Girls Math. & Boys Math	11.0		2.12	1.67	0.099	64

* P ∠ .10

TABLE 13

GRADE ELEVEN ATTITUDE STATISTICS (P.M.A.S. OCTOBER)

SUBJECT	ENTIRE SAMPLE				GIRLS			BOYS		
	No.	Mean	Median	S.Dev.	No.	Mean	S.Dev.	No.	Mean	S.Dev.
Science	66	62.9	63.5	21.7	20	62.0	21.3	46	63.2	22.1
Math.	66	71.7	82.5	21.4	20	76.3	18.0	46	69.8	22.6

TABLE 14

STATISTICAL COMPARISONS OF ATTITUDES (P.M.A.S. OCTOBER)

COMPARISON	MEAN DIFF.	CORR.	F-VALUE	T-VALUE	PROB.	DEGREES FREEDOM
Sc. & Math. (entire)	-8.9	-0.370		-2.02	0.047	65 *
Girls Sc. & Boys Sc.	-1.2		1.08	-0.21	0.833	64
Girls Math. & Boys Math.	6.5		1.57	1.14	0.257	64

* $P < .05$

Grade Twelve Students' Interests

Table 15 indicates that scores for interests in both science and mathematics in grade twelve sample were below the Kuder percentile norms.

Table 16 indicates that there were no significant differences in interest scores either between science and mathematics, or between boys and girls.

Table 17 indicates that scores for attitudes toward science and mathematics were close to, or slightly below the indifference point. Further comparisons were not made because the sample here was only ten students.

TABLE 17

GRADE TWELVE ATTITUDE STATISTICS (P.M.A.S. OCTOBER)*

Subject	No.	Mean	Median
Science	10	51.6	68
Math.	10	54.4	57.5

*Not Classified by sex because of small sample.

Comparisons Between Grades

In the preceeding section, data were given to determine how interests and attitudes of the samples in this study compare with the norms of the measurement instruments used, and thereby aid in the assessment of these interests and attitudes at the grade levels studied.

TABLE 15

GRADE TWELVE INTEREST STATISTICS (K.G.I.S. OCTOBER)

SUBJECT	ENTIRE SAMPLE				GIRLS			BOYS		
	No.	Mean	Median	S.Dev.	No.	Mean	S.Dev.	No.	Mean	S.Dev.
Science	22	38.2	38.0	25.4	6	48.3	24.6	15	35.4	26.0
Math.	22	41.2	38.5	26.2	6	43.7	25.3	15	40.5	28.2

TABLE 16

STATISTICAL COMPARISONS OF INTERESTS (K.G.I.S. OCTOBER)

COMPARISON	MEAN DIFF.	CORR.	F-VALUE	T-VALUE	PROB.	DEGREES FREEDOM
Sc. & Math. (entire)	-3.0	-0.218		-0.35	0.730	21
Girls Sc. & Boys Sc.	12.9		1.11	1.04	0.310	19
Girls Math. & Boys Math.	3.2		1.24	0.24	0.812	19

Another major objective of this study was to determine how interests and attitudes towards science and mathematics vary between the different grade levels of the Interlake secondary schools and between boys and girls. These results should reveal any trends in the variation of attitudes and interests of students as they go from the end of grade eight (beginning of grade nine for interests), to grade eleven.

Table 18 contains comparisons between samples of boys from grades eight and nine, grades nine and ten, grades ten and eleven, and grades nine and eleven with respect to their attitude towards science and towards mathematics. The following results are indicated:

1. Scores for attitude towards both science and mathematics in grade eight are higher than those in grade nine at the .01 level of confidence
2. Scores for attitude towards science and mathematics in grade ten are higher than those in grade nine at the .01 and .10 levels of confidence respectively
3. Scores for attitude towards mathematics in grade ten are higher than those in grade eleven at the .10 level of confidence, but there is no significant difference in scores for attitude towards science in these grades
4. There is no significant difference between grade nine attitude scores and grade eleven attitude scores for mathematics

TABLE 18

COMPARISON OF BOYS' ATTITUDES (P.M.A.S.) BETWEEN GRADES

GRADES COMPARED	SUBJECT	MEAN DIFF.	F-VAL.	T-VAL.	2-TAIL PROB.	DEGREES FREEDOM	
Grade eight (66) and grade nine (34)	Science	12.4	1.92	5.90	0.000	98	*
	Math.	8.0	1.97	2.94	0.004	98	*
Grade nine (34) and grade ten (32)	Science	-13.3	1.37	-2.66	0.010	64	
	Math.	-5.2	1.13	-1.39	0.170	64	
Grade ten (32) and grade eleven (46)	Science	2.1	1.41	0.43	0.666	76	
	Math.	7.6	2.36	1.66	0.101	76	**
Grade nine (34) and grade eleven (46)	Science	-11.2	1.03	-2.26	0.027	78	*
	Math.	2.3	2.10	0.52	0.603	78	

* $P < .05$ ** $P < .10$

TABLE 19

COMPARISON OF BOYS' INTERESTS (K.G.I.S.) BETWEEN GRADES

GRADES COMPARED	SUBJECT	MEAN DIFF.	F-VAL.	T-VAL.	2-TAIL PROB.	DEGREES FREEDOM
Grade nine (34) and grade ten (32)	Science	-0.2	1.32	-0.02	0.981	64
	Math.	-5.4	1.36	-0.95	.346	64
Grade ten (32) and grade eleven (46)	Science	0.8	1.03	0.14	0.892	76
	Math.	7.6	1.11	1.44	0.153	76
Grade nine (34) and grade eleven (46)	Science	0.6	1.28	0.10	0.917	78
	Math.	1.9	1.23	0.35	0.725	78

5. Grade eleven scores for attitude towards science are higher than those of grade nine at the .05 level of confidence

Table 19 is similar in format to Table 18, comparing interest scores of boys in various grades with the following observations:

1. There are no significant differences between grade interest scores in science and mathematics in grade nine and grade ten
2. Interest scores in mathematids in grade ten are higher than interest scores in grade eleven boys, but this is only significant at the .20 level of confidence
3. Interest scores in science and mathematics are not significantly different in grades nine and ten.

Table 20 compares scores for attitude towards science and mathematics on the part of girls between different grades. This table indicates that:

1. Scores for attitude towards science and mathematics in grade eight are higher than in grade nine at the .01 and .10 levels of confidence respectively
2. Scores for attitude towards science and mathematics in grade ten are higher than in grade nine at the .20 level of confidence
3. There are no significant differences between attitude scores in grades ten and eleven
4. Scores for attitude towards science in grade eleven

TABLE 20

COMPARISON OF GIRLS' ATTITUDES (P.M.A.S.) BETWEEN GRADES

GRADES COMPARED	SUBJECT	MEAN DIFF.	F-VAL.	T-VAL.	2-TAIL PROB.	DEGREES FREEDOM	
Grade eight (84) and grade nine (23)	Science	23.4	2.02	5.98	0.000	105	*
	Math.	5.3	4.63	1.61	0.110	105	
Grade nine (23) and grade ten (30)	Science	-9.2	1.26	-1.44	0.156	51	
	Math.	-6.9	3.26	-1.43	0.158	51	
Grade ten (30) and grade eleven (20)	Science	-6.3	1.28	-0.99	0.348	48	
	Math.	5.0	2.10	1.17	0.248	48	
Grade nine (23) and grade eleven (20)	Science	15.5	1.02	-2.37	0.023	41	*
	Math.	-1.9	1.56	- .30	0.763	41	

* P ⁄⁄ .05

TABLE 21

COMPARISON OF GIRLS' INTERESTS (K.G.I.S.) BETWEEN GRADES

GRADES COMPARED	SUBJECT	MEAN DIFF.	F-VAL.	T-VAL	2-TAIL PROB.	DEGREES FREEDOM	
Grade nine (23) and grade ten (30)	Science	7.6	1.37	-0.90	0.370	51	
	Math.	-15.0	1.62	-2.31	0.025	51	*
Grade ten (30) and grade eleven (20)	Science	3.4	1.54	0.39	0.700	48	
	Math.	2.0	1.73	0.24	0.810	48	
Grade nine (23) and grade eleven (20)	Science	-4.3	1.12	-0.52	0.607	41	
	Math.	-13.0	2.81	-1.55	0.128	41	

* P ⁄⁄ .05

are higher than those in grade nine at the .05 level of confidence

Table 21 compares interest scores of girls at various grade levels and indicates that:

1. Interest scores in mathematics are higher in grade ten than in grade nine at the .05 level of confidence
2. There are no significant differences between interest scores in grades ten and eleven
3. Interest scores in mathematics in grade eleven are higher than in grade nine at the .15 level of confidence

Comparison by Science Courses

A third objective of this study was to determine if there were changes in interests and attitudes of students as they completed various science courses in grades ten and eleven. The courses considered in this study were Science 100 (I.P.S.), Science 101 (I.M.E.), Biology 201 and Physical Science 201.

Table 22 compares interest and attitude scores of girls before taking Science 100, with interest and attitude scores of girls after having completed Science 100. This table indicates that the only statistically significant difference between these scores was that the scores for attitude towards mathematics before taking Science 100 were higher at the .05 level of confidence.

TABLE 22

COMPARISON OF GIRLS' INTERESTS AND ATTITUDES BEFORE AND AFTER TAKING SCIENCE 100 (I.P.S.)

MEASUREMENT	NO. IN SAMPLES		MEAN DIFF.	F-VAL.	T-VAL.	2-TAIL PROB.	DEGREES FREEDOM
	PRE SC.100	POST SC.100					
K.G.I.S. Sc.	41	38	3.6	1.45	0.57	0.568	77
K.G.I.S. Math.	41	38	7.7	1.66	1.25	0.214	77
P.M.A.S. Sc.	41	38	-5.6	1.36	-1.15	0.255	77
P.M.A.S. Math.	41	38	7.3	2.50	2.09	0.040	77 *

* P .05

TABLE 23

COMPARISON OF BOYS' INTERESTS AND ATTITUDES BEFORE AND AFTER TAKING SCIENCE 100 (I.P.S.)

MEASUREMENT	NO. IN SAMPLES		MEAN DIFF.	F-VAL.	T-VAL.	2-TAIL PROB.	DEGREES FREEDOM
	PRE SC.100	POST SC.100					
K.G.I.S. Sc.	50	58	0.5	1.18	0.09	0.928	106
K.G.I.S. Math.	50	58	7.6	1.23	1.55	0.125	106
P.M.A.S. Sc.	50	58	-2.0	1.03	-0.48	0.632	106
P.M.A.S. Math.	50	58	8.1	2.35	2.18	0.031	106 *

* $P < .05$

Table 23, which compares interest and attitude scores of boys before and after taking Science 100, indicates that the sample <u>before</u> taking Science 100:

1. had higher interest scores for mathematics at the .15 level of confidence
2. had higher attitude scores towards mathematics at the .05 level of confidence than the sample after taking Science 100

Table 24, which compares scores for interest and attitude of girls before and after taking Science 101 indicates that the sample before taking Science 101 had higher attitude scores at the .05 level of confidence. Other differences here were not significant.

Table 25 which compares interest and attitude scores of boys before and after taking Science 101 shows that the sample before taking Science 101 had higher attitude scores at the .15 level of confidence.

Table 26 and 27 compare the interest and attitude scores of a sample having completed Science 100, with the interest and attitude score of the sample which completed Science 101. Here there is little difference in mathematics interest or attitude scores between these two groups. However, the post Science 100 sample indicates higher scores for interest in science at the .06 level of confidence, and higher scores for attitude towards science at the .05 level of confidence.

TABLE 24

COMPARISON OF GIRLS' INTERESTS AND ATTITUDES BEFORE AND AFTER TAKING SCIENCE 101 (I.M.P.)

MEASUREMENT	NO. IN SAMPLES PRE SC.101	NO. IN SAMPLES POST SC.101	MEAN DIFF.	F-VAL.	T-VAL.	2-TAIL PROB.	DEGREES FREEDOM
K.G.I.S. Sc.	49	46	2.2	1.42	0.39	0.700	93
K.G.I.S. Math.	49	46	4.0	1.21	0.72	0.471	93
P.M.A.S. Sc.	49	46	-1.9	1.06	-0.47	0.640	93
P.M.A.S. Math.	49	46	7.3	2.92	1.99	0.050	93 *

* P ⫽ .05

TABLE 25

COMPARISON OF BOYS' INTERESTS AND ATTITUDES BEFORE AND AFTER TAKING SCIENCE 101 (I.M.E.)

MEASUREMENT	No. IN SAMPLES PRE SC.101	No. IN SAMPLES POST SC.101	MEAN DIFF.	F-VAL.	T-VAL.	2-TAIL PROB.	DEGREES FREEDOM
K.G.I.S. Sc.	38	54	5.8	1.13	1.12	0.265	90
K.G.I.S. Math.	38	54	5.8	1.18	1.14	0.259	90
P.M.A.S. Sc.	38	54	3.6	1.24	.80	0.428	90
P.M.A.S. Math.	38	54	6.1	2.29	1.53	0.129	90

TABLE 26

COMPARISON OF INTERESTS AND ATTITUDES
BY GRADE TEN SCIENCE COURSE COMPLETED

MEASUREMENT	POST SC. 100			POST SC. 101		
	NO.	MEAN	S.DEV.	NO.	MEAN	S.DEV.
K.G.I.S. Sc.	30	41.6	24.6	34	30.0	23.1
K.G.I.S. Math.	30	44.7	30.3	34	42.9	24.9
P.M.A.S. Sc.	30	69.5	18.1	34	57.5	23.1
P.M.A.S. Math.	30	71.6	20.2	34	72.6	22.4

TABLE 27

STATISTICAL COMPARISON OF POST SC.100 WITH POST SC.101

MEASUREMENT	MEAN DIFF.	DEGREES FREEDOM	F-VAL.	T-VAL.	2-TAIL PROB.	
K.G.I.S. Sc.	11.6	62	1.14	1.95	0.056	*
K.G.I.S. Math.	1.8	62	1.48	0.27	0.786	
P.M.A.S. Sc.	8.0	62	1.63	2.28	0.026	*
P.M.A.S. Math.	1.0	62	1.24	-0.20	0.846	

* P $\angle$ .05

Table 28 compares interest and attitude scores of students before and after taking Biology 201. Although there appears to be little difference in interest scores between the two groups, the attitude scores of the group before taking Biology 201 were higher at the .15 confidence level for science, and .05 confidence level for mathematics.

Table 29 compares interest and attitude scores of students before taking Biology 201 with Science 201, with students after having taken these two courses. There is little difference in interest scores between these two groups. Although the means appear to be considerably lower in the P.M.A.S. Science and Mathematics scores for the sample that had taken the above courses, the smallness of the samples has contributed to differences significant at only the .16 and .18 levels of confidence.

Table 30 compares the interest and attitude scores of students who have taken Biology 201 as their only grade eleven science elective, with students who have taken both Biology 201 and Science 201. No significant differences are indicated, again possibly because of the small samples used.

TABLE 28

COMPARISON OF STUDENTS' INTERESTS AND ATTITUDES

BEFORE AND AFTER TAKING BIOLOGY 201

MEASUREMENT	NO. IN SAMPLES		MEAN DIFF.	F-VAL.	T-VAL	2-TAIL PROB.	DEGREES FREEDOM
	PRE BIOL.201	POST BIOL.201					
K.G.I.S. Sc.	29	18	-5.5	1.03	-0.76	0.454	45
K.G.I.S. Math.	29	18	-4.2	1.52	-0.56	0.578	45
P.M.A.S. Sc.	29	10	11.8		1.83	0.152	37
P.M.A.S. Math.	29	10	15.4		2.16	0.043	37 *

* $P < .05$

TABLE 29

COMPARISON OF STUDENTS' INTERESTS AND ATTITUDES

BEFORE AND AFTER TAKING BIOLOGY 201 WITH SCIENCE 201

MEASUREMENT	NO. IN SAMPLE PRE BIOL. AND SC.	NO. IN SAMPLE POST BIOL. AND SC.	MEAN DIFF.	F-VAL.	T-VAL.	2-TAIL PROB.	DEGREES FREEDOM
K.G.I.S. Sc.	7	10	-3.0	1.12	-0.20	0.843	15
K.G.I.S. Math.	7	10	-1.9	1.18	-0.16	0.877	15
P.M.A.S. Sc.	7	10	22.8		1.53	0.162	15
P.M.A.S. Math.	7	10	20.6		1.45	0.187	15

TABLE 30

COMPARISON OF STUDENTS' INTERESTS AND ATTITUDES FOLLOWING

BIOLOGY 201 WITH INTERESTS AND ATTITUDES FOLLOWING BIOLOGY 201 WITH SCIENCE 201

MEASUREMENT	NO. IN SAMPLE POST BIOL. 201	NO. IN SAMPLE POST BIOL. 201, SC. 201	MEAN DIFF.	F-VAL.	T-VAL.	2-TAIL PROB.	DEGREES FREEDOM
K.G.I.S. Sc.	8	10	-1.9	2.65	-0.16	0.875	16
K.G.I.S. Math.	8	10	-1.3	1.55	-0.09	0.926	16
P.M.A.S. Sc.	8	10	-10.4	1.32	-0.75	0.466	16
P.M.A.S. Math.	8	10	-10.4	1.22	-0.68	0.507	16

Summary

In this chapter, data have been presented from measurements of interests in and attitudes towards science and mathematics from samples of students in grades eight to twelve in the Interlake School Division of Manitoba. The results of these measurements were first compared with the norms of the measuring instruments. Other comparisons were made between boys and girls, between science and mathematics, between different grades, between different courses completed, and before and after taking certain science courses. The major findings, with levels of confidence in parenthesis, were as follows:

1. Attitude scores were below the indifference point in: Grade nine science (girls and boys), grade ten girls science, and grade twelve science and mathematics
2. Interest scores were below the Kuder norm in: grade nine science and mathematics (girls and boys), grade ten science, grade eleven science and boys' mathematics, grade twelve science and mathematics
3. Scores for attitude towards mathematics were significantly higher (more positive) than towards science in grade eight ($P < .01$), grade nine ($P < .01$), grade ten ($P < .01$), and grade eleven ($P < .05$)
4. Scores for interest in mathematics were significantly higher than science in grade nine ($P < .20$), grade ten ($P < .01$), and grade eleven ($P < .06$)

5. Scores for interest on the part of girls were higher than boys in grade eleven mathematics ($P < .10$)

6. Scores for attitude on the part of boys were higher than girls in grades eight science ($P < .20$) and grade ten science ($P < .10$)

7. Boys' attitude scores were higher:

   a) in grade eight science and mathematics than in grade nine science and mathematics ($P < .05$)

   b) in grade ten science and mathematics than in grade nine science and mathematics ($P < .10$ and $P < .20$)

   c) in grade eleven mathematics than in grade ten mathematics ($P < .10$)

   d) in grade eleven science than in grade nine science ($P < .05$)

8. Boys' interest scores were higher in grade eleven mathematics than in grade ten mathematics ($P < .20$)

9. Girls' attitude scores were higher:

   a) in grade eight science and mathematics than in grade nine ($P < .01$ and $P < .11$)

   b) in grade ten science and mathematics than in grade nine ($P < .16$)

   c) in grade eleven science than in grade nine ($P < .05$)

10. Girls' interest scores were higher:

    a) in grade ten mathematics than in grade nine ($P < .05$)

    b) in grade eleven mathematics than in grade nine ($P < .15$)

11. After taking Science 100:

    a) girls had lower attitude scores for mathematics ($P < .05$)

    b) boys had lower interest and attitude scores for mathematics ($P < .13$ and $P < .05$)

12. After taking Science 101:

    a) girls had lower attitude scores for mathematics ($P < .05$)

    b) boys had lower attitude scores for mathematics ($P < .13$)

13. Students taking Science 100 had higher scores for science interest and attitude ($P < .06$ and $P < .03$)

14. After taking Biology 201, students had lower scores for attitude towards science and mathematics ($P < .15$ and $P < .05$)

15. After taking both Biology 201 and Science 201, students had lower scores for attitude towards science and mathematics ($P < .16$ and $P < .19$)

These findings will be discussed further in the following chapter.

CHAPTER V

INTERPRETATIONS, CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

Introduction

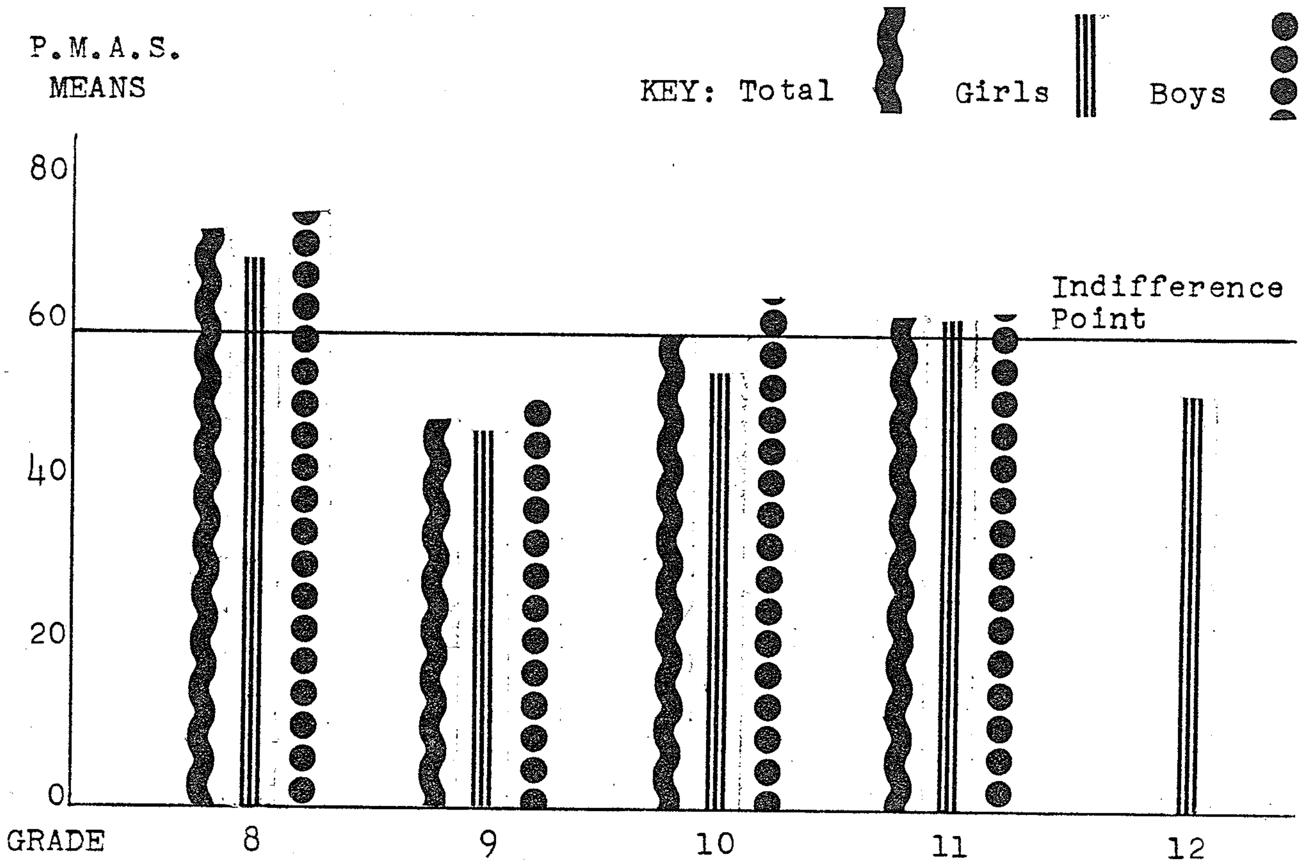
This chapter begins with an interpretation of the collected data, and speaks to the questions raised in Chapter I. Comparisons are then made between the findings from the research literature cited in Chapter II and the findings of this study. Conclusions and implications for educators are drawn from these comparisons. The chapter concludes with suggested areas for further study, and recommendations pertaining to science and mathematics education.

Interpretation of Data and Answers to Questions

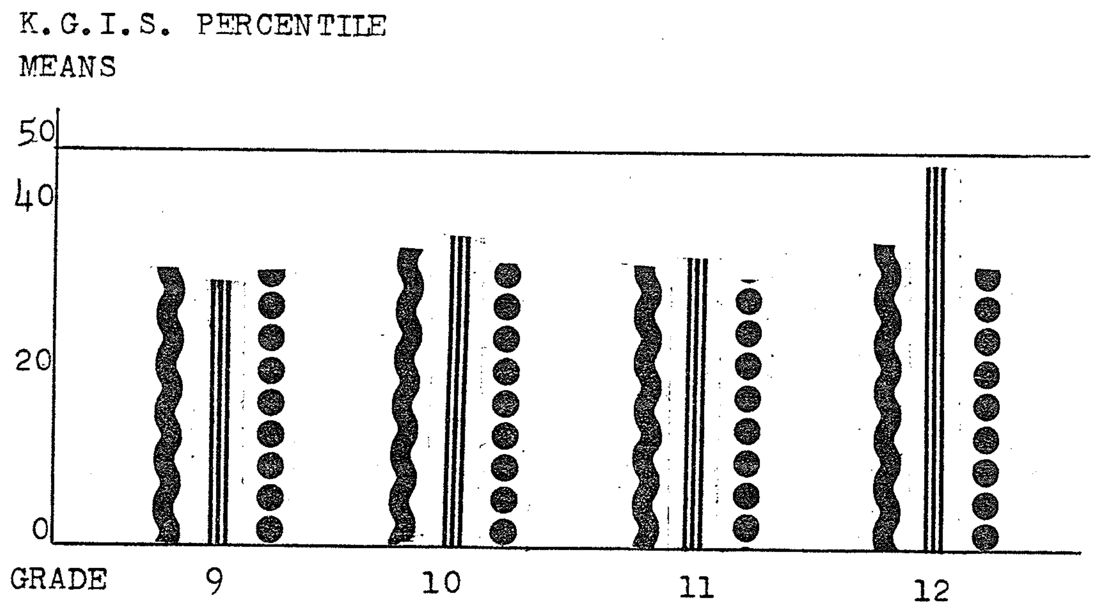
1. How does interest in science on the part of secondary school students in Interlake School Division compare with interest of the general population of secondary school students as indicated by standardized norms?

The means of the percentile scores for samples of students from grades nine to twelve using the K.G.I.S. are shown in Figure 2. All groups, with the exception of grade

ATTITUDE TOWARDS SCIENCE BY GRADE Figure 1



INTEREST IN SCIENCE BY GRADE Figure 2



twelve girls, scored below the 40th percentile with respect to the Kuder norms. Thereis a difference between the means of the percentile scores of boys and girls at each grade level. None of these differences is statistically significant[1].

2. Where do the attitudes of these secondary students towards science lie on a continuum that ranges from strongly negative to strongly positive?

The P.M.A.S. mean scores for science (Figure 1) show that the grade eight sample was somewhat above the indifference point of 60. Grades ten and eleven scored close to the indifference point, while mean scores for grade nine and twelve were slightly below this point. Mean scores for boys were higher than girls' mean scores in all grades. This difference is tentatively significant in grade ten as well as in grade eight and rejected in grades nine and eleven.

3. Is there any change in interest in science of Interlake secondary students as measured by the Kuder General Interest Survey from the time they begin to the time they complete the following courses:

[1]The levels of significance, as defined in Chapter III are:
i) Significant $p \leq .05$
ii) Tentatively significant $p \leq .06 - .10$
iii) Borderline $p \leq .11 - .20$

a) grade nine General Science (Thurber and Kilburn)?

b) grade ten Science 100 (I.P.S.)?

c) grade ten Science 101 (I.M.E.)?

d) grade eleven Biology 201?

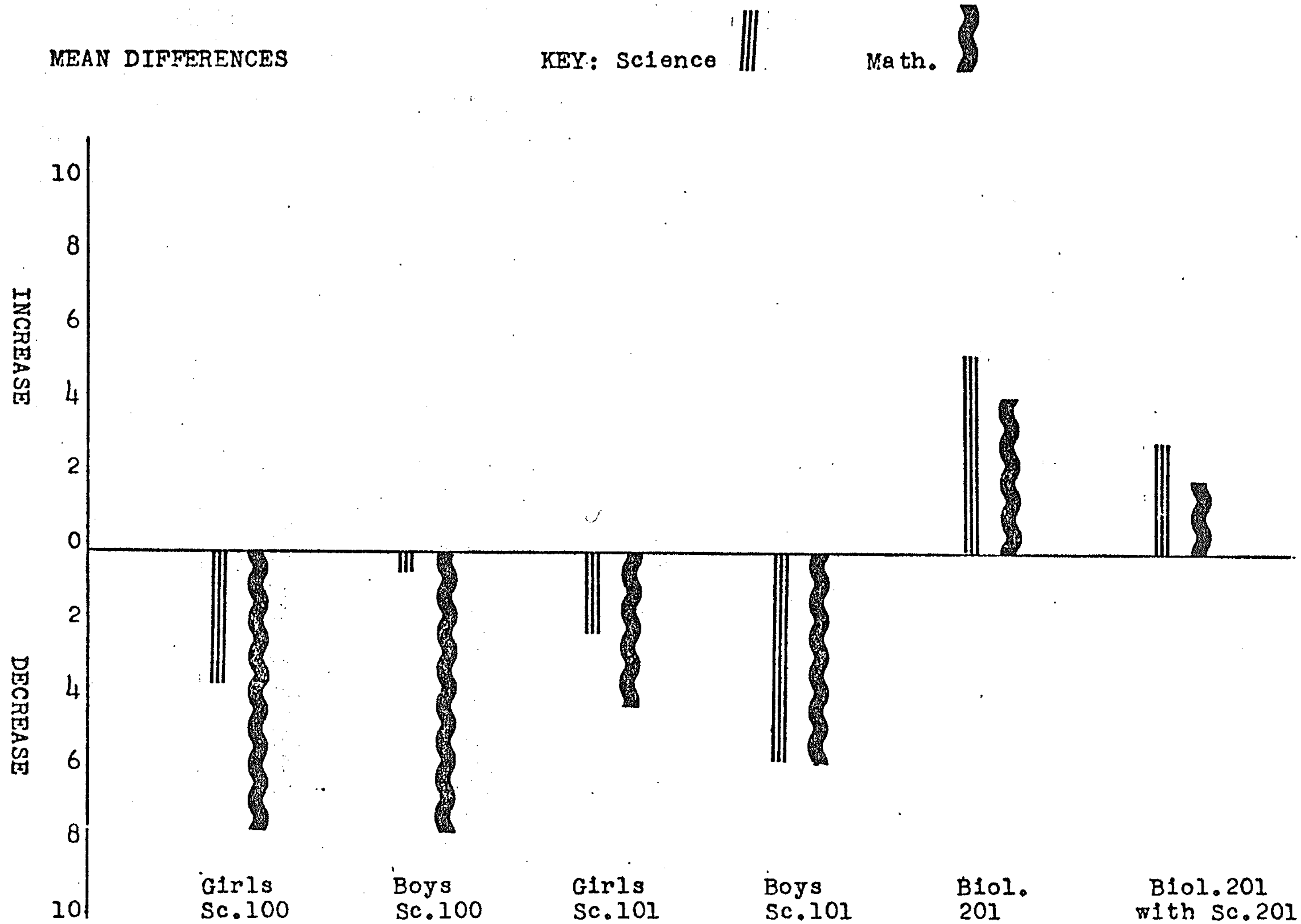
e) grade eleven Biology 201 with Physical Science 201?

All grade nine students in the Interlake School Division were using the Thurber and Kilburn text at the time samples were taken. The means of percentile scores using the K.G.I.S. (Figure 2) are lower for grade nine than for grade ten, but this difference is not statistically significant.

The difference between means of percentile scores using the K.G.I.S. for samples that had not yet taken grade ten science courses, compared with those that had completed Science 100 and Science 101 (Figure 3), indicate that the means of percentile scores in science were lower in the samples that had completed Science 100 and Science 101. Small increases were noted with the samples that had completed Biology 201 or both Biology 201 and Science 201. However, these differences are not statistically significant.

4. Are there any significant changes in attitudes of students towards science, as measured by the P.M.A.S. from the time they begin to the time they complete the following courses:

CHANGES IN K.G.I.S. PERCENTILE MEANS AFTER SCIENCE COURSES Figure 3



a) grade nine General Science (Thurber and Kilburn)?

b) grade ten Science 100 (I.P.S.)?

c) grade ten Science 101 (I.M.E.)?

d) grade eleven Biology 201?

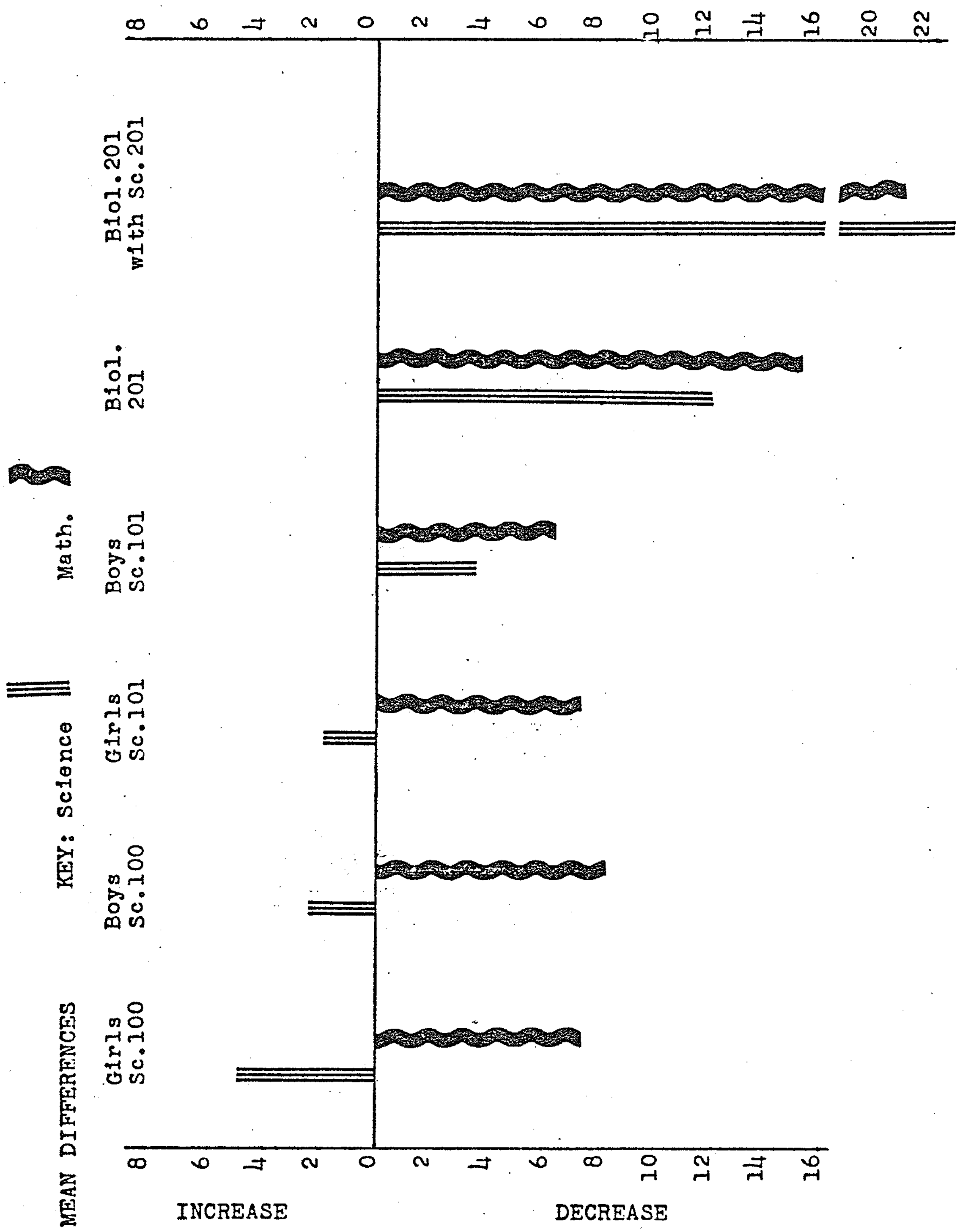
e) grade Eleven Biology 201 with Physical Science 201?

The P.M.A.S. mean score for science is lower in grade nine than in grade ten. This difference is tentatively accepted as significant for boys, and borderline for girls. P.M.A.S. mean scores for science are higher for students who took Science 100, and for girls who took Science 101 (Figure 4), but this is not statistically significant. The remaining samples, boys who took Science 101, and students who took Biology 201 or Biology 201 with Science 201, had lower P.M.A.S. mean scores for science. Of these, only a borderline significance is found in the scores of the samples who took Biology 201, or Biology 201 with Science 201.

5. If there is a change in interest in science, what is the degree of change after having taken:

   a) Science 100 as compared to Science 101?

   b) Biology 201 as compared to Biology 201 concurrently with Physical Science 201?


MEAN DIFFERENCES
KEY: Science
Math.
Girls Sc.100
Boys Sc.100
Girls Sc.101
Boys Sc.101
Biol. 201
Biol.201 with Sc.201
8 6 4 2 0 2 4 6 8 10 12 14 16
8 6 4 2 0 2 4 6 8 10 12 14 16 20 22
INCREASE
DECREASE

The K.G.I.S. mean of percentile scores in science for students who had taken Science 100 is significantly higher than for those who had taken Science 101[1]. The K.G.I.S. mean of percentile scores of students who completed Biology 201 is not significantly different from that of students who completed both Biology 201 and Science 201.

6. If there is a change in attitude towards science, what is the degree of change after having taken:

   a) Science 100 as compared to Science 101?

   b) Biology 201 as compared to Biology 201 concurrently with Physical Science 201?

Students who completed Science 100 had a significantly higher P.M.A.S. mean score in science than students who completed Science 101. The P.M.A.S. mean score of students who completed Biology 201 is not significantly different from that of students who completed both Biology 201 and Science 201.

7. How do girls' interests in science compare with those of boys in grades nine, ten and eleven?

There is a small difference between the means of percentile scores of boys and girls using the K.G.I.S. (Figure 2) at each grade level, but none of these differences is statistically significant.

[1]Possible reason is discussed on Page 124.

8. How do girls' attitudes towards science compare with those of boys in grades eight, nine, ten and eleven?

There is a difference between the P.M.A.S. mean scores of boys and girls at each grade level (Figure 1). The only difference which is statistically significant is found in grade ten where the P.M.A.S. mean score of boys is higher than that of girls.

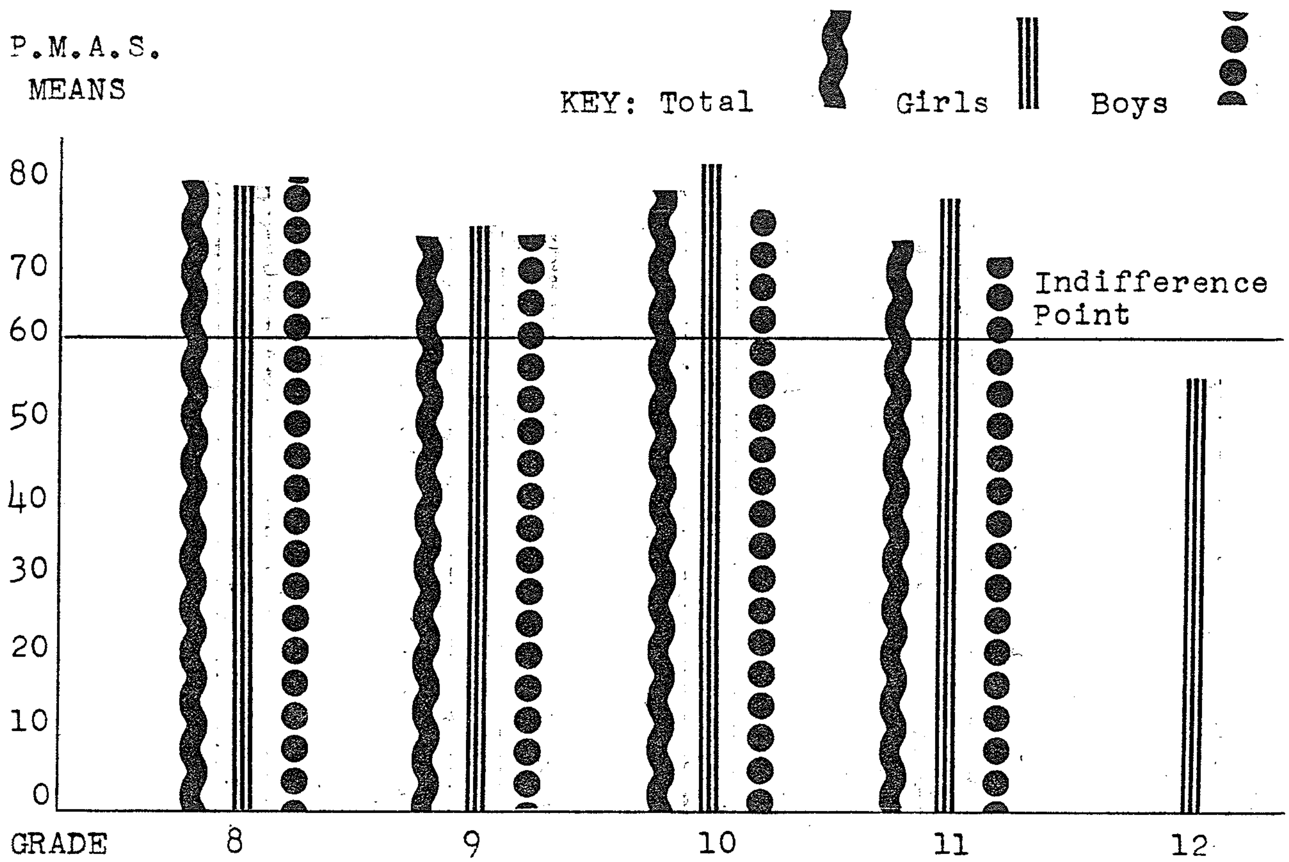
9. How does interest in mathematics on the part of secondary school students in Interlake School Division compare with interest of the general population of secondary school students as indicated by standardized norms?

The means of the percentile scores for samples of students from grades nine to twelve using the K.G.I.S. (Figure 6) show that only grade ten and eleven girls scored above the 50th percentile. The means of the percentile scores for all students in grades nine and twelve, and for boys in grade eleven are below the 45th percentile of the Kuder norms.

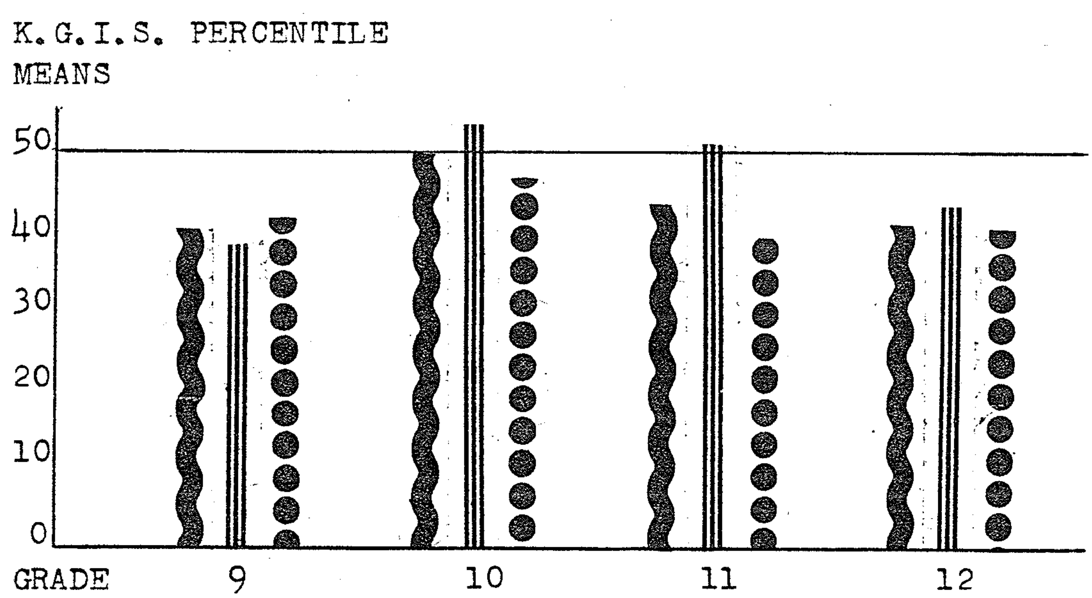
10. Where do the attitudes of these secondary students towards mathematics lie on a continuum that ranges from strongly negative to strongly positive?

As shown in Figure 3, P.M.A.S. mean scores are well above the indifference point for all grade samples, with the

ATTITUDE TOWARDS MATHEMATICS BY GRADE Figure 5



INTEREST IN MATHEMATICS BY GRADE Figure 6



exception of the grade twelve mean score which is slightly below.

11. Is there any significant change in students' interests in mathematics from the time they begin to the time they complete the following courses:

    a) grade nine General Science (Thurber and Kilburn)?

    b) grade ten Science 100 (I.P.S.)?

    c) grade ten Science 101 (I.M.E.)?

    d) grade eleven Biology 201?

    e) grade eleven Biology 201 with Physical Science 201?

The mean of percentile scores using the K.G.I.S. (Figure 6) is lower for grade nine than for grade ten, but this difference is only significant for girls. The means of percentile scores using the K.G.I.S. for samples that had not yet taken grade ten science courses are higher than those that had completed Science 100 and Science 101 (Figure 3). Small increases were noted with the samples that had completed Biology 201, or both Biology 201 and Science 201. None of these differences is statistically significant.

12. Is there any change in students' attitude towards mathematics from the time they begin to the time they complete the following courses:

a) grade nine General Science (Thurber and Kilburn)?

b) grade ten Science 100 (I.P.S.)?

c) grade ten Science 101 (I.M.E.)?

d) grade eleven Biology 201?

e) grade eleven Biology 201 with Physical Science 201?

The P.M.A.S. mean score for mathematics (Figure 5) is lower in grade nine than in grade ten. This difference is only of borderline significance for boys and girls. Comparisons of P.M.A.S. mean scores between samples that had not yet taken the science courses in grade ten and eleven and samples that had completed these courses (Figure 4) indicate that all mean scores for mathematics are lower for the samples who had completed the courses. These differences are considered significant for the samples completing Science 100, Biology 201, and for girls completing Science 101. The difference for the sample completing the combination Biology 201 and Science 201 and for boys completing Science 101 is considered to be borderline.

13. If there is a change in attitude towards mathematics, what is the degree of change after having taken:

a) Science 100 as compared to Science 101?

b) Biology 201 as compared to Biology 201 with Physical Science 201?

The P.M.A.S. mean scores in mathematics for students who had completed Science 100 or Biology 201 are not significantly different from those that had completed Science 101 or the combination Biology 201 and Science 201, respectively.

14. If there is a change in interest in mathematics, what is the degree of change after having taken:

    a) Science 100 as compared to Science 101?

    b) Biology 201 as compared to Biology 201 with Physical Science 201?

The means of K.G.I.S. percentile scores for students who had completed Science 100 or Biology 201 are not significantly different from those that had completed Science 101 or the combination Biology 201 and Science 201, respectively.

15. How do girls' interests in mathematics compare with those of boys in grades nine, ten and eleven?

The means of the K.G.I.S. percentile scores (Figure 6) for grade eleven girls was tentatively accepted as being higher than that for grade eleven boys. Differences between the means of percentile scores for boys and girls in other grade levels are not statistically significant.

16. How do girls' attitudes towards mathematics compare with those of boys in grades eight, nine, ten and eleven?

No significant differences are found between the P.M.A.S. mean scores of girls and boys for mathematics (Figure 5).

17. For students who have completed grade eight, grade nine, grade ten and grade eleven, how do:
    a) interests in science compare with interests in mathematics?
    b) attitudes towards science compare with attitudes towards mathematics?

The means of the K.G.I.S. percentile scores for mathematics (Figure 6) are higher than those for science (Figure 2) at the grade levels studied, and are accepted as significantly higher in grade ten, and tentatively accepted in grade eleven. The grade nine difference is borderline. A comparison of the means of percentile scores for science among grade nine, ten and eleven, indicated that there are no significant differences.

The P.M.A.S. mean scores for mathematics are significantly higher than the mean scores for science, in grades eight, nine, ten and eleven. A comparison of P.M.A.S. mean scores between grade levels shows that:

i) Mean scores for boys are significantly higher in grade eight science and mathematics than in grade nine science and mathematics, and are higher in grade eleven science than in grade nine science.

ii) Mean scores for boys are higher in grade ten science than in grade nine science, and in grade eleven mathematics than in grade ten mathematics. These differences are tentatively significant.

iii) Mean scores for boys are higher in grade ten mathematics than in grade nine mathematics with borderline significance.

iv) Mean scores for girls are significantly higher in grade eight science than in grade nine science, and significantly higher in grade eleven science than in grade nine science.

v) Mean scores for girls are higher in grade eight mathematics than in grade nine mathematics, and higher in grade ten science and mathematics than in grade nine science and mathematics. These differences are of borderline significance.

Conclusions

Literature and Research

There was much emphasis in the literature cited in Chapter II on the desirability of improving interests and fostering favourable attitudes in students. Interests and attitudes were considered important in such areas as achievement, course selection and vocational choice, as well as being worthwhile ends in themselves, and have often contributed to the relevancy of learning in schools. It was observed that a frequently stated objective of science courses has been the development or improvement of worthwhile interests and attitudes.

The literature indicates that various factors such as teachers, pedagogical methods, and curricular materials have been submitted as having influenced students' interests and attitudes.

A pertinent question is how successful has our educational system been in improving interests and engendering positive attitudes in our school children? Literature has indicated that the situation is not satisfactory. A decline was evidenced, more pronounced on the part of girls than boys, in interests and favourable attitudes towards science and mathematics as they proceeded through the elementary and junior high grades. In the secondary grades specific science courses have had little beneficial effect and there was a decline in attitude towards the curriculum in general. These data suggest that at least partly as a result of this, enrollment in science courses had decreased. Similarly, this may also have contributed to the more recent criticisms that the school curriculum lacks relevance and humanism. Nevertheless, little was being done to assess the interests and attitudes of school children, or to develop curricula which would promote these factors. One of the few promising approaches was the development of specially designed courses, methods, and materials which can improve interests and attitudes of specific groups of students.

This was borne out in studies done by Bingham and Milson who used small group success oriented activities, discovery approach, simplified communication and first hand experiences[1 2].

Findings of This Study

The results of this study of the Interlake School Division lend support to a number of the above findings, especially for interest and attitude toward science. The authorized curriculum guides and course introductions note the importance of improving students' interests and engendering more positive attitudes, but offer little direction as to how this may be done[3 4]. Perhaps the decline in recent years in enrollments in some grade eleven and twelve physical science courses can be attributed to neglect in this area.

The bleak observation of the Committee on Designs

[1]N.E. Bingham et al., Demonstration of an Improved Science Curriculum for Underachieving Students (Florida University, ERIC Document ED 041 730, 1969).

[2]J.L. Milson, "The Development and Evaluation of Physical Science Curriculum Materials to Improve Students' Attitudes". Journal of Research in Science Teaching, vol.9 (April 1972):p.74.

[3]Manitoba, Department of Education, High School Programme of Studies, (Winnipeg: Queen's Printer, 1972):p.1.

[4]Manitoba, Department of Education, Chemistry 200-300 (Winnipeg: Dept. of Education Printing, 1971):p.2.

for Progress in Science in 1969[1], as well as a similar statement by Westmeyer in 1972[2] implies that interests of students in the sciences was declining, along with the general image and popularity of science. This observation was borne out in this study. Interest in science, with the exception of grade twelve girls, was below the 40th percentile of the K.G.I.S. norms for grades nine to twelve. The difference between the sexes with respect to interest in science was not significant. Science interest appeared to be at the lowest level in grade nine with little increase in following grades.

The attitude of secondary students towards science was generally unfavourable for all grade levels,indicating indifferent to negative attitudes. Although the grade eight sample scored above the indifference level, grade nine was well below the indifference point, which may be interpreted as indicating an unfavourable attitude. Grades ten and eleven were very close to the indifference point, with grade twelve below this point.

Attitude towards mathematics was substantially more favourable than attitude towards science at all grade levels except grade twelve. Again, however, grade nine

[1] David P. Butts, ed., "Designs for Progress in Science Education", Washington, D.C.: National Science Teachers' Ass'n., (1969):p.7,13.

[2] J. Westmeyer, "The Flight From Science", Address to Twentieth Annual Meeting of the National Science Teachers' Association, Mar. 1972.

was below the point of indifference. Interest in mathematics, while somewhat higher than interest in science was still near the 40th Kuder percentile for grade nine. There was some increase in grade ten, followed by a decline in grades eleven and twelve. These results are substantially in agreement with the findings reported by Clark and by Ryan that there was a decline in attitude towards mathematics to the end of grade nine, and towards curriculum in general to the end of grade eleven[1 2].

With respect to differences in interests and attitudes between boys and girls, the findings of this study do not lend support to those of Craven, Whetjen and Feeley who reported that boys were generally more interested in science than girls, and Cox who found that boys had more favourable attitude towards mathematics than girls[3 4 5 6].

[1]Cleveland O. Clark, "Commonalities of Science Interests Held by Intermediate Children", Science Education, vol. 56(June 1972):p.125-36.

[2]J.J. Ryan, "Effects of Modern Conventional Mathematics Curriculum on Pupil Attitudes, Interests and Perception of Proficiency"(Washington, D.C.:U.S.O.E. Bureau of Research, 1968).

[3]Eleanor B. Craven, The Use of Interest Inventories in Counseling (Chicago: Science Research Associates Inc., 1961):p.14.

[4]Walter B. Whetjen, "Learning and Motivation: Implications for the Teaching of Science", The Science Teacher, vol.32(May, 1965):p.22-26.

[5]Id., John F. Feeley, "Interest Patterns and Media Preferences", 1972.

[6]Linda S. Cox, "Attitude Toward Arithmetic at 4th and 5th Grade Levels", Arithmetic Teacher, vol.16(Mar. 1969):p.215-20.

In this study, differences in interests and attitudes between boys and girls at the grade levels sampled were small, with the exception of girls' interest in mathematics being significantly higher than boys at the grade eleven level, and boys' attitude scores towards science significantly higher than girls' attitude scores at the grade ten level.

An important result of this study is the indication that students who have completed various science courses did not show statistically significant improvement in interest or attitude towards science or mathematics. In fact, there were several instances where the sample that had completed a particular course had lower interest or less favourable attitude.

These results are in keeping with the findings of several earlier studies: Mackay found that grade eleven P.S.S.C. students lost interest in physics, while Luchas found that grade twelve biology students lost enjoyment of biology[1 2]. Starr reported no attitude change in B.S.C.S. students, and a study reported in the Manitoba Science Teacher indicated no change in attitude towards science

[1]Lindsay D. Mackay, "Changes on Affective Domain Objectives During Two Years of Physics in Victoria Schools", Australian Science Teachers' Journal, vol.17(May 1971): p.67-71.

[2]A.M. Luchas, "Changes in Skills, Knowledge and Attitudes During Two Terms of Grade Twelve Biology Instruction", Australian Science Teachers' Journal, vol.18(Mar. 1972):p.66-74.

among I.P.S. students[1 2].

It must be remembered that there are many factors other than the course itself which may have contributed to any changes in students' interests and attitudes. However, the fact remains that the total experience in the taking of any of the science courses dealt with in this study under conditions such as are found in the Interlake secondary schools, would not improve students' interest in or attitude towards science or mathematics, and in some instances these would actually decline.

Another noteworthy result was that the sample that completed Science 100 had significantly higher interest and more positive attitude towards science than the sample that had completed Science 101. Since, as has already been pointed out, studying the particular science courses apparently did not contribute to the increased interest or more positive attitude, one must suspect that the students of the sample that elected Science 100 already had more favourable attitudes and interests than the sample that elected to take Science 101.

Finally, it appeared that there are general factors operating in the entire secondary educational process as

[1]Robert J. Starr, "The Use of 'Invitations to Inquiry' and Student Attitude", Journal of Research in Science Teaching, vol.9(Mar.1972):p.247-51.

[2]"IPS vs Thurber", The Manitoba Science Teacher, vol.13(Apr.1972):p.14-17.

well as in more specific subject areas which contribute to the formation of a students' interests and attitudes. For instance, this study showed that grade nine students had the lowest interest and most negative attitude in both science and mathematics. On the other hand, there were several instances already noted in which interest and attitude scores for mathematics were significantly more positive from those for science.

Limitations

Certain deficiencies of this study have limited the extent to which meaningful data have been obtained from the samples. This would include:

1. Interests of the grade eight sample were not measured and thus possible changes from grade eight to grade nine could not be determined
2. The grade twelve sample used for attitude measurement was too small to divide into boys and girls for statistical analysis
3. While samples were classified according to science courses taken, this was not done with respect to mathematics courses
4. The post grade eleven sample did not include students enrolled in the "00" science courses, and was thus not representative of the entire school population at this level

Caution should be used in the interpretations placed on the findings concerning student attitudes. The measuring instrument used (P.M.A.S.), while appearing to be adequate for this type of study involving comparisons between groups, has been criticized for its lack of norms, and inability to discriminate finely between attitudes of individuals[1 2]. For further research, where these factors are critical, another instrument such as that developed by Dr. R. Hedley, University of Manitoba, might be preferable.

The failure to make any statistical comparisons between interest and attitude measurements may have been a significant omission. This study did not show if and how these factors may be related.

Implications for Educators

While most would agree that fostering desirable interests and favourable attitudes is a worthwhile educational objective, it appears that the science programme in the Interlake Division, and perhaps, in many other school divisions having similar programmes, is doing little in this regard. To begin with, much more could be done by way of monitoring the interests and attitudes of students

[1] Mental Measurements Yearbook, Oscar K. Buros, ed., (New Brunswick, Rutgers Univ. Press, 1938):p.43,44.

[2] Mental Measurements Yearbook Third Edition, Oscar K. Buros, ed., (New Brunswick, Rutgers Univ. Press, 1949): p.68.

to indicate the current levels of these factors in the school population. Reliable test instruments are available and school administrations should promote their regular use. The information derived would help teachers to evaluate the effectiveness of the school programme. The next step would be to determine more specifically how to engender interest in students, and how to foster more positive attitudes. As a result of such an assessment, curriculum and course developers could take student interests and attitudes into greater consideration; programmes could be designed to promote worthwhile interests and positive attitudes, and teachers could focus more attention on the development of specific interests and attitudes. Similarly, teacher training institutions and inservice programmes should devote adequate time and effort to this area.

Teachers and administrators need to recognize that affective dimensions are as important as cognitive and psychomotor objectives. New materials, different methods and various strategies must be devised which aim at developing greater interests and more favourable attitudes. Some recent innovations such as school or student initiated courses and programmes seem to hold promise in this area. It is clear that the past approach has been far from satisfactory. Educators must become more innovative in science education and be more experimental with the increasing variety of options already at their disposal.

In evaluating the new trends in education, the affective development of the student should also be a major criterion. It is in conjunction with such efforts that the frequently mentioned but often ignored factors of relevancy and humanism can be incorporated into the school experience. Before this can be done, there is still much that has to be learned in this area.

Suggestions for Further Study

It is acknowledged that keen interests and positive attitudes of secondary school students are important in the educative process. However, the findings of this study indicated that much has yet to be done to determine the optimum conditions for the realization of these objectives. The study showed that interests and attitudes towards science were generally unsatisfactory: the next step would be to determine the factors which most significantly contribute to the formation of a secondary school student's interest and attitude towards a specific school subject. This, in turn, would provide information concerning which factors may be amenable to suitable manipulation in the educative process.

Another area for further investigation is identification of factors which underlie grade level differences in interests and attitudes. For instance, why is grade nine the low point for secondary school students' interests and attitudes? Does the changeover from the elementary system (grades one to eight) to the secondary system (grades nine to twelve), as it occurs in the Interlake school division, have some deletorious effects on students' interests and attitudes? If so, what kind and to what degree? After some improvement in grade ten, why is there little or no further improvement in interests or attitudes? Are these indications generally true for other school systems, since there are similarities in the curricula? Answers to such questions should lead to the necessary steps in improving the current situation.

The failure of any of the science courses to improve interests and attitudes in science or mathematics (in some instances these actually declined) was disappointing, but also enlightening. Here too, more investigation is needed, to establish the role of the course in the promotion of favourable interests and attitudes, as well as in the specific parts and approaches of science courses (such as labwork, experimental projects and field studies).

The focus of this study has been on students' interests and attitudes towards science and mathematics. However, it is not clear if the findings are specific only to these two subject areas, or if they represent, at least in part, a more general condition that pervades the entire secondary school programme. For instance, are interests and attitudes of students towards English or geography any

any more or less promising? To determine this, investigations are needed into interests and attitudes pertaining to a variety of subject areas. Only then could one determine if a student's interests or attitudes were general to all subject areas, or if they varied more or less independently from subject to subject. Furthermore, to get a more comprehensive picture of any trend or pattern in interests and attitudes as students proceed through the public school system, it would be necessary to investigate these factors at a much earlier grade level and continue to the end of grade twelve. Thus, a study encompassing elementary as well as all grade levels of secondary students would be extremely valuable in determining such a trend or pattern. As an alternative, the findings of this study could be extended by investigating the elementary grade levels and grade twelve. This should indicate any pronounced success or problem areas by grade level as well as by subject area.

The process of course selection by secondary students is also in need of further study. There is some indication in this study that students who elected Science 100 have more favourable interests and attitudes in science than those who elected Science 101. Is this also true for the 200-201 and the 300-301 science courses? Are certain science courses attracting the students with more favourable interests and attitudes, while other courses become a "catch-all". A study of grades eleven and twelve encompassing these stubject areas could answer this question. Finally, and perhaps even more important, do students' interests and attitudes play a significant role in course selection?

In conclusion, this study has indicated that a problem - or perhaps a series of related problems - exists in the areas of interests and attitudes towards science, and to a lesser degree mathematics, of the secondary school students of the Interlake School Division. In light of the similarity of science curricula, school organization, teaching staffs and school population in many school divisions in the province and elsewhere, it would be reasonalbe to assume that such a problem situation exists in other school systems. Further investigation is needed to substantiate the foregoing assumption, to identify the factors and conditions responsible for students' interests and attitudes towards school subjects, and to provide ways and means to improve the unfavourable situation implied in this study. This may be a formidable task, but should prove well worth the effort.

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APPENDIX A

Kuder General Interest Survey - Form E

KUDER

E

GENERAL INTEREST SURVEY

Reorder No. 7-3411

S R A Science Research Associates, Inc., 259 East Erie Street, Chicago, Illinois 60611
A Subsidiary of IBM

NAME ______________________________ AGE ____ SEX ____ GROUP ____________________ DATE OF TEST ________
Print Last First Initial M or F

DIRECTIONS

The *Kuder General Interest Survey* is exactly what its title suggests: a survey of your interests in a wide range of activities. It is not a test. There are no answers that are right or wrong for everyone. An answer is right if it is true for you.

If corrugated paper has been distributed to you, place it in the booklet just before the profile section, page 33.

On each page of this booklet you will see a list of things to do, in groups of three. First read the list of all three activities in a group. Decide which of the three you like *most*. In the answer section there are two circles on the same line as this activity—one in the column marked M for *most* and one in the column marked L for *least*. Using the pin provided, punch a hole through the left-hand circle following this activity. (Hold the pin straight up and down when you punch your answers.) Then decide which activity you like *least*, and punch a hole through the right-hand circle of the two circles following this activity.

In the examples below, the person answering has indicated for the first group of three activities that he prefers the activity "visit a museum" *most*, and the activity "browse in a library" *least*. For the second group of three activities he has indicated he prefers the activity "collect signatures of famous people" *most*, and the activity "collect butterflies" *least*.

EXAMPLES

Punch your choices for these activities in the section at the right.

		M O L	
P. Visit an art gallery		● P ●	
Q. Browse in a library		● Q ○	←LEAST
R. Visit a museum	MOST→	○ R ●	
S. Collect signatures of famous people.	MOST→	○ S ●	
T. Collect coins		● T ●	
U. Collect butterflies		● U ○	←LEAST

Please pretend that you can do *all* of the things listed, even those that require special training. Make your choices as if you were equally familiar with *all* of the activities. Do not choose an activity just because it is new or different, or because you think others might consider it a good choice.

You may like all three activities in a group, or you may dislike all three. In either case, show what your choices would be if you *had* to choose. *It is important that you answer all questions.* For each group of activities, it is essential that you choose the activity *most* preferred and the activity *least* preferred.

Do not spend a great deal of time on any one group. Do not talk over the questions with anyone. Unless an answer represents what *you* think, it will not contribute to a helpful picture of your interests.

If you want to change an answer, punch two more holes close to the answer you wish to change; then punch the new answer in the usual way.

Each time you turn a page, firmly crease it along the perforation on the left-hand margin of the booklet. Keep the bound spine always pointing to the left. This will assure accurate alignment of the pin-punches for scoring.

Start now and continue working until you have indicated your choices for all pages, columns 1 through 12.

Be sure to put your name, sex (F for female and M for male), age at your last birthday, grade, and today's date—month, day, and year—at the top of this page.

NOTE: For each group of 3 activities punch your choice for the **most** preferred activity in the column marked **M** and also punch your choice for the **least** preferred activity in the column marked **L**.

After you punch your choices on each page, turn and crease it firmly on the perforated left-hand margin, keeping the bound edge always pointing to the left.

	M		L
a. Read a book to yourself	●	a	●
b. Read a book to someone else	●	b	●
c. Have someone read a book to you	●	c	●
d. Repair a broken lock	●	d	●
e. Look for mistakes in a typewritten report	●	e	●
f. Add columns of figures	●	f	●
g. Talk more than you listen	●	g	●
h. Listen more than you talk	●	h	●
j. Talk about as much as you listen	●	j	●
k. Take a tour of a big fruit farm	●	k	●
l. Take a tour of an airplane factory	●	l	●
m. Take a tour of a large prison	●	m	●
n. Take special notice of people when you are traveling	●	n	●
p. Watch for beautiful scenes when you are traveling	●	p	●
q. Take special notice of the farm crops when you are traveling	●	q	●
r. Read lessons to a blind student	●	r	●
s. Keep a record of cars passing a certain place	●	s	●
t. Talk with people to find out their opinions for a newspaper	●	t	●
u. Go to the amusements at a country fair	●	u	●
v. See the canned foods shown at a country fair	●	v	●
w. See the animals at a country fair	●	w	●
x. Look for interesting books in a library	●	x	●
y. Watch a large orchestra practice	●	y	●
z. Watch fish and other water animals in large glass tanks	●	z	●
A. Collect the signatures of famous people	●	A	●
B. Collect butterflies	●	B	●
C. Collect pieces of different kinds of wood	●	C	●
D. Explore the ruins of an ancient city	●	D	●
E. Give lectures about ancient cities	●	E	●
F. Write articles about ancient cities	●	F	●
G. Be in charge of planning a club party	●	G	●
H. Decorate for the party	●	H	●
J. Send out the invitations for the party	●	J	●
K. Visit a weather station	●	K	●
L. Visit a company that prepares advertising	●	L	●
M. Visit a factory where typewriters are made	●	M	●
N. Guide visitors in a national park	●	N	●
P. Make fine jewelry	●	P	●
Q. Write music for an orchestra	●	Q	●
R. Take a course in drawing	●	R	●
S. Take a course in the science of plant and animal life	●	S	●
T. Take a course in metalworking	●	T	●

M 2 L

A. Build birdhouses . . . A
B. Write stories about birds . . . B
C. Draw pictures of birds. . . . C

D. Read the funnies in a newspaper first . . . D
E. Read the news in a newspaper first . . . E
F. Read the editorials in a newspaper first . . . F

G. Hear a talk on how to grow good fruit . . . G
H. Hear a talk on how to make things of copper and silver . . . H
J. Hear a talk on how to take pictures of animals . . . J

K. Help a new friend get acquainted in the neighborhood . . . K
L. Teach tricks to a dog . . . L
M. Sell the most tickets to a club play . . . M

N. Figure out the percent of people who choose each answer in opinion polls . . . N
P. Write for a newspaper . . . P
Q. Teach handicraft in a camp for poor children . . . Q

R. Visit the laboratory of a famous inventor . . . R
S. Visit a national park in the mountains . . . S
T. Visit a place where a famous battle was fought . . . T

U. Read about how famous scientists made their discoveries . . . U
V. Read what some people think a perfect world would be like . . . V
W. Read about the early pioneers of the country . . . W

X. Help people learn to get along better with others . . . X
Y. Catch rare animals for a museum . . . Y
Z. Cash checks for people in a bank . . . Z

a. Join a club that discusses problems of modern life . . . a
b. Join a club that discusses new books . . . b
c. Join a club that studies the stars and planets . . . c

d. Have a teacher find fault with a paper of yours in front of the class . . . d
e. Have the teacher write her comments on your paper . . . e
f. Have the teacher find fault with your paper when talking to you alone . . . f

g. Work out your own way of doing a job . . . g
h. Be told exactly how to do a job . . . h
j. Have general directions but work out the details yourself . . . j

k. Help a child learn to tie his shoes . . . k
l. Help prevent an argument between two young children . . . l
m. Think up ideas for new foods to cook. . . . m

n. Make cookies and candy . . . n
p. Sell the cookies and candy . . . p
q. Take telephone orders for cookies and candy . . . q

r. Run a bookshop . . . r
s. Be the director of a band. . . . s
t. Be an expert on taking pictures . . . t

		M 3 L
a.	Write some letters a blind friend dictates to you	● a ●
b.	Help a blind friend plan to make the best use of his money	● b ●
c.	Write letters of recommendation for a blind friend looking for work	● c ●
d.	Earn part of your expenses in college by helping in a laboratory	● d ●
e.	Earn part of your expenses in college by grading papers	● e ●
f.	Earn part of your expenses in college by playing in a band	● f ●
g.	Write a history of the Red Cross	● g ●
h.	Search for new facts about a famous event in history	● h ●
j.	Write a musical play	● j ●
k.	Work in the reference room of a library, helping students	● k ●
l.	Work in the order department of a library, writing orders for books	● l ●
m.	Work at the loan desk of a library, meeting the general public	● m ●
n.	Learn new words	● n ●
p.	Improve your handwriting	● p ●
q.	Improve your ability to speak in public	● q ●
r.	Listen to a discussion about politics	● r ●
s.	Take part in a discussion about politics	● s ●
t.	Take the lead in a discussion about politics	● t ●
u.	Be in charge of employing people for a business	● u ●
v.	Write articles about wild animals	● v ●
w.	Write a column of personal advice for a newspaper	● w ●
x.	Read about modern business methods	● x ●
y.	Read about customs of people in other countries	● y ●
z.	Read about modern farming methods	● z ●
A.	Work at a weather station at the South Pole	● A ●
B.	Work at a weather station in a city	● B ●
C.	Work at a weather station in the mountains	● C ●
D.	Be well known as a director of scientific research	● D ●
E.	Be well known as a social worker	● E ●
F.	Be well known as a person who writes his opinions of books	● F ●
G.	Design the scenery for a play	● G ●
H.	Test a new product in the laboratory to see how good it is	● H ●
J.	Write an article for housewives on how to fix electrical things	● J ●
K.	Think what you'd do if you could have any three wishes come true	● K ●
L.	Think about plans for your next vacation	● L ●
M.	Think about what it would feel like to lose your memory for a year	● M ●
N.	Build a loom to weave cloth by hand	● N ●
P.	Collect figures on what is happening in business	● P ●
Q.	Make a study of what young people think about going to church	● Q ●
R.	Write the business news for a newspaper	● R ●
S.	Work on the development of a new metal that is light and strong	● S ●
T.	Manage a well-planned village for factory workers	● T ●

M 4 L

A. Visit a fine arts museum
B. Visit a place where poor people can go to have fun
C. Visit a laboratory where new medicines are developed

D. Read about recent developments in the field of music
E. Read reviews of new books
F. Read about social customs in different countries

G. Write the words for a song
H. Discover a sure cure for hay fever
J. Develop better ways of doing office work for a business

K. Buy an expensive article by paying a little at a time
L. Borrow money from a friend to buy the article
M. Save until you can pay cash for the article

N. Explain new discoveries in science to children
P. Show children how to use timetables
Q. Explain to children how the buying value of the dollar changes

R. Sell newspapers at a busy street corner
S. Make a record of the number of cars passing the corner each hour
T. Hand out notices of store sales at the corner

U. Help lame children learn to walk better
V. Grow vegetables
W. Teach weaving and basketmaking

X. Ask people for money for a charity drive
Y. Write daily reports of the progress of a charity drive
Z. Keep a record of how much money people have promised to give

a. Take charge of the arrangements for a big wedding
b. Address the invitations to a big wedding
c. Write a news article about a big wedding

d. Write stories
e. Do research on how music affects people
f. Make dishes and ashtrays out of clay

g. Make studies to find the best way of selling certain products
h. Sort mail in a post office
j. Make up jokes for radio and television programs

k. Write a newspaper column on current events
l. Give popular lectures on chemistry
m. Help young people choose what to do for a living

n. Have people tell you what was wrong about a talk you made
p. Have people tell you what they liked about your talk
q. Have people say nothing about your talk

r. Be in charge of a large department in a store
s. Do research to improve television
t. Organize social activities for groups of poor people

M 5 L

a. Keep shelves filled in a grocery store . . . . a
b. Run a gift shop . . . . b
c. Type letters c

d. Have someone make you look foolish . . . . d
e. Make someone else look foolish . . . . e
f. Not have anyone made to look foolish . . . . f

g. Try to make candy for which you don't know the recipe . . . . . . g
h. Tell stories to children . . . . h
j. Paint with watercolors . . . . j

k. Do chemical research . . . . k
l. Talk to people to decide whether to hire them l
m. Write human-interest stories for a newspaper . . . . m

n. Draw a picture of sailboats . . . . n
p. Try out different sails on a toy sailboat to see which works best . . p
q. Write a poem about sailboats . . . . q

r. Sell tickets for a neighborhood play . . . . r
s. Make the tickets for the play . . . . s
t. Be the treasurer for the play . . . . t

u. Figure out the cost of producing a new type of dishwasher . . . . u
v. Persuade people to back a company to make the dishwasher v
w. Teach people to use the dishwasher . . . . w

x. Dictate letters by speaking into a tape recorder x
y. Type letters that someone dictates to you . . . . y
z. Obtain orders for tape recorders . . . . z

A. Read new evidence about the causes of various diseases . . . . . . A
B. Read about how leaders of industry became successful . . . . B
C. Read about how to raise animals on a farm C

D. Go to a party where most of the people are strangers . . . . D
E. Go to a party where you know most of the people . . . . E
F. Go to a party where you know about half of the people . . . . . . F

G. Sell art supplies . . . . G
H. Grow flower seeds . . . . H
J. Raise white mice for scientists . . . . J

K. Perform laboratory experiments . . . . K
L. Make furniture L
M. Sell insurance . . . . M

N. Visit a showing of machines that solve problems . . . . N
P. Visit a showing of machines that copy drawings rapidly . . . . . . P
Q. Visit a famous research laboratory . . . . Q

R. Weigh packages and look up how much postage they should have . . R
S. Decide whether to publish stories writers send to a magazine . . . . S
T. Try out new automobiles to find out how they can be improved . . T

A. Be an expert on cutting jewels	A
B. Do research on developing a better kind of rubber	B
C. Give music lessons	C
D. Deliver mail	D
E. Collect garbage	E
F. Sort mail in a post office	F
G. Draw designs for new flowerpots	G
H. Be in charge of workers who make flowerpots	H
J. Work out better ways of making flowerpots	J
K. Add up customers' bills in a cafeteria	K
L. Teach children how to make model airplanes	L
M. Keep record books for a scientist	M
N. Direct a playground for poor children	N
P. Be a cook in a restaurant	P
Q. Sell medicines to doctors	Q
R. Assemble a good set of woodworking tools	R
S. Make a scrapbook of pictures of paintings you like	S
T. Get together a first-aid kit	T
U. See which person at a party can tell the biggest lie	U
V. See which person at a party can tell the best joke	V
W. Act out famous sayings at a party	W
X. Be in charge of a play to be given by your club	X
Y. Get the programs and tickets printed for the play	Y
Z. Write the play	Z
a. Play a game with someone who usually beats you	a
b. Play a game with someone who hardly ever beats you	b
c. Play a game with someone of about your own ability	c
d. Address and mail out advertising for a new can opener	d
e. Figure out how much it costs to produce the can opener	e
f. Sell the can opener	f
g. Help a child with his spelling lesson	g
h. Help a child with his arithmetic problems	h
j. Help a child improve his handwriting	j
k. Pick cherries	k
l. Drive a tractor on a farm	l
m. Work in a chemistry laboratory	m
n. Take a course in public speaking	n
p. Take a course about why people behave as they do	p
q. Take a course in short story writing	q
r. Read about research on various diseases	r
s. Read about improved methods of raising cattle	s
t. Read about improvements in methods of building houses	t

M 6 L

a. Use an adding machine . . . . a
b. Put the parts of adding machines together . . . . b
c. Sell adding machines c
d. Draw pictures for magazine stories . . . . d
e. Raise beef cattle . . . . e
f. Grow fruit for the market . . . . f
g. Be the best insurance salesman in the country . . . . . g
h. Be an expert bookkeeper . . . . h
j. Be an expert on taxes . . . . j
k. Repair a broken connection on an electric iron . . . . . k
l. Build a fire in a fireplace l
m. Type a letter for a sick friend . . . . m
n. Manage a music store . . . . n
p. Draw plans for buildings . . . . p
q. Make studies of how old people can keep happy . . . . q
r. Take a new mechanical toy apart to see how it works . . r
s. Play checkers . . . . s
t. Play chess . . . . t
u. Take a tour of a city with a large group . . . . u
v. Wander around to see things on your own v
w. Have a friend who knows the city take you on a tour . . . w
x. Be the treasurer of a club x
y. Grow new kinds of flowers . . . . y
z. Talk with people about their problems . . . . z
A. Have a job visiting poor people to help them . . . . . . A
B. Manage the social affairs of a famous person . . . . . . B
C. Prepare the advertising for a book company C
D. Write a story for a magazine . . . . D
E. Write an article on how to raise chickens . . . . E
F. Write an article about first-aid methods . . . . F
G. Wait on people in a restaurant . . . . G
H. Look up addresses of lists of people in telephone books . H
J. Take care of old people . . . . J
K. Make things with clay . . . . K
L. Make a talk on your favorite way to spend a vacation . . L
M. Take part in a play given by your club . . . . M
N. Write letters answering questions about a summer camp . N
P. Keep track of the costs of running the camp . . . . . . P
Q. Keep the camp equipment in good repair . . . . Q
R. Look for mistakes in a report . . . . R
S. Wash dishes . . . . S
T. Cook a meal . . . . T

	M 8 L
A. Teach people how to design and build houses	A
B. Obtain orders for advertisements in a magazine	B
C. Repair watches	C
D. Be considered hard to get along with	D
E. Be considered fair-minded	E
F. Be considered intelligent	F
G. Go on trips to find rare animals	G
H. Go on trips to fight diseases among the natives	H
J. Have a job helping people who are very poor	J
K. Study rapid methods of solving arithmetic problems	K
L. Study methods of supplying crops with water	L
M. Study how to write better business letters	M
N. Have many friends and very little money	N
P. Have few friends and a lot of money	P
Q. Have many friends and a lot of money	Q
R. Help poor families plan to use their money wisely	R
S. Put labels on library books	S
T. Be an expert on the care of trees	T
U. Draw plans for bridges	U
V. Do work that requires a lot of mental arithmetic	V
W. Do typing and filing in an office	W
X. Teach a course in banking in college	X
Y. Raise money for a college	Y
Z. Teach a foreign language in college	Z
a. Take a course in how to write business letters	a
b. Take a course in printing	b
c. Take a course in methods of selling	c
d. Draw plans for houses	d
e. Write advertisements for new houses	e
f. Write articles about modern homes	f
g. Read about plays of long ago	g
h. Read about music of long ago	h
j. Read about studies of how words influence people	j
k. Teach children who are not very bright	k
l. Teach average children	l
m. Teach very bright children	m
n. Help young people choose what to do for a living	n
p. Draw new designs for cloth	p
q. Figure out for customers the cost of printing books	q
r. Be in charge of the manufacture of greeting cards	r
s. Decide on the selling prices of the greeting cards	s
t. Design the greeting cards	t

M 9

a. Be the best arithmetic student in a class
b. Be the most helpful student in the class
c. Be the best science student in the class

d. Have people treat you as an equal
e. Have people act as if they were better than you
f. Have people pay no attention to you

g. Do research on why people behave as they do.
h. Be in charge of building bridges
j. Plan gardens and landscapes

k. Put books back where they belong in a library
l. Write music
m. Try to help mentally ill people get well

n. Write about money problems for a newspaper.
p. Run a large farm
q. Sell houses and land

r. Take care of deaf people
s. Draw charts showing the rise and fall of prices
t. Wait on people in a store

u. Write books
v. Be an authority on outdoor advertising
w. Be a church leader

x. Have work you like with high pay
y. Have work you like with low pay
z. Have work you don't like with high pay

A. Teach poor people how to keep in good health
B. Write for a magazine
C. Buy and sell famous paintings

D. Play a game that requires mental arithmetic
E. Play checkers
F. Work mechanical puzzles.

G. Write a play
H. Be in charge of selling tickets for a play
J. Direct the play.

K. Write articles on hobbies
L. Make tables of figures on costs of living
M. Repair and refinish old furniture

N. Take a course in bookkeeping
P. Take a course in salesmanship
Q. Take a course in business English

R. Do experiments with electricity
S. Run a printing press
T. Raise fine dogs

M10L

A. Have people tease you . . . . A
B. Have people act afraid of you . . . . . B
C. Have people tell you their troubles . . . C

D. Draw funnies for the papers . . . . . . D
E. Write advertising for washing machines . E
F. Raise vegetables on a small farm . . . . F

G. Memorize a speech . . . . G
H. Memorize a poem . . . . H
J. Memorize important dates in history . . J

K. Teach arithmetic . . . . K
L. Train dogs to lead blind people L
M. Write letters for a famous scientist . . . M

N. Repair automobiles . . . . N
P. Design buildings . . . . P
Q. Do research on travel through space . . Q

R. Buy groceries for a meal . . . . R
S. Mend a broken toy . . . . S
T. Wash a friend's hair . . . . T

U. Help give first aid at a hospital . . . . U
V. Wait on people in a flower shop V
W. Address envelopes . . . . W

X. Paint pictures of famous people X
Y. Draw funny pictures of famous people . Y
Z. Paint pictures of beautiful scenes . . . Z

a. Draw pictures for magazines . . . . . . a
b. Write stories for magazines . . . . . . b
c. Be in charge of selling a magazine . . . c

d. Answer the business mail for a store . . d
e. Teach children to draw and paint . . . e
f. Write for an art magazine . . . . f

g. Sell life insurance . . . . g
h. Write stories for magazines . . . . . . h
j. Make file cards for new library books . j

k. Choose your own clothes . . . . k
l. Get advice on choosing your clothes . . l
m. Have someone else choose your clothes . m

n. Take a course in physical education . . n
p. Take a course in shopwork . . . . . . p
q. Take a course in mathematics . . . . . q

r. Do housework . . . . r
s. Answer questions at an information desk s
t. Sell magazines . . . . t

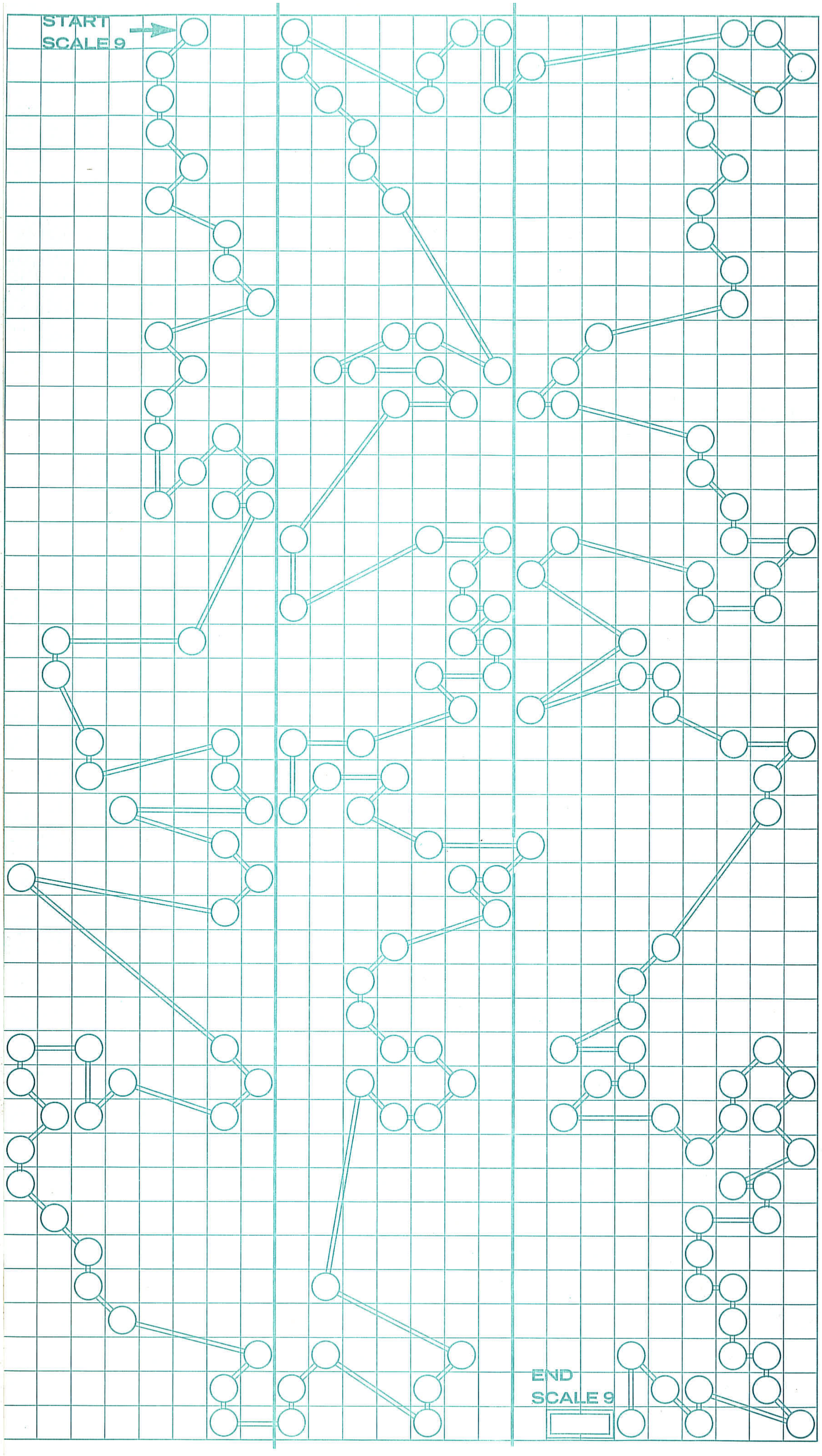
		M ? L	
a. Take care of the mail for a camp	a		
b. Lead the camp band	b		
c. Give first aid in the camp	c		
d. Sell from door to door	d		
e. Sell by mail	e		
f. Wait on people in a store	f		
g. Be the president of a club	g		
h. Be the treasurer of the club	h		
j. Be the secretary of the club	j		
k. Write poems	k		
l. Paint pictures	l		
m. Do social work among the poor	m		
n. Be a guide on camping trips	n		
p. Design camp equipment	p		
q. Sell camp equipment	q		
r. Enter a typing contest	r		
s. Enter a singing contest	s		
t. Enter a public-speaking contest	t		
u. Study alone	u		
v. Study where others are studying	v		
w. Study where others are talking	w		
x. Sell in a store	x		
y. Work for a record company	y		
z. Work for a book company	z		
A. Paint pictures of people	A		
B. Do research on earthquakes	B		
C. Build bridges	C		
D. Teach in a nursery school	D		
E. Supervise a playground	E		
F. Sell toys	F		
G. Repair a broken ironing board	G		
H. Wash dishes	H		
J. Put a room in order	J		
K. Teach furniture making	K		
L. Correct articles for a newspaper	L		
M. Teach arithmetic	M		
N. Decorate store windows	N		
P. Keep office machines in order	P		
Q. Make out bills for a store	Q		
R. Work at a telephone switchboard	R		
S. Sell brushes	S		
T. Teach games to children	T		

	M 12 L
Play in an orchestra . . .	A
Work in an office	B
Take care of old people . .	C
Visit a sick friend	D
Teach a trick to a dog . . .	E
Repair a broken toy . . .	F
Build boats	G
Settle labor disputes . . .	H
Compose music	J
Have many friends	K
Have good health	L
Have high social position .	M
Sell vegetables	N
Play an organ	P
Raise vegetables	Q
Work at a desk	R
Work on a ranch	S
Do house-to-house selling .	T
Work in a candy factory . .	U
Raise chickens	V
Give eye examinations . .	W
Do typing and filing . . .	X
Teach English	Y
Sell art supplies	Z
Go to a tennis match . . .	a
Go to a funny movie . . .	b
Go to a wrestling match . .	c
Help in a sickroom	d
Sell musical instruments . .	e
Repair household equipment	f
Build bird feeders	g
Keep a bird feeder filled . .	h
Make drawings of birds . .	j
Start a newspaper	k
Start an art school	l
Start an orchestra	m
Have friends	n
Have power	p
Have fame	q
Put new covers on books .	r
Look after sick children . .	s
Type letters	t

END OF SURVEY.

Name ________________________________

For each group of 3 activities, be sure you have punched your choice for the most preferred activity in the column marked **M** for *most* and also your choice for the least preferred activity in the column marked **L** for *least*. Be sure you have punched your choices on every page, columns *1 through 12*. Now print your name.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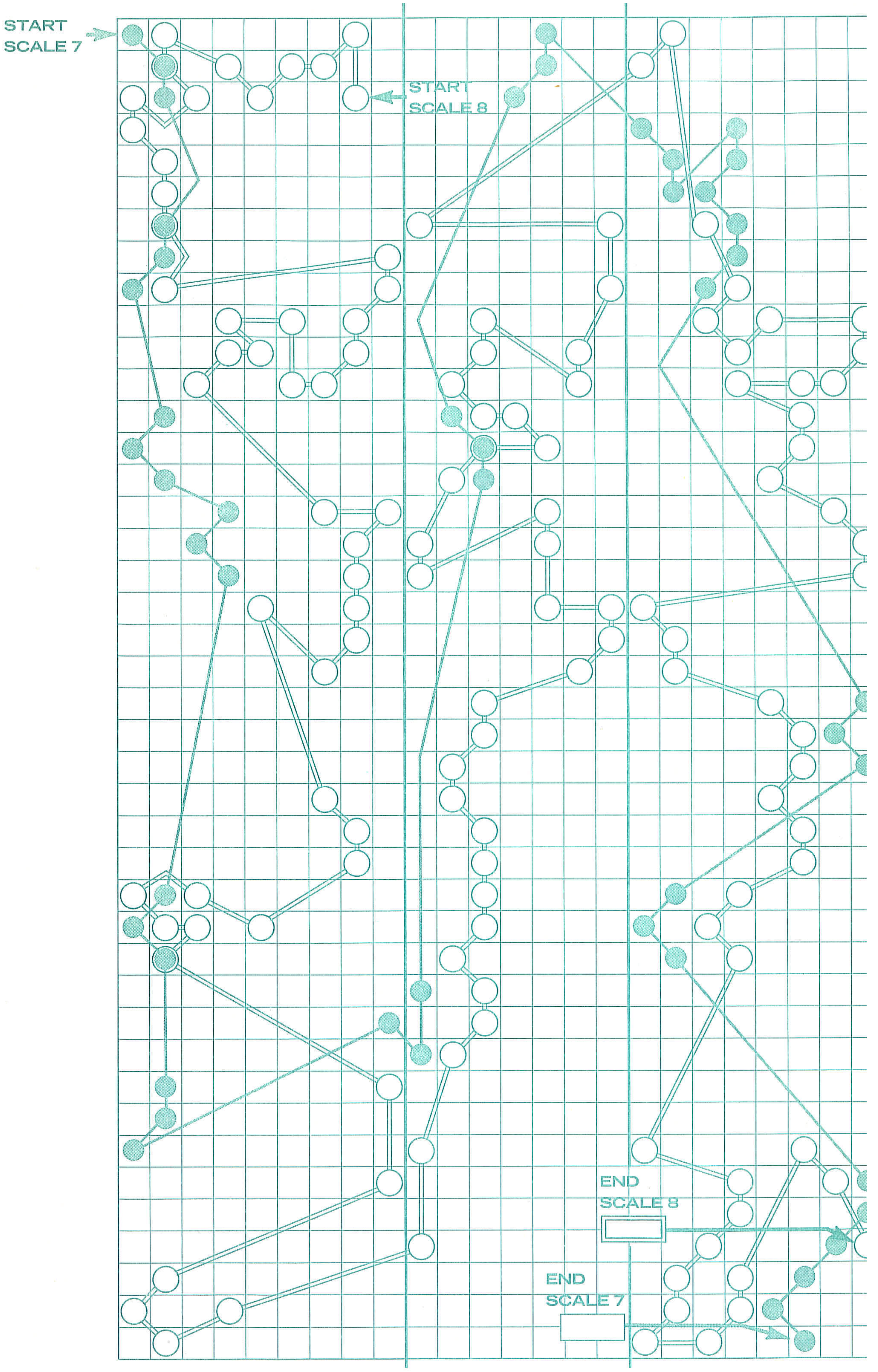
SCALE 9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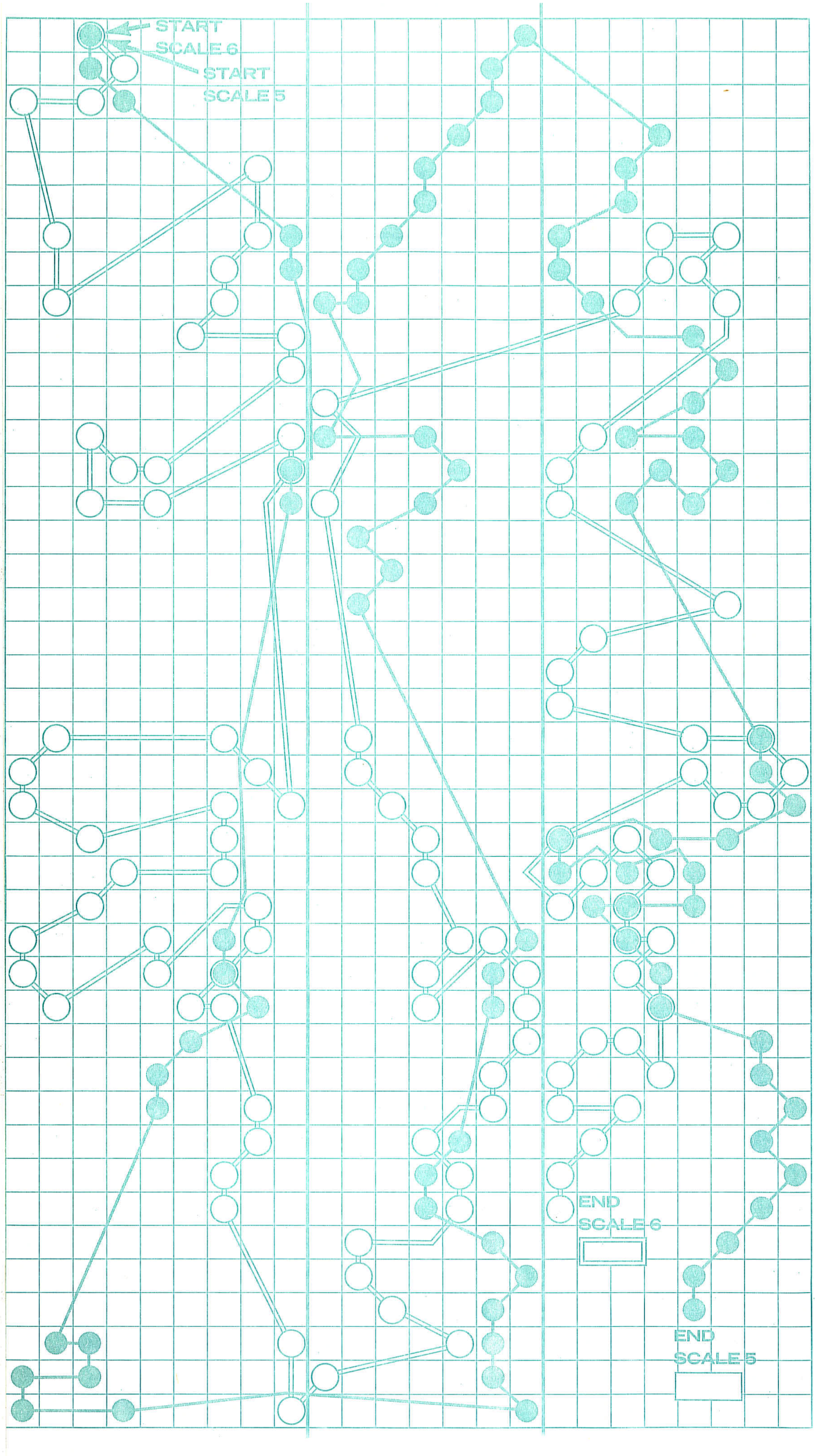
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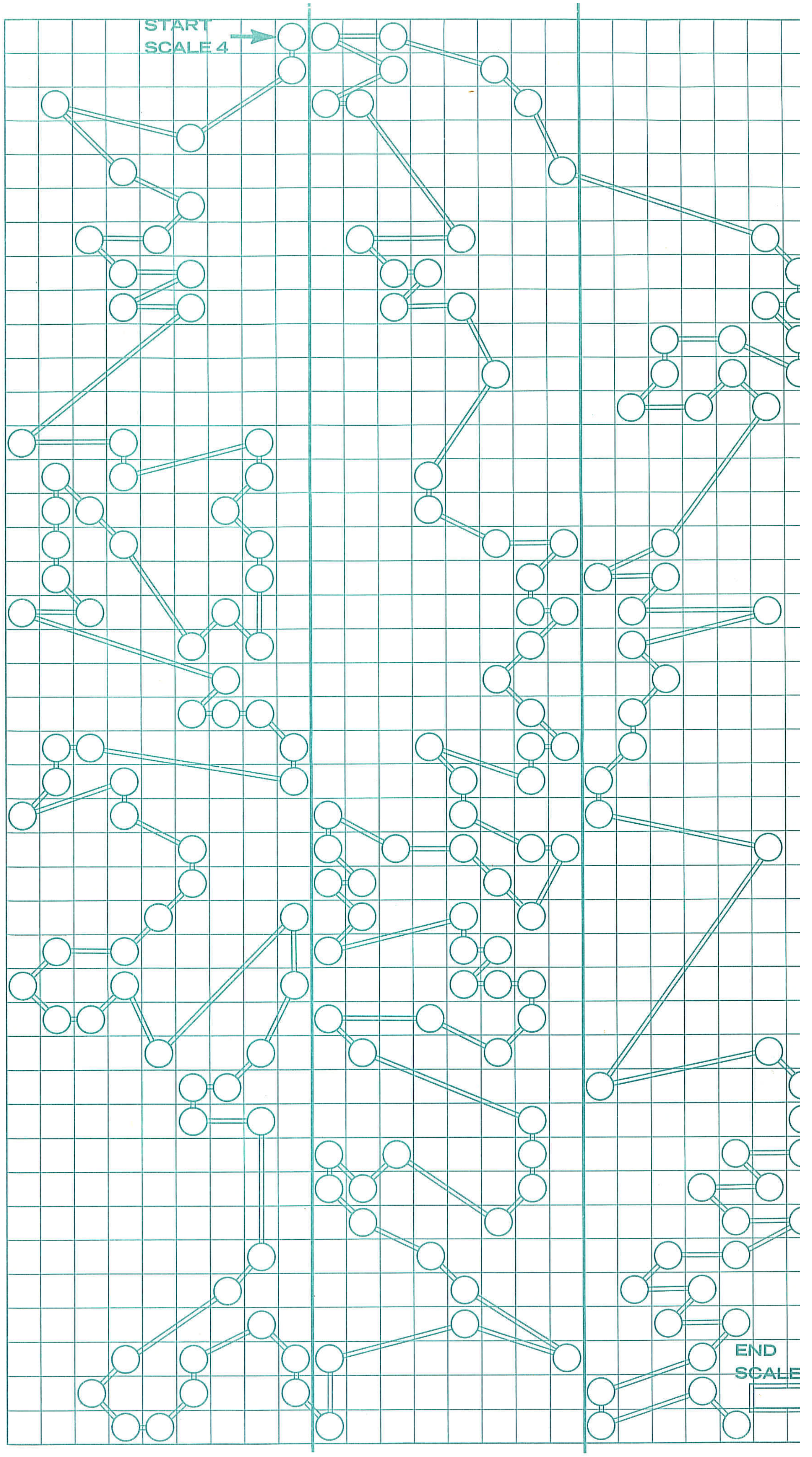
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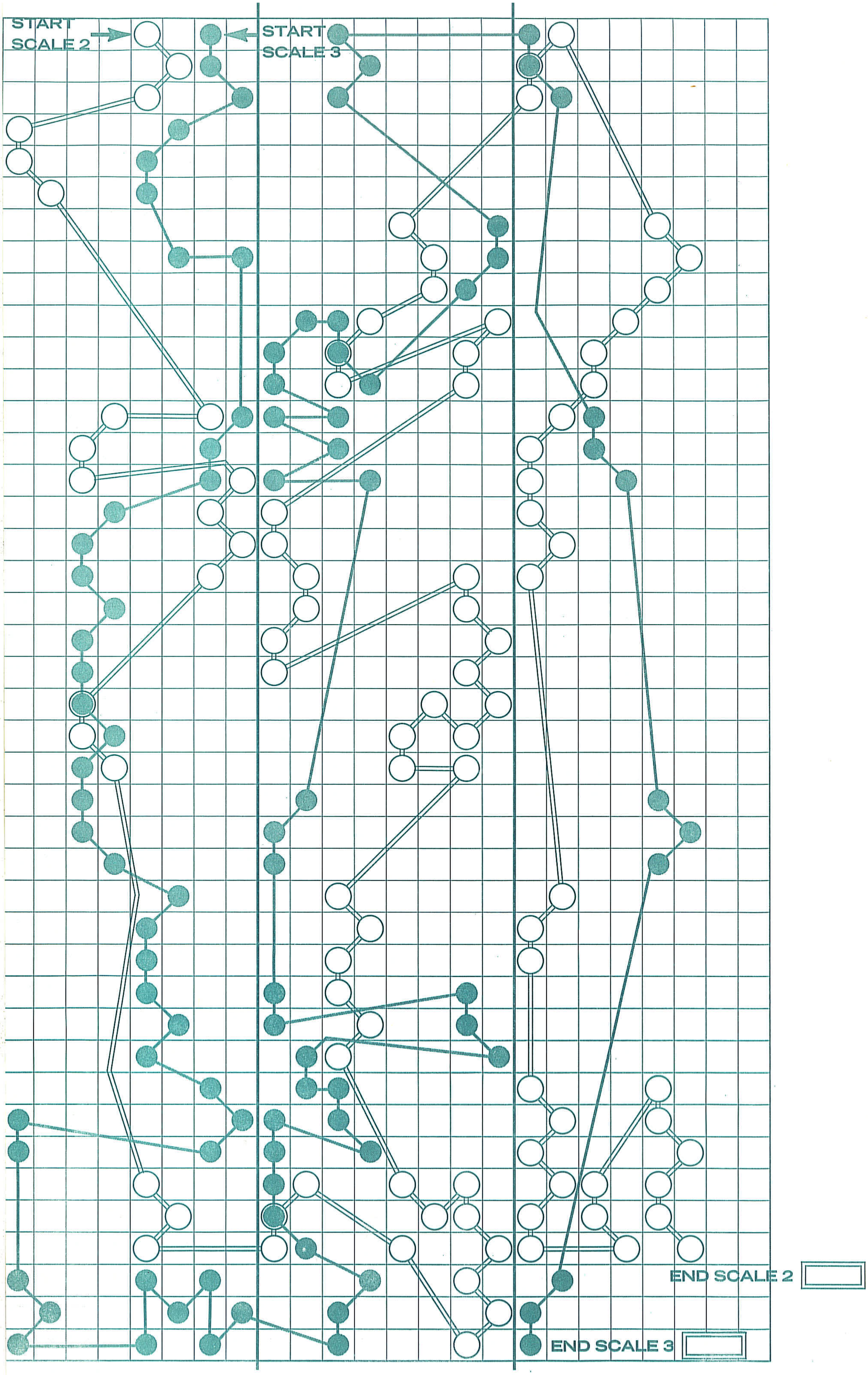
SCALE



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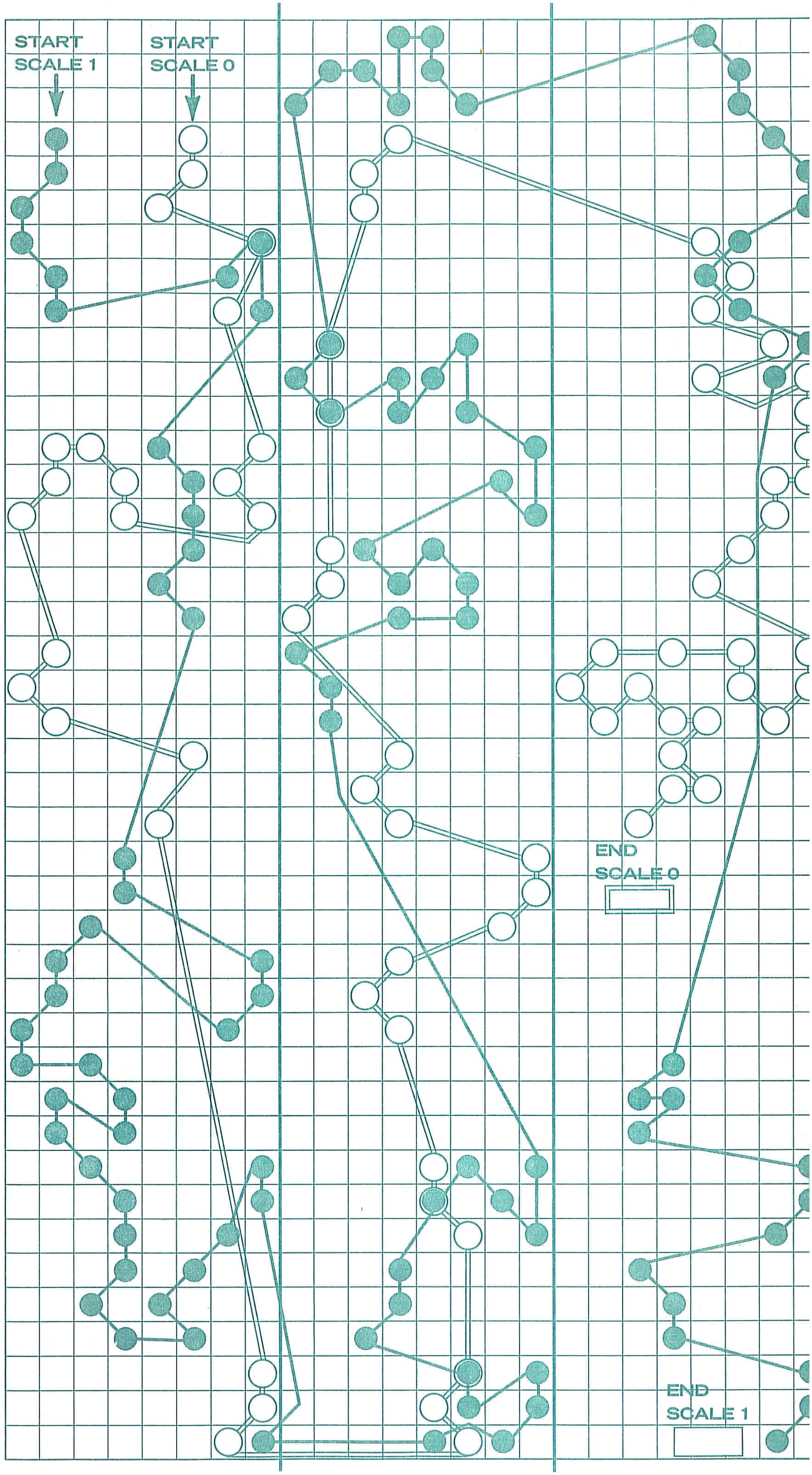
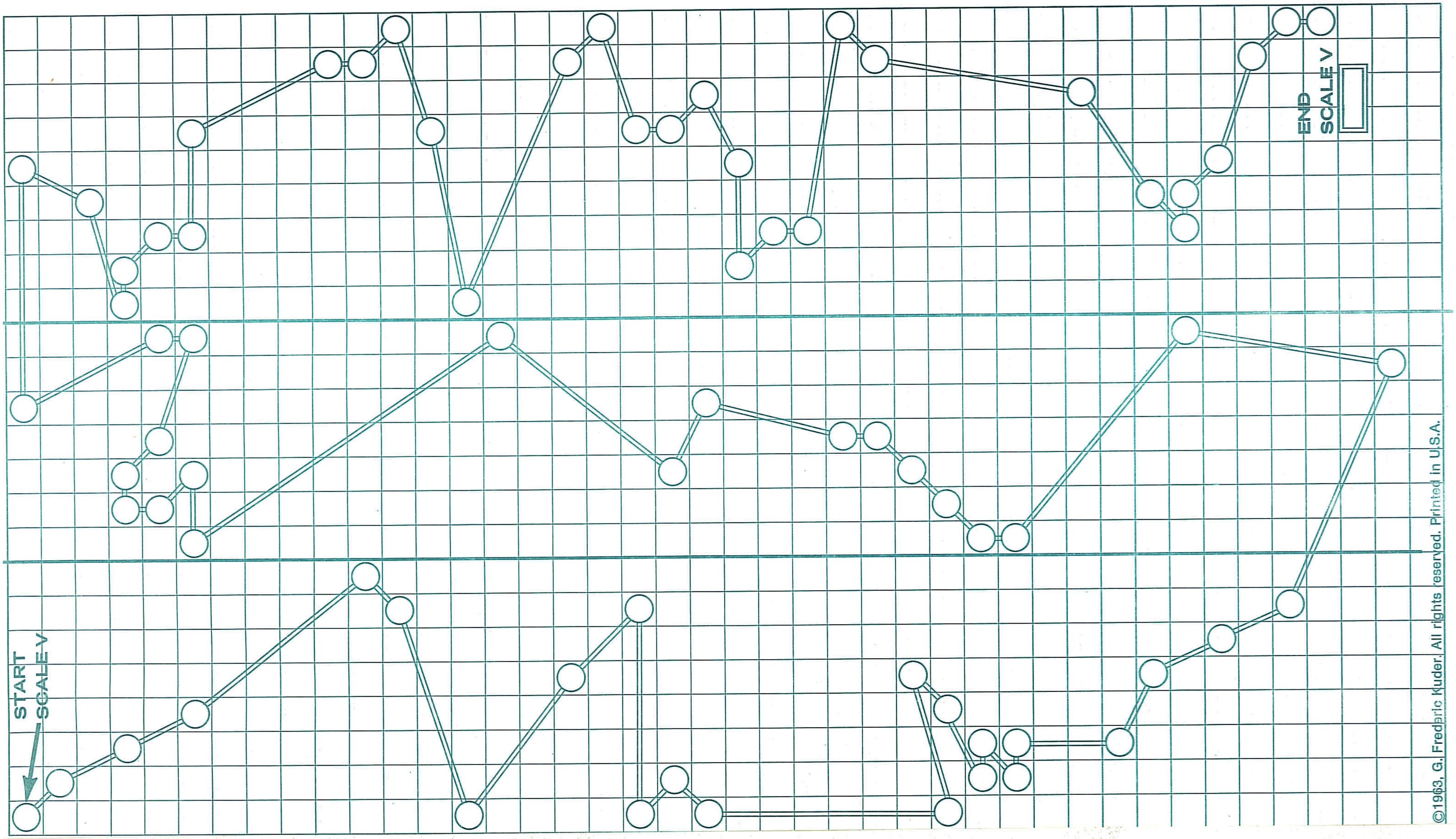
SCALE 2
START
SCALE 3
END SCALE 2
END SCALE 3

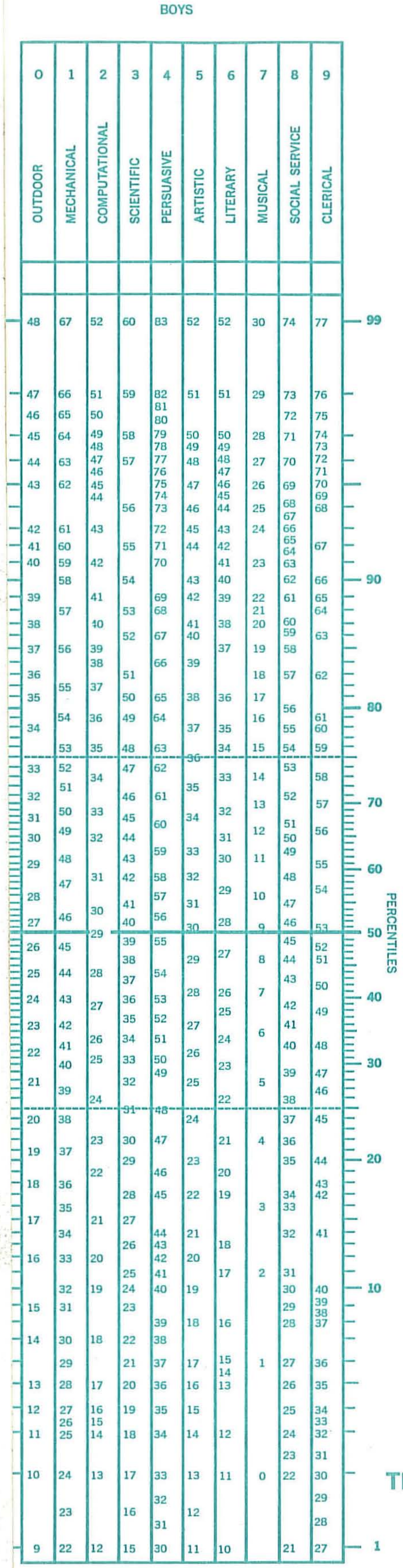

START
SCALE 1
START
SCALE 0
END
SCALE 0
END
SCALE 1

1. Start at the arrow on this page and follow the chain of circles over the page, counting the circles in which holes are punched. Do not count the circles where there are *three* punches, since these are the choices you changed your mind about. If a punched hole falls within a square containing a circle but doesn't fall within that circle, count it as if it fell within the circle. In the box at the end of the V scale, record the number of holes you have counted. Count the punched circles in the other scales on the following pages in the same way, recording your score for each scale in the box provided at the end of the scale.
2. On this page there is only one scale, so there is only one chain of circles, all the same. On some pages there are two scales, but since they look different it is easy to tell them apart. One scale is a chain of circles connected by a double line, and the other scale is a chain of dots connected by a single line. You are to count the punched holes separately for each scale. *If you have punched a circle with a dot in it, count it once for each scale.* Remember—a punched hole that falls within a square containing a circle or dot counts whether or not it actually falls within that circle or dot.
3. Obtain the count again for each score and record it in the box provided for that scale in the profile section (page 33 if you are in grades 6–8, page 34 if you are in grades 9–12).
4. Compare the scores in the profile section with those entered on the inside pages. In case of differences, count again until you are sure that each of your scores is counted correctly. The scores in the profile section and on the inside pages should agree.



NAME ____ AGE ____ SEX ____
PRINT LAST FIRST INITIAL M OR F

GRADE __________ DATE OF TEST __________________________________



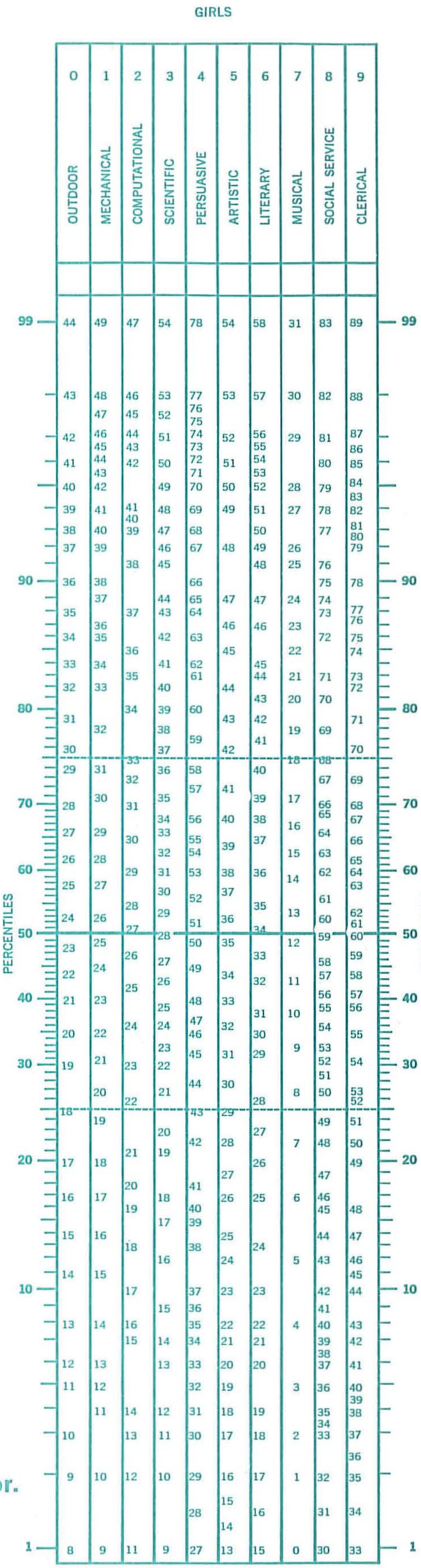
PROFILE SECTION GRADES 6-8

If you are in Grades 6-8, to get a picture, or profile, of your scores, follow the directions below carefully, using the profile form at the left if you are a boy and the one at the right if you are a girl.

1. Look at your V score on the back page of the answer section. If it is 15 or over, tell the teacher or counselor who has given you the *Kuder General Interest Survey.* He may want you to take it again, because a high V score usually means that something has gone wrong and there is some question concerning the value of your other scores. If your V score is *less* than 15, go on to Step 2.
2. Copy the scores for scales 0 through 9 from the answer section in the boxes at the top of the profile chart. Be sure to put the scores in the correct boxes.
3. In each column, find the number that is the same as your score in the box at the top of that column. Draw a line through the number from one side of the column to the other. If your score is higher than the highest number in the column, draw a line across the top of the column. If your score is lower than the lowest number in the column, draw a line across the bottom.
4. With pencil, blacken the entire space between the line you have drawn in the OUTDOOR column and the bottom of the chart. Do the same for the other columns.

Now you have a profile of your interests in the ten areas listed across the top of the chart.

This page is to be kept by your counselor.



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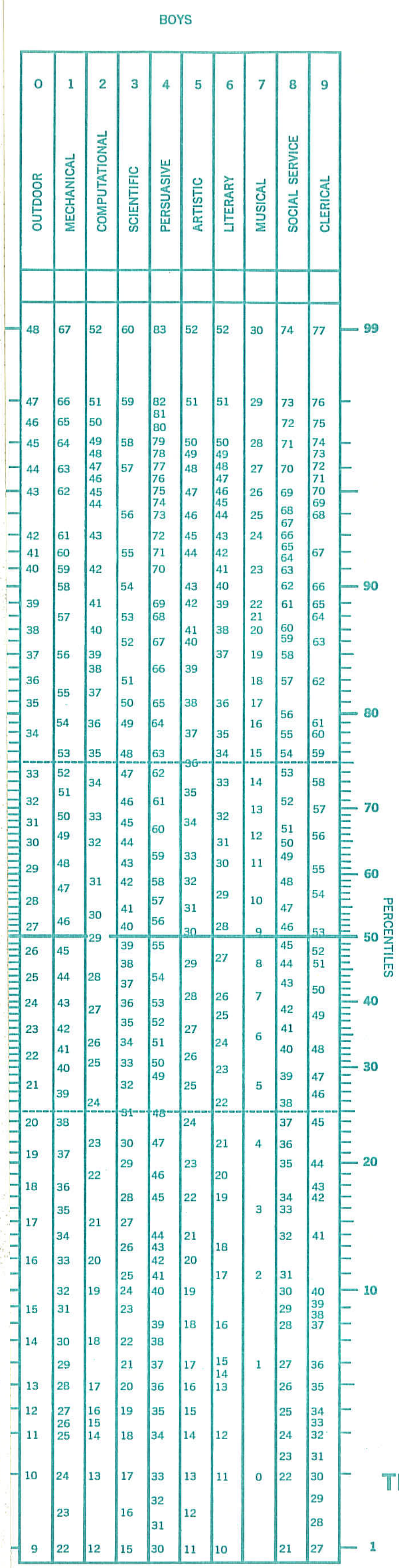
ME ______ AGE ______ SEX ______
INT LAST FIRST INITIAL M OR F
ADE ______ DATE OF TEST ______



PROFILE SECTION GRADES 6-8

If you are in Grades 6-8, to get a picture, or profile, of your scores, follow the directions below carefully, using the profile form at the left if you are a boy and the one at the right if you are a girl.

1. Look at your V score on the back page of the answer section. If it is 15 or over, tell the teacher or counselor who has given you the *Kuder General Interest Survey*. He may want you to take it again, because a high V score usually means that something has gone wrong and there is some question concerning the value of your other scores. If your V score is *less* than 15, go on to Step 2.
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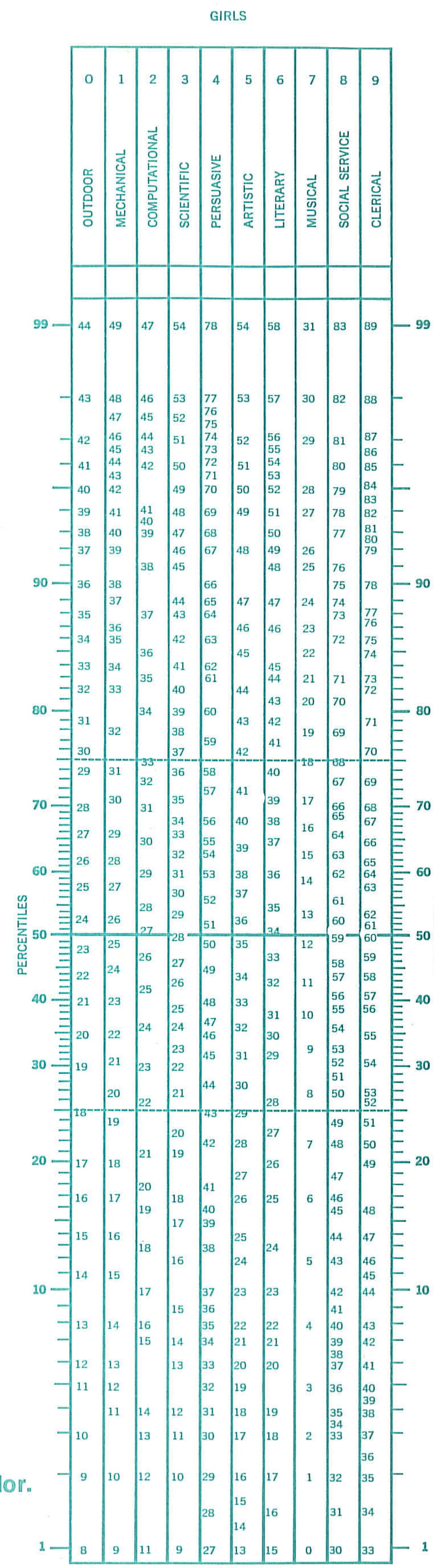
4. With pencil, blacken the entire space between the line you have drawn in the OUTDOOR column and the bottom of the chart. Do the same for the other columns.

Now you have a profile of your interests in the ten areas listed across the top of the chart.

This page is to be kept by your counselor.



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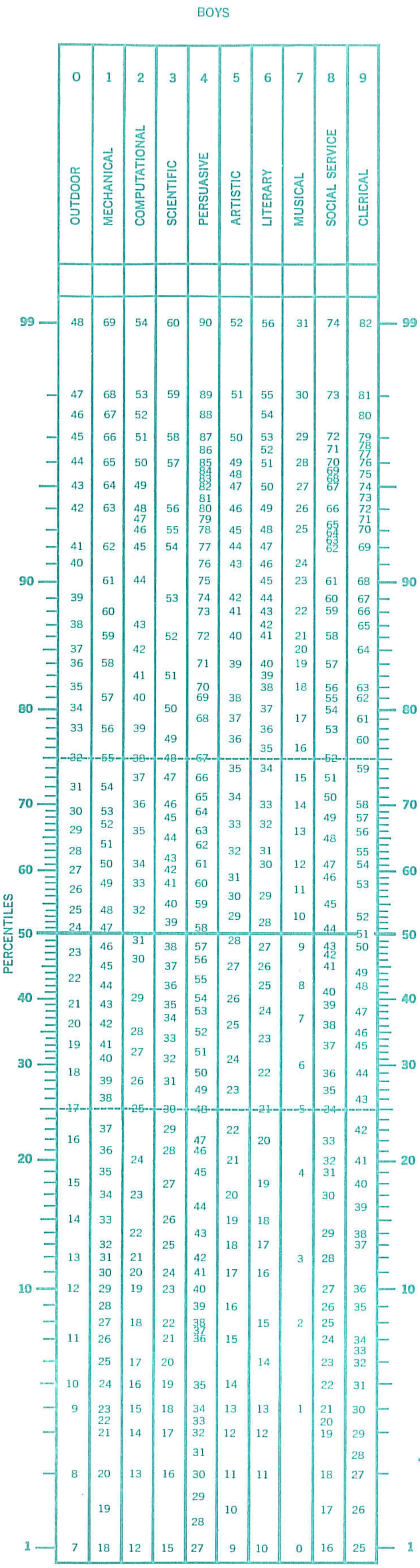
NAME ______ AGE ____ SEX ____
PRINT LAST FIRST INITIAL M OR F
GRADE ______ DATE OF TEST ______



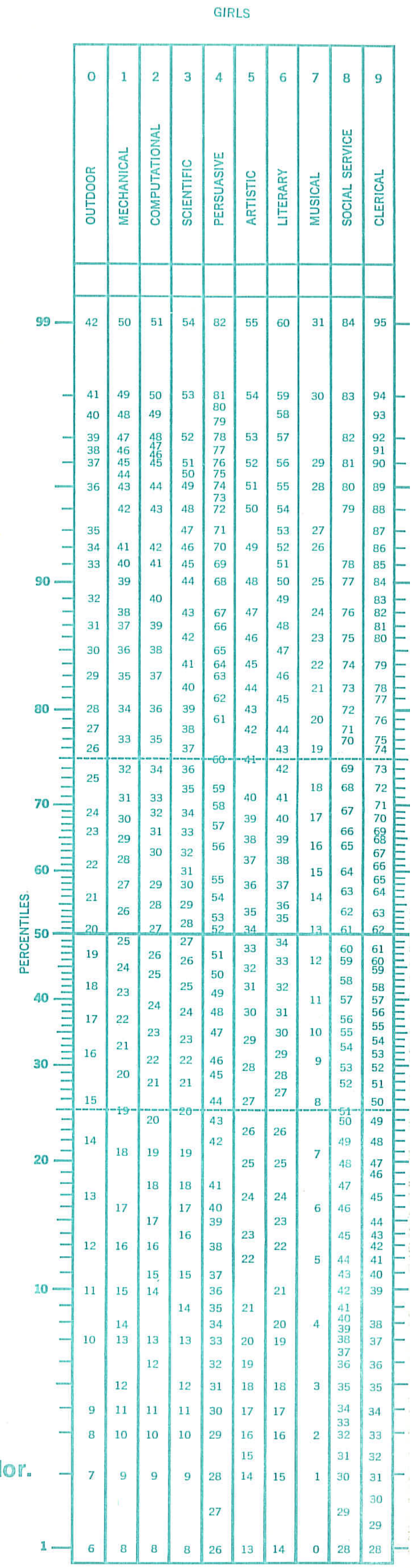
PROFILE SECTION GRADES 9-12

If you are in Grades 9-12, to get a picture, or profile, of your scores, follow the directions below carefully, using the profile form at the left if you are a boy and the one at the right if you are a girl.

1. Look at your V score on the back page of the answer section. If it is 15 or over, tell the teacher or counselor who has given you the *Kuder General Interest Survey*. He may want you to take it again, because a high V score usually means that something has gone wrong and there is some question concerning the value of your other scores. If your V score is *less* than 15, go on to Step 2.
2. Copy the scores for scales 0 through 9 from the answer section in the boxes at the top of the profile chart. Be sure to put the scores in the correct boxes.
3. In each column, find the number that is the same as your score in the box at the top of that column. Draw a line through the number from one side of the column to the other. If your score is higher than the highest number in the column, draw a line across the top of the column. If your score is lower than the lowest number in the column, draw a line across the bottom.
4. With pencil, blacken the entire space between the line you have drawn in the OUTDOOR column and the bottom of the chart. Do the same for the other columns.

Now you have a profile of your interests in the ten areas listed across the top of the chart.

This page is to be kept by your counselor.



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INTERPRETING YOUR INTEREST PROFILE

You are interested in something if you enjoy doing it. Your interest profile indicates whether your interests in the ten areas measured are high, average, or low compared with those of other boys or girls at your grade level across the nation.

A score above the top dotted line in any column is a high score. It means that you have indicated a preference for activities in that area more frequently than most young people at your grade level. (The percentile on the same line as your score for an interest area tells you what percentage of students expressed preference for activities in that area less frequently than you did.) A score between the two dotted lines means that your interest in the area represented is about average. A score below the bottom dotted line is a low score. It indicates that you have not expressed preference for activities in that area as often as most young people.

Like most people, you probably have scores that are high in some areas, low in some, and average in others. Looking at *all* your scores is important, because most school subjects and jobs involve a combination of two or more interests.

The more interested you are in a school subject, a job, or anything you do, the greater your chances are for success in it. It is easier and more satisfying to put your efforts into activities you enjoy than into those you dislike. Of course, no one can do *only* what interests him. Studying your interests, however, will help you direct your activities mainly into channels where you are more likely to achieve satisfaction. In addition, such study may help you find some things that appeal to your interests even in chores that you dislike.

An important fact to keep in mind is that low scores sometimes mean that you haven't had enough of an opportunity to develop interests in certain areas. Imagine, for example, a young person whose family and friends are not particularly interested in music, and who has not had an opportunity to learn to play an instrument, to listen attentively to records, or to go to concerts. He may not score as high in musical interest as someone who has had more experience with music. You have to be introduced to or discover an activity before you can like it or dislike it. Participating in something you've decided you might like may in turn tend to strengthen your interest in it. As you mature and are exposed to a variety of new experiences, some of your old interests may change and some new ones may develop.

High interests are not *better* than low interests; nor is one interest better—or worse—than another. What counts is knowing what your interests are and considering them whenever you have an important educational or vocational decision to make.

Here is what the ten interest areas measured by the *Kuder General Interest Survey* mean.

OUTDOOR interest means preference for work or activity that keeps you outside most of the time—usually work dealing with plants and other growing things, animals, fish, and birds. Foresters, naturalists, fishermen, telephone linemen, and farmers are among those high in outdoor interest.

MECHANICAL interest means preference for working with machines and tools. If you like to tinker with old clocks, repair broken objects, or watch a garage mechanic at work, you might enjoy shop courses in school. Aviator, toolmaker, machinist, plumber, automobile repairman, and engineer are among the many jobs involving high mechanical interest.

COMPUTATIONAL interest indicates a preference for working with numbers and an interest in math courses in school. Bookkeepers, accountants, bank tellers, engineers, and many kinds of scientists are usually high in computational interest.

SCIENTIFIC interest is an interest in the discovery or understanding of nature and the solution of problems, particularly with regard to the physical world. If you have a high score in this area, you probably enjoy working in the science lab, reading science articles, or doing science experiments as a hobby. Physician, chemist, engineer, laboratory technician, meteorologist, dietitian, and aviator are among the occupations involving high scientific interest.

PERSUASIVE interest is an interest in meeting and dealing with people, in convincing others of the justice of a cause or a point of view, or in promoting projects or things to sell. Most salesmen, personnel managers, and buyers have high persuasive interest. If you have a high score in this area, you may enjoy such activities as debating, selling tickets for a school play or dance, or selling advertising space for the school paper.

ARTISTIC interest indicates a preference for doing creative work with the hands—usually work involving design, color, and materials. If you like to paint, draw, sculpture, decorate a room, design clothes, or work on sets for school plays, you are probably high in this interest. So are artists, sculptors, dress designers, architects, hairdressers, and interior decorators.

LITERARY interest is an interest in reading and writing. Persons with literary interest include novelists, English teachers, poets, editors, news reporters, and librarians. If you have a high score on the literary scale, English is probably one of your favorite subjects, and you may enjoy writing for the school paper or magazine.

MUSICAL interest usually is demonstrated by persons who enjoy going to concerts, playing an instrument, singing, or reading about music and musicians. Musicians, music teachers, and music critics are among those who have directed high musical interest into a vocation.

SOCIAL SERVICE interest indicates a preference for activities that involve helping people. Nurses, Boy Scout or Girl Scout leaders, vocational counselors, tutors, personnel workers, social workers, hospital attendants, and ministers, rabbis, and others in religious service are among those high in this interest area.

CLERICAL interest means a preference for work that is clearly defined for you—work that involves specific tasks requiring precision and accuracy. If you have high clerical interest, you probably enjoy school subjects and activities that require attention to detail. Jobs such as bookkeeper, accountant, file clerk, salesclerk, statistician, teacher of commercial subjects, and traffic manager fall in this area.

The ten interest areas discussed here are not the *only* ones; nor is the classification system used the only one possible (for example, interests may be classified by specific occupations or by preferences for certain kinds of personal situations). The interest areas described, however, are the ones that will mean most to you in making decisions about school subjects and broad fields of work to explore.

Scores in related interest areas are much higher for some occupations than for others. For example, authors, editors, and reporters are at the 97th percentile in literary interest. Musicians and music teachers are at the 99th percentile in musical interest. Mechanics and repairmen, on the other hand, are at the 65th percentile in mechanical interest—their highest score; and surgeons are at the 75th percentile in scientific interest.

Some occupational groups have scores nearly as high—or higher—in apparently unrelated interest areas as in related areas. In one survey the highest percentile for lawyers and judges was 82, on the literary scale. The next was 61, on both the musical and the clerical scales. In another survey the second-highest interest for surgeons was outdoor interest, with a percentile of 68. Their next-highest interest was literary, with a percentile of 66. The main reason for results of this type is that people often have more than one strong interest. They may go into a career that makes use of their combined interests, or they may direct one or more of their strong interests into a satisfying after-work activity that provides a change of pace and broadens the range of their activities. Businessmen may find relaxation and a chance to get away from people and pressures in such activities as hunting and fishing. One retail salesman, for example, may enjoy many do-it-yourself activities involving high mechanical interest. Another may enjoy fishing or gardening or acting in a community theater. A businessman may, in his free time, play in a string quartet, paint or sculpture, or engage in some other kind of activity not clearly related to the work he performs for a living.

Knowledge of your interests can tell you only what you *enjoy* doing; *it cannot tell you how well you do these things.* What you do well depends on many things besides interest—particularly, your abilities. Your counselor can help you find out whether your abilities measure up to your interests. He can help you with your decisions about what course of study and school subjects to take. Your counselor may also be able to suggest ways in which you can explore and broaden your interests—extracurricular activities you might enjoy, books appropriate to your interests, and kinds of part-time or summer jobs you might want to consider. At various points during your school years—especially before making plans for college or a job—you may want to reexamine your interests. Your counselor can suggest other Kuder interest inventories for this purpose.

You can learn more about the meaning of interests by reading the booklets *Discovering Your Real Interests,* written by Blanche Paulson for high school students, and *The Job in Your Future,* prepared by SRA Staff for students in junior high. The counselor's office or the library may have copies of these publications.

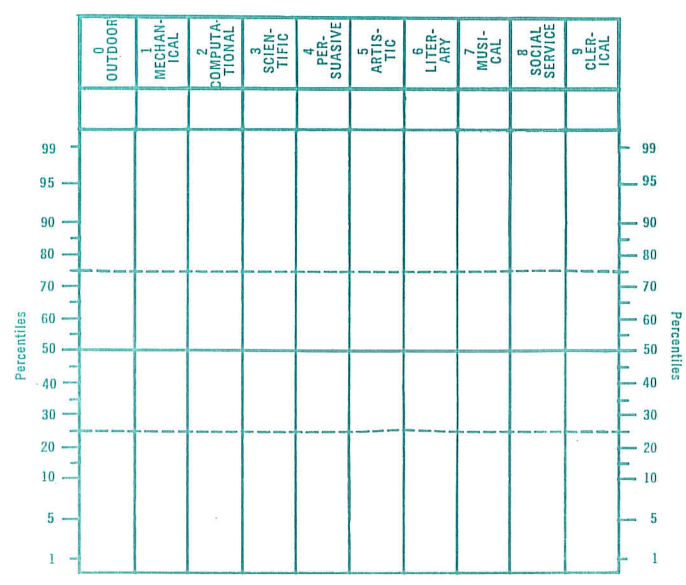
MY INTEREST PROFILE

Name________________________________

Grade________________________________

Date________________________________

*(You may want to keep your own record of your high and low interests. Use the small profile form at the right to plot your ten scores so that they fall at approximately the same percentiles as in the large profile on page 33 or 34). NOTE: You may keep pages 35 and 36; your counselor may keep pages 33 and 34. The remaining pages of the booklet may be destroyed.



SRA
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APPENDIX B

Purdue Master Attitude Scale

A SCALE TO MEASURE ATTITUDE TOWARD ANY SCHOOL SUBJECT

Form A

Edited by H. H. Remmers

Date____________________

'ame (optional)____________________________________ Sex (circle one) M F

ge______________________________ Grade__________________________

'irections: Following is a list of statements about school subjects. Put a plus sign ‡) before each statement with which you agree about the subjects listed at the left of ıe statements. The person in charge will tell you the subject or subjects to write ı at the head of the columns to the left of the statements. Your score will not affect our grade in any course.

ject

1. No matter what happens, this subject always comes first.
2. This subject has an irresistible attraction for me.
3. This subject is profitable to everybody who takes it.
4. Any student who takes this subject is bound to be benefited.
5. This subject is a good subject.
6. All lessons and all methods used in this subject are clear and definite.
7. I am willing to spend my time studying this subject
8. This subject is a good pastime.
9. I don't believe this subject will do anybody any harm.
10. I haven't any definite like or dislike for this subject.
11. This subject will benefit only the brighter students.
12. My parents never had this subject, so I see no merit in it.
13. I am not interested in this subject.
14. This subject reminds me of Shakespeare's play -- "Much Ado About Nothing."
15. I would not advise anyone to take this subject.
16. This subject is a waste of time.
17. I look forward to this subject with horror.

P.M.A.S. SCORING SCALE

Note that these scales require no norms beyond the scale values that follow. The norms are, so to speak, "built in," since what is being measured is the affective value of an attitude object defined by the scale values of the items endorsed by respondents.

Scale Values for Forms A and B

Item	Scale Value	Item	Scale Value	Item	Scale Value	Item	Scale Value
1.	10.3	5.	8.5	9.	6.0	13.	3.1
2.	9.6	6.	8.1	10.	5.5	14.	2.6
3.	9.2	7.	7.7	11.	4.7	15.	2.2
4.	8.9	8.	6.5	12.	3.6	16.	1.6
						17.	1.0

Scoring

The median scale value of the statements endorsed is the attitude score. If an odd number of statements is endorsed, the scale value of the middle item of those endorsed gives the score. For example, if three items are endorsed, say, for example, items Nos. 2, 3, and 5, the score is the scale value of item No. 3, i.e., 9.2, a highly favorable attitude.

If an even number of items is endorsed, say, for example, items Nos. 1, 2, 3, and 4, the score will be halfway between the scale values for items Nos. 2 and 3 i.e., 9.4. The indifference point on all scales is 6.0. Scores above 6.0 indicate a favorable attitude, scores below 6.0, an unfavorable attitude.

This method of scoring, much more rapid and convenient than Thurstone's method (averaging the scale values of the items endorsed) was extensively validated by Sigerfoos.

APPENDIX C

Raw Scores on K.G.I.S. and P.M.A.S.

GRADE 8 - RAW SCORES

Student Number	Male	Female	P.M.A.S. Science	P.M.A.S. Math.
1		X	6.0	8.7
2		X	5.5	8.9
3		X	6.2	8.3
4		X	6.0	8.7
5		X	7.7	8.7
6	X		6.3	8.1
7	X		8.5	7.9
8	X		8.1	8.5
9		X	4.7	8.5
10	X		7.7	8.3
11	X		3.1	6.0
12		X	6.5	8.5
13		X	3.1	8.3
14	X		8.5	8.9
15	X		6.5	8.5
16		X	5.8	8.5
17		X	7.7	8.5
18	X		8.1	8.5
19		X	4.7	8.1
20		X	6.0	8.3
21		X	8.1	6.0
22	X		7.7	8.3
23		X	6.0	8.1
24		X	6.5	8.5
25	X		8.1	8.5
26		X	8.3	8.5
27		X	7.9	8.7
28		X	7.7	8.3
29		X	8.1	8.5
30		X	5.7	8.7
31		X	8.1	3.6
32		X	2.6	8.7
33		X	6.2	8.5
34		X	4.3	8.5
35		X	5.5	8.7
36	X		8.5	7.7
37		X	8.1	8.5
38		X	5.5	8.9
39		X	7.9	6.0
40	X		8.3	5.1

GRADE 8 RAW SCORES

Student Number	Male	Female	P.M.A.S. Science	P.M.A.S. Math.
41	X		8.9	6.2
42		X	7.7	7.7
43	X		8.5	5.7
44	X		9.1	8.1
45		X	8.1	8.5
46	X		6.5	8.9
47	X		8.3	8.3
48	X		8.5	8.5
49		X	8.1	8.5
50		X	6.5	4.7
51		X	6.0	8.5
52		X	5.7	8.5
53	X		7.9	8.1
54	X		6.2	8.7
55	X		6.5	8.5
56		X	7.9	6.0
57	X		6.0	8.5
58	X		1.9	8.5
59	X		3.1	8.7
60		X	8.1	5.5
61	X		4.0	8.1
62	X		8.1	7.7
63	X		6.5	8.3
64	X		8.3	8.7
65	X		8.1	8.3
66		X	7.7	6.2
67		X	8.3	8.3
68		X	6.0	8.9
69		X	7.9	8.5
70	X		9.6	7.7
71	X		8.1	8.9
72		X	8.5	8.3
73	X		8.1	8.7
74		X	7.7	8.7
75	X		5.5	8.3
76	X		8.5	8.5
77		X	6.5	8.1
78		X	3.1	8.7
79	X		6.5	7.7
80		X	7.9	6.0

GRADE 8 RAW SCORES

Student Number	Male	Female	P.M.A.S. Science	P.M.A.S. Math
81	X		8.1	8.1
82		X	6.5	8.1
83	X		8.1	8.3
84		X	3.6	8.5
85	X		8.5	8.1
86		X	8.5	8.7
87	X		8.5	8.3
88	X		7.4	7.4
89	X		8.3	8.3
90		X	8.1	8.1
91	X		8.5	8.5
92	X		8.1	8.5
93		X	6.5	7.7
94		X	6.5	6.5
95		X	7.7	8.7
96		X	7.7	7.4
97	X		8.7	8.7
98	X		3.1	8.5
99		X	5.1	7.0
100		X	5.5	7.2
101		X	8.7	8.5
102		X	8.3	8.3
103		X	8.3	7.9
104		X	8.5	6.5
105	X		6.2	8.5
106	X		8.5	8.5
107	X		6.1	8.5
108		X	7.4	8.9
109		X	8.5	8.7
110	X		8.5	8.7
111		X	6.0	8.7
112	X		8.1	8.5
113	X		8.5	5.5
114	X		7.2	8.5
115		X	8.3	8.1
116	X		8.1	8.3
117	X		8.5	8.3
118	X		8.3	8.9
119	X		8.1	8.5
120		X	2.8	7.2

GRADE 8 RAW SCORES

Student Number	Male	Female	P.M.A.S. Science	Math
121	X		7.7	6.5
122	X		6.0	8.1
123		X	8.1	8.3
124		X	8.5	8.5
125	X		7.4	8.9
126	X		7.4	8.5
127	X		8.5	8.3
128	X		7.7	8.5
129		X	8.5	8.3
130		X	8.1	8.1
131	X		6.0	2.4
132		X	8.3	8.7
133	X		5.7	8.5
134		X	8.1	8.9
135		X	6.0	8.1
136		X	7.7	8.1
137		X	7.7	6.0
138		X	8.1	6.5
139		X	7.9	7.1
140	X		8.1	8.5
141		X	8.5	8.1
142		X	8.1	8.1
143	X		8.1	8.1
144	X		8.5	8.5
145	X		8.5	8.5

GRADE 9 - RAW SCORES

Student Number	Male	Female	K.G.I.S. Science	K.G.I.S. Math	P.M.A.S. Science	P.M.A.S. Math
146	X		21	33	7.1	7.7
147		X	19	33	7.7	8.1
148	X		15	22	3.6	5.1
149		X	44	22	7.1	7.7
150	X		30	30	3.6	5.5
151	X		38	25	8.5	8.5
152	X		43	18	6.0	5.7
153		X	15	34	6.5	8.3
154		X	17	17	2.4	7.7
155		X	13	17	6.0	7.7
156		X	7	19	3.1	7.9
157	X		18	16	2.6	2.8
158	X		46	40	8.3	5.5
159	X		29	25	7.9	4.7
160	X		21	19	4.7	5.7
161	X		29	34	8.3	8.7
162		X	20	28	2.6	7.9
163	X		40	16	6.0	6.0
164		X	14	21	5.5	6.5
165		X	30	30	4.7	8.1
166		X	7	27	7.9	8.1
167	X		34	31	4.7	8.9
168	X		41	24	6.0	8.3
169	X		22	39	6.0	8.5
170	X		59	41	8.9	8.1
171	X		27	32	7.4	7.6
172	X		46	24	5.7	7.4
173	X		29	33	6.5	6.5
174	X		33	15	6.5	6.5
175	X		29	40	5.5	7.9
176		X	24	34	5.5	8.7
177	X		24	39	2.2	6.5
178		X	25	26	5.5	3.1
179	X		46	25	5.7	5.7
180		X	24	23	2.2	8.9
181		X	33	32	5.5	8.9
182		X	21	28	3.3	8.1
183		X	5	24	2.6	8.1
184	X		45	24	8.1	8.5
185		X	18	19	4.7	8.3

GRADE 9 - RAW SCORES

Student Number	Male	Female	K.G.I.S. Science	K.G.I.S. Math	P.M.A.S. Science	P.M.A.S. Math
186	X		24	29	3.1	8.5
187	X		51	22	7.9	4.7
188	X		42	26	2.9	8.5
189	X		36	29	2.9	8.9
190	X		24	31	2.6	8.3
191		X	32	20	5.5	9.0
192	X		17	38	3.1	8.7
193	X		18	33	2.6	8.3
194	X		13	34	2.9	8.5
195	X		32	24	3.6	8.1
196	X		40	36	2.6	7.9
197		X	13	24	3.6	9.0
198	X		28	30	2.8	8.5
199		X	35	14	4.7	9.0
200		X	12	25	3.9	8.7
201		X	25	23	3.1	8.7
202		X	36	24	8.9	3.3
203						

GRADE 10 - RAW SCORES

Student Number	Male	Female	Science	K.G.I.S. Science	K.G.I.S. Math	P.M.A.S Science	P.M.A.S Math
204	X		00	24	35	7.1	9.1
205	X		00	27	30	8.1	8.5
206		X	00	32	27	5.5	8.5
207		X	00	11	19	2.2	8.7
208		X	00	21	41	8.1	8.9
209		X	--	11	38	2.9	8.5
210		X	00	13	24	2.2	8.5
211		X	00	14	25	2.6	8.9
212		X	--	11	20	3.1	8.2
213	X		01	25	29	5.5	7.0
214		X	01	35	22	1.6	8.1
215	X		--	28	33	2.6	8.1
216		X	00	11	19	1.6	7.5
217		X	--	13	30	3.1	8.9
218	X		01	44	22	8.5	8.3
219	X		01	36	21	7.7	8.5
220	X		01	51	25	6.9	7.7
221	X		00	30	26	8.1	7.7
222	X		01	34	36	4.3	5.5
223	X		00	46	34	8.3	8.7
224	X		01	37	38	7.0	9.6
225	X		01	--	--	5.5	6.5
226	X		00	38	28	7.7	8.5
227	X		01	20	27	7.7	8.3
228	X		01	20	23	6.5	8.9
229	X		00	35	43	8.5	8.9
230		X	00	19	27	2.9	8.5
231		X	01	21	19	9.2	8.3
232		X	--	42	34	5.5	8.3
233		X	--	12	27	6.0	8.9
234		X	00	14	35	6.0	8.5
235		X	00	46	23	8.5	8.3
236		X	00	33	37	6.5	6.0
237	X		01	37	32	7.5	4.3
238	X		01	20	32	6.9	7.7
239		X	00	19	29	6.0	8.7
240	X		00	53	35	8.7	8.5

GRADE 10 - RAW SCORES

Student Number	Male	Female	Science	K.G.I.S. Science	K.G.I.S. Math	P.M.A.S. Science	P.M.A.S. Math
241		X	00	33	27	7.7	8.7
242	X		01	27	31	8.3	3.1
243		X	01	19	21	8.3	8.9
244	X		01	24	35	8.1	8.5
245	X		01	40	27	8.5	8.1
246	X		01	40	31	7.9	8.1
247	X		00	31	35	6.0	8.3
248		X	00	21	45	5.5	8.3
249	X		01	26	25	5.5	6.0
250	X		00	41	27	5.5	5.5
251		X	00	20	39	8.9	8.1
252	X		00	37	30	7.7	6.5
253		X	--	17	28	4.7	8.9
254		X	01	25	36	4.7	9.0
255		X	00	40	17	6.5	8.9
256	X		01	26	30	4.7	8.9
257		X	00	37	17	8.7	3.1
258		X	00	42	30	8.3	7.4
259	X		01	33	28	3.9	8.2
260	X		01	31	42	4.1	8.7
261		X	01	36	22	6.0	8.1
262		X	00	29	36	6.2	8.9
263	X		00	43	33	2.6	8.5
264	X		01	17	39	3.1	8.7
265		X	01	48	38	8.1	5.5

GRADE 11 - RAW SCORES

Student Number	Male	Female	Sci.	Biol.	Phys. Sci.	K.G.I.S. Sci.	K.G.I.S. Math	P.M.A.S. Sci.	P.M.A.S. Math
266	X		01			29	15	4	7
267	X		00			51	29	8.9	5.7
268	X		00			50	36	8.9	6.0
269	X		01	01		45	18	5.7	5.7
270		X				32	37	5.7	9.0
271	X		01	01		40	29	5.5	8.1
272	X		01			28	35	2.7	8.9
273	X					26	26	5.1	6.5
274	X		01	01	01	22	34	7.7	8.5
275		X				6	21	5.8	9.2
276	X		01	01		36	36	6.0	8.7
277		X	00			16	15	5.1	4.0
278		X	00			29	50	8.1	8.9
279		X	01		01			6.2	8.3
280	X		01	01		36	28	2.6	8.7
281	X		01	01		22	23	2.6	2.4
282	X		01	01	01	35	21	6.0	8.7
283	X		00	01	01	35	26	8.9	8.9
284	X		01	01	01	56	20	8.3	3.3
285		X	00			35	45	6.0	8.5
286	X		01	01	01	33	38	2.2	8.9
287	X		00	01		35	27	8.1	8.3
288		X	01			5	38	7.7	8.1
289		X	01		01	25	29	2.8	8.5
290	X		00			29	43	5.5	9.0
291	X		01		01	23	28	5.5	8.9
292		X	00	01		29	12	8.1	3.1
293		X	00			37	34	8.1	8.1
294	X		00			25	34	7.4	8.7
295	X		01	01		30	29	6.5	7.7
296	X		01	01	01	45	37	8.5	8.7
297	X		01	01		34	26	8.1	8.5
298	X		00			29	22	3.1	8.3
299	X		00			26	23	7.7	3.1
300		X	00	01		38	42	8.1	8.7
301	X		01	01		33	23	8.3	8.3
302	X		00	01		40	27	6.0	8.9
303		X	00			32	18	8.5	8.7
304		X	00			25	23	8.5	8.5
305	X		01		01	30	27	6 0	8.7

GRADE 11 - RAW SCORES

Student Number	Male	Female	Sci.	Biol.	Phys. Sci.	K.G.I.S. Sci.	K.G.I.S. Math.	P.M.A.S. Sci.	P.M.A.S. Math.
306	X		01		01	30	27	8.9	5
307	X		01	01		30	30	3.1	7.9
308	X		01			6	37	5.1	9.2
309		X	01			28	31	2.8	8.5
310	X		00			27	34	7.7	8.1
311		X	00		01	18	28	8.5	4.7
312		X	01			20	32	8.1	5.7
313	X		00		01	30	32	6.2	8.5
314		X	00			27	30	6.0	6.5
315	X		01	01	01	22	25	8.5	5.5
316		X	00			19	12	5.7	8.9
317		X			01	27	28	7.1	8.5
318		X	01			27	33	5.7	8.9
319	X		00			39	23	8.5	4.7
320	X		00	01		24	30	4.7	8.7
321	X		01	01		40	26	7.9	3.6
322	X		00			44	35	5.7	8.5
323		X	00			8	34	2.8	8.5
324	X		00	01		39	23	8.1	5.1
325	X		00			36	36	3.3	8.1
326		X	01			21	28	3.6	9.0
327	X		00					8.1	3.6
328	X		01	01		38	29	8.5	5.5
329	X		00	01		43	16	8.5	5.5
330	X		01	01		22	30	3.3	8.1
331	X		01	01		26	36	8.7	3.1
332		X	01					3.6	8.5
333	X		01	01		25	34	2.9	8.1

GRADE 12 - RAW SCORES

Student Number	Male	Female	Biol.	Phys. Sci.	K.G.I.S. Sci.	K.G.I.S. Math.	P.M.A.S. Sci.	P.M.A.S. Math.
334	X		01		36	24		
335	X		01	01				
336	X		01	01	26	37		
337	X		01	01	26	37		
338		X	01	01	40	24		
339		X	01		32	26		
340		X	01		20	36		
341	X		01	01	24	24		
342		X	01		17	30		
343	X		01	01	24	16		
344		X	01		26	17		
345		X	01		30	18		
346	X		01	01	47	35		
347	X		01		43	13	8.3	3.1
348	X		01	01	33	24	3.1	8.1
349	X		01	01	13	26	7.7	3.6
350	X			01	16	34	2.6	8.2
351	X		01	01	39	23	7.1	5.5
352	X		01	01	36	36	6.5	6.0
353	X		01	01	46	29	7.7	4.7
354		X	01	01	35	10	8.9	3.3
355	X		01	01	47	25	4.1	8.7
356	X		01		31	43	2.9	8.5