1954

Mathematics in the Billings High School Billings Montana

Richard Dale Fox
The University of Montana

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MATHEMATICS
IN THE BILLINGS HIGH SCHOOL,
BILLINGS, MONTANA

by

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B. A., Montana State University, 1949

Presented in partial fulfillment
of the requirements for the degree of
Master of Education

MONTANA STATE UNIVERSITY
1954

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James E. Short
Chairman, Board of Examiners

Don B. Rehk
Dean, Graduate School

July 19, 1954

Date
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CHAPTER I

THE PROBLEM

Statement of the problem. Mathematics is a vital part of the curriculum of the secondary school. The present trend is a curriculum adapted to the needs of the community and its students. Assuming that any phase of the secondary curriculum should meet the needs of the community and its students, the problem is, therefore, to determine the degree to which the Billings High School mathematics curriculum is meeting such needs. The problem is also to determine whether or not the mathematics curriculum conforms to mathematics objectives in the high school as outlined by authorities in the field of mathematics education and by the teachers and administrators of Billings High School.

Purpose of the study. In general, the purpose of this study was to evaluate the mathematics program in Billings Senior High School in terms of (1) the specific needs of the community of Billings, and (2) the recommendations of authorities. More specifically this study has been conducted for the following purposes:

1. To determine what mathematics is being taught in Billings High School.
2. To determine the attitudes of the mathematics teachers and administrators in regard to these offerings.
3. To determine what standards have been set up in the field of mathematics education concerning the mathematics training needs of Billings High School.

4. To evaluate the mathematics program of Billings High School in terms of the findings enumerated above.

Setting of the problem. A short study was made of Billings, Montana, in order to describe Billings in terms of principal occupations and social groups.

The Chamber of Commerce of Billings listed the population for the city as follows:¹

Population 1953

<table>
<thead>
<tr>
<th>Category</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Billings</td>
<td>37,900</td>
</tr>
<tr>
<td>Greater Billings</td>
<td>51,249</td>
</tr>
<tr>
<td>Public School Enrollment</td>
<td>8,102</td>
</tr>
<tr>
<td>Parochial School Enrollment</td>
<td>1,520</td>
</tr>
</tbody>
</table>

Billings, Montana, is the County seat of Yellowstone County and the commercial and industrial center of eastern Montana and Northern Wyoming. The economy of Billings is based on its Agriculture, Wholesale Trade, the Oil Business, Industry, and Transportation. Agriculture based on the

¹Billings Chamber of Commerce, "Interesting Facts about Billings." (Billings: 1953) p. 3.
livestock industry is the foundation for the economy of Billings. A substantial live-stock and by-products marketing and slaughtering industry flourishes in Billings. The sale and distribution of commodities to the adjacent agricultural area is next in importance to agriculture in the economy of Billings.

There have been substantial increases in population and in the cost of living in Billings in the past few years. These changes have been credited to the oil business. Billings has become the principal refining center of the Northwest, processing a steady flow of crude oil from the Elk basin fields in Southern Montana and Northern Wyoming. The city is the administrative center for the oil producers in the Williston Basin Fields. More than 150 oil companies dealing in various phases of production, leasing royalties and services, maintain offices in Billings. The oil industry employs 2,300 people in Billings. A pipeline for the transportation of oil products from Billings to Spokane is being built in 1954. Completion of the development of the Williston Basin oil potential will take an estimated twenty years.

Increased population and a stable purchasing power since the war has resulted in the expansion of industry at Billings. Complete development of the Yellowstone River land and water resources will add some 457,000 acres of
farm land for irrigation in the area and provide future markets for industries. A recent survey shows 106 manufacturing establishments at Billings.²

Sixteen elementary schools and the Billings High School constitute the public school system. There are three parochial grade schools and a high school. Eastern Montana College of Education (which is a unit of the University of Montana), Rocky Mountain College, and Billings Business College are the institutions of higher learning in the city. In the 14-17 year group, 90.4 per cent are attending school at the present time. The median school years completed for persons 25 years of age and over is 12.1 years.

The population of Billings is made up of 1.2 per cent non-whites. In the age group of 14 years and over 82.4 per cent of the male population and 23 per cent of the female make up the labor force. Of people able to work, 5.7 per cent are unemployed at the present time. Of this labor force, 28.6 per cent have an income of over $10,000. The median income of the working people of Billings is $3,212.³

²Ibid., p. 7.

This is the community that supports Billings High School. Billings Senior High School is a three-year school consisting of grades 10, 11, and 12. The total number of students making up these three grades is 1,400. The education of these students is handled by a staff of 51 teachers.

In past years, about 130 students have dropped out before the end of the school term. These dropouts were distributed quite evenly as far as the three grades were concerned, with a few less seniors dropping as compared with the juniors and sophomores. Of the graduating seniors, 20 per cent go on to college while the other 80 per cent take their places in the community, enter the Armed Services, or seek their fortunes elsewhere.
Aims and objectives of secondary school mathematics.

In general, the mathematics program of the first eight years of school contains the knowledge which is essential to everyday living of practically every citizen. It is a common core of knowledge adapted to the sameness of our society. Arithmetic skills and arithmetic reasoning are developed, improved, and extended. Arithmetic is applied to the problems of the home, business, insurance, savings, investments and of the shop. Practical geometry is taught as applied in measurement, design, scale drawings, and elementary surveying. The formula, the simple equation, and the graph are taught as they are found in the public press. The entire emphasis is on applications and use in life, not on mathematics for its own sake.

In the ninth and tenth years, to a large extent, the program is a continuation of education for sameness and at the same time a continuation of education for individual differences.

In the tenth year the work in plane geometry continues the core knowledge by offering methods of thinking. Methods of proof, types of reasoning, and derived facts for everyday social behavior should be a large part of the course.
The eleventh and twelfth years provide a mathematics education designed for one reason, to provide a background for college mathematics.

The purpose for the study of mathematics is the same as in other high school courses. All have one common objective, enable students to live effectively in our democratic society.

James H. Zant\(^1\) believes that the chief aim for mathematics in general education is teaching the students the meaning and use of critical thinking. This should not only be done in mathematical situations but also in enough life situations so that they will understand clearly the use of this knowledge and skill in many fields.

The general objectives of secondary mathematics given by the Joint Commission of the Mathematical Association of America and the National Council of Teachers of Mathematics\(^2\) are:

1. Abilities to think clearly
   a. Gathering and organizing data
   b. Representing data
   c. Drawing conclusions
   d. Establishing and judging claims of proof

\(^1\)James H. Zant, "Critical Thinking as an Aim in Mathematics Courses for General Education" *The Mathematics Teacher*, 249-256, April, 1952.

2. Ability to use information, concepts, and general principles
3. Abilities to use fundamental skills
4. Desirable attitudes
   a. Respect for knowledge
   b. Respect for good workmanship
   c. Respect for understanding
   d. Social mindedness
5. Interest and appreciation (Under this heading special attention is directed to the schools obligation to arouse and cultivate new interests as well as to foster and develop those desirable ones which the students have already acquired.)

The National Committee on Mathematical Requirements, after giving mental discipline as a function of mathematics, listed as having more importance a practical aim of the utility of the processes of arithmetic in the life of every individual. Of almost equal importance to every educated person is an understanding of the language of algebra and the ability to use this language intelligently and readily in the expression of such simple quantitative relations as occur in everyday life. Included also were the aims of giving enough algebra, fundamental laws and drill, to enable the student to understand the processes of arithmetic, to interpret graphical material and to be familiar with the geometric forms in nature, life and industry.

The Course of Study for Montana summarizes the

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general aims of mathematics as follows:

1. To develop in the students such habits and abilities of a mathematical nature as will be of value to him in ordinary life pursuits.
2. To provide the student with a knowledge of the fundamental principles of mathematics which will help him to a better understanding of our modern industrial life.
3. To give a student an introductory knowledge of the principal branches of mathematics which will serve as a basis for advanced study.
4. To develop an appreciation of the value and beauty of mathematics and the part it has played in developing our modern civilization.
5. To stimulate and make habitual, thinking which is careful, accurate, and independent.

Factors in curriculum building. A portrayal of the course sequences in secondary school mathematics with the purposes they should serve, is found in the 1940 report of the Joint Committee. The report was titled "The Place of Mathematics in Secondary Education." This commission was set up under the joint auspices of the Mathematical Association of America and the National Council of Teachers of Mathematics to define the place of Mathematics in the modern educational program and to organize a mathematics curriculum for grades 7 to 14 which provides continuity and development.

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4State Department of Public Instruction, A Course of Study For the Secondary Schools of Montana, (Helena: 1932) p. 176.

The college pre-technical sequence, grades nine through twelve, is the widely accepted sequence: algebra, geometry, higher algebra, trigonometry, and solid geometry. These are oriented to needs in engineering and other scientific curricula. This sequence has received primary attention in curriculum studies since the report, in 1893, of the Committee of Ten (Committee on Secondary School Studies).

The prestige of these national committees and the carefulness with which they carried through their studies and made their reports, have led to a wide acceptance of their findings. The fact that the findings were largely directed toward the articulation of high school and college has given prestige to the college preparatory sequence with which they were chiefly concerned. Perhaps it is largely for this reason that in the high school of today the technical college preparatory sequence is thought of as the normal sequence for pupils studying mathematics. The burden of proof is on the school when it comes to guiding a pupil into any other mathematical sequence even though only a minority of high school pupils have any intention of going on to college.

Mathematics for the student who is not going to college now holds a recognized place in all curriculum reports. While there is no precise agreement as to
appropriate content or procedures since these must await upon experimental verification, the purposes are recognized to be those that will provide the citizen with mathematical competences needed for personal and social efficiency in meeting the problems of life.

Recent literature tends to an increasing agreement with the report of the Joint Commission in stressing emphasis on each of two purposes: the mathematical and the social.

The 1940 report of the Committee on the Function of Mathematics in General Education announced its basic position on organizing the curriculum in these words:

A mathematics curriculum may be built by locating and studying concrete problem situations which arise in meeting needs in the basic aspects of living. The major concepts here emphasized play a fundamental role in the analysis of these problems. These concepts help to clarify the methods of attack as they recur systematically in diverse problems. This recurrence, in itself, provides for the development of a sense of unity in mathematics as a method of dealing with problems. But in addition, these major concepts serve to unify sub-concepts and related abilities customarily classified in separate subject-fields, such as algebra and geometry. These sub-concepts, encountered first in concrete situations, should eventually be abstracted and generalized, and in similar fashion, the major concepts should eventually serve to throw light on the analysis of problems, arising in many different fields of thought.

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The Joint Commission of the Mathematical Association of America and the National Council of Teachers of Mathematics outlined in their 1940 yearbook two plans for the teaching of mathematics in the secondary school. The whole subject of secondary school mathematics was divided into seven fields: (1) the field of numbers and computation, (2) the field of geometric forms and of space perception, (3) the field of graphic representation, (4) the field of elementary analysis, (5) the field of logical thinking, (6) the field of relational thinking, and (7) the field of symbolic representation and thinking. These seven fields were further divided into the following categories: (1) basic concepts, principles, and terms; (2) fundamental processes; (3) fundamental relations; (4) skills and techniques; and (5) application.

The course of study for the Secondary Schools of Montana lists the following as general statements which may be of assistance in determining the place and emphasis due mathematics in the high school curriculum:

1. Every school should arrange its programs of studies so that students in any course may elect at least one year of math.

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7Joint Commission of the Mathematical Association of America, Inc., op. cit., p. 61.

8State Department of Public Instruction, op. cit., p. 177.
2. A reasonable provision for individual differences based on the needs and abilities of the students, should be made in the high school math courses.

3. One unit of elementary algebra, one unit of plane geometry, one half unit of intermediate algebra and one half unit of solid geometry constitute the necessary high school program to prepare students for everyday life and to constitute all college entrance requirements. A special demand justifies a few schools in adding other mathematics courses but any student may secure such courses after entering college.

4. An effort should be made to correlate the different courses and insure the general progress of the students with each succeeding mathematics course pursued.

Course offerings. The National Committee on Mathematical Requirements⁹ recommended that the course of study in mathematics during the seventh, eighth and ninth years contain the fundamental notions of arithmetic, of algebra, of intuitive geometry, of numerical trigonometry and at least an introduction to demonstrative geometry. The committee recommended that this body of material be required of all secondary school pupils.

In the senior high school, the committee did not wish to require additional mathematics of all pupils, but urged the teachers and principals to encourage in every way all pupils to take as much mathematics as possible.

³⁹National Committee on Mathematical Requirements, op. cit., p. 1.
The committee declared that there is no conflict between the needs of those pupils who ultimately go to college and those who do not. The following courses were recommended for the tenth, eleventh, and twelfth grades and the report listed the major topics to be developed in each course.

1. Plane demonstrative geometry
2. Algebra (including equations up to three unknowns, exponents, radicals and logarithms; geometric progressions; binomial theorem)
3. Solid geometry
4. Trigonometry
5. Elementary statistics
6. Elementary calculus
7. Mathematics of investment
8. Shop mathematics
9. Surveying and navigation
10. Descriptive or projective geometry

In spite of a decline in emphasis in the secondary school upon advanced math, especially upon algebra and geometry, a few new courses have been added to this area. General or practical mathematics is the newcomer which has swept the field: these general courses take the place of the year which was devoted to advanced arithmetic and the introduction to elementary algebra. In addition, senior math or advanced general mathematics, socio-business arithmetic and business mathematics have been instituted for boys and girls who are about ready to graduate from

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secondary school. The trend has been toward more different courses and different types of mathematics to meet the changing needs of individuals, rather than in any fundamental change in the subject matter scope of the traditional mathematics curriculum.

To an increasing extent, high schools are providing a "double-track" in mathematics. The high school student may choose either (1) the traditional college preparatory courses, or (2) a series of general mathematics courses.

The traditional college preparatory courses usually begin with elementary algebra (9th grade) followed by plane geometry and further algebra. Large high schools also provide additional courses that may include trigonometry, solid geometry, college algebra, analytic geometry, and surveying. Of course, small schools cannot provide this many courses. However, more and more schools are using correspondence courses to supplement offerings.

The courses on the "other track" include such electives as (a) general mathematics—now widely offered as an alternative to algebra in the ninth grade, (b) shop mathematics, and (c) for the later years of the senior high school, consumer mathematics and possibly statistics.

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Students in commercial courses may elect business arithmetic sometimes as early as the ninth grade.

Paul R. Mort suggests all juniors in the modern high school be required to take an arithmetic achievement test. Those failing to achieve the eighth grade norm should be required to schedule an arithmetic service course during the senior year. This course would carry no high school credit, and would be only a refresher course. A pupil may drop it at any time that he satisfactorily passes an arithmetic achievement test. Different tests should be used each time. (There is a wide selection on the market.) The purpose of this practice is to make as certain as possible that graduates of the high school can do simple arithmetic. Frequent criticisms to the contrary were formerly heard. Yet, the way the school curriculum is designed for some students, the last look they get at arithmetic is in the ninth grade and they have three long years in which to forget before graduation.

C. C. MacDuffie recommends a course in which advanced algebra and the rudiments of analytic geometry

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are integrated, and which contains a few of the essential ideas of the calculus in the second semester. This course has been offered and is being offered in many schools of the nation. This course would very definitely help the college freshman in analytic geometry.

A number of conclusions may be drawn from the foregoing pages concerning literature on the mathematics curriculum in the secondary school. The curriculum in the secondary school should:

1. Be adjusted to the needs of the students.
2. Provide mathematics subjects for all students regardless of future aims.
3. Make provision for individual differences based on abilities of the students.
4. Make an effort to correlate the different courses and insure the general progress of the students with each succeeding mathematics course pursued.

Evaluation of instruction in secondary mathematics.

The need today in secondary mathematics is for more realistic and specific recognition of not only the fact that mathematics is essential but also of what mathematics is essential where.14

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Administrators owe it to the students and the nation to provide time for and competent instruction in high school mathematics. The administrators, advisors, and mathematics teachers have a responsibility to criticize, reorganize, improve and investigate the content, materials, and methods in mathematics instruction.

According to Douglass, the criteria upon which the selection of curriculum materials and experiences proceed will be conditioned by one's concepts of the role of the school in modern society. For example, increasing emphasis is being given to the need of education youth for intelligent participation in democratic life. The nature of the content selected will be affected materially by the nature of the general objectives which are determined for education, as well as those defined for a specific subject or unit of work. The major purpose of content is to provide effective means for the attainment of educational goals.

The teacher himself is still the biggest interest creator of mathematics. He needs to be well-groomed far beyond the level of the students and must himself believe in the value of mathematics. Hassler and Smith list

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the following as what a good mathematics teacher should do for his pupils.

1. Make sure that fundamental processes are clearly understood and not applied as by "rule of thumb".
2. Develop a certain degree of mechanical efficiency in the processes used most. It is secured only through the solution of many exercises.
3. Relate the subject matter in every way possible to practical applications.
4. Aim to develop independent thinkers with initiative and resourcefulness, whose ideals are precision of thought, clearness and accuracy of statement, and efficiency in deeds.

The aims and purposes of the teaching of mathematics must be sought in the nature of the subject. The role it plays in the practical, intellectual and spiritual life in the world and in the interests and capacities of the students. The primary purposes of the teaching of mathematics should be: (1) to develop those powers of understanding and analyzing relations of quantity and of space which are necessary to an insight into a control over the environment, (2) to develop an appreciation of the progress of civilization in its various aspects, and (3) to develop those habits of thought, and of action which will make those powers effective in the life of the individual.

Ability grouping, honor courses, supervised study, differential curriculums, and assignments and individual instruction have been most prominent among provisions
for taking care of both the gifted and the slow pupil.\textsuperscript{17}

If the mathematics instruction really works toward the following objectives, then the instruction the students receive under the mathematics teacher is well worth while.

1. To develop ability to think clearly.
2. To develop fundamental skills, knowledge and concepts.
3. To develop desirable attitudes.
4. To develop interests and appreciations in the humanities, arts and sciences that make for cultural growth and richness of living.

CHAPTER III

METHODS OF OBTAINING INFORMATION

Questionnaires for the seniors. One hundred graduating seniors were questioned through a written answer form (see appendix) to determine their attitudes on the mathematics they had studied. Thirty-nine of these seniors were enrolled in the advanced mathematics classes this year. Eleven of these seniors were enrolled in either the first or second year of high school mathematics. The other fifty seniors questioned were seniors who had received one or two years of high school mathematics, but who were not at present enrolled in a mathematics class. This form was used to determine what these seniors planned on doing after graduation and how they figured they would use the mathematics they had studied. This form was also used to determine the attitudes of these students on present mathematics in Billings High School.

The six mathematics teachers were given enough forms for the seniors in their mathematics classes. These teachers made an assignment of the filling out of these forms and allowed class time for the writing. All of the forms were returned with practically all the questions answered. These teachers were then asked to study the forms filled out in their classes. This was done to give the teachers some idea about the attitudes of their
students toward the courses they were taking.

In order to get the other fifty forms answered, teachers of senior classes were supplied with forms and asked to give them to seniors, in their classes, who had one or two years of high school mathematics. This was continued until fifty forms were returned.

Questionnaires for the mathematics teachers and administrators. Although most of the information gathered from the mathematics teachers and administrators was obtained through interviews, a good bit of this basic information could be gathered through the use of a few short questions. A written form (see appendix) was prepared and presented to each of the six mathematics teachers. The following background information was gathered concerning the teacher himself:

1. Years experience teaching mathematics.
2. The different mathematics courses handled in this time.
3. Years experience teaching mathematics in Billings High School.
4. The different courses the teacher has handled in Billings High School.

This form was also used to obtain information concerning the present position of each of these six teachers. The following information was gathered:
1. The mathematics courses each teacher is handling the current year.
2. Number of boys and girls in each class.
3. Grade standing of the students in these courses.
4. Textbook used for each course and teacher's comment on the book.
5. A listing of the extra textbooks and workbooks used, and the teacher's comment on these aids.

A paper containing just one question was prepared and handed each teacher. The question was worded as follows: Will you write a little of your personal attitude on the worth of the courses you are teaching? If a student spoke up in one of your classes and asked, "What good is this stuff ever going to do me?" how would you answer in each of the courses you are teaching?

A form (see appendix) was prepared and presented to the office of the principal. This was used to gain information on such items as the following:

1. Total enrollment in Billings High School
2. Enrollment by grade (Sophomore, Junior, Senior)
3. Total number of teachers in the school and number of teachers having one or more courses in mathematics.
4. Number of dropouts per grade during current year.
5. Mathematics classes, teacher, and enrollment in each.
Interviews with the mathematics teachers. Each of the six mathematics teachers was asked to comment on fifteen questions. These questions were typed on 4 x 6 inch cards, one question to a card. This questioning and the writing of the answers extended over a period of four weeks.

When the card file of the questions and answers was completed, a tabulation of the answers was made. The answers to each question were typed on a separate sheet of paper. On this paper then, a summation of the teachers' attitudes was written out. Tables were then constructed after the tabulations were completed.

Interviews with the administrators. The three administrators were also interviewed. These three people were asked to comment on ten questions in order to obtain their attitudes on the present mathematics program. The questioning and tabulation of this information were handled in the same way as that of the mathematics teachers.

Additional information obtained in the interviews was in most cases tabulated in the same manner as the information recorded in the card file.
CHAPTER IV

RESULTS OF QUESTIONNAIRES AND INTERVIEWS

Results of questionnaires for the administrators.

TABLE I shows a breakdown of the enrollment in Billings High School for the current year.

TABLE I

ENROLLMENT AND DROPOUTS IN BILLINGS HIGH SCHOOL 1953-54

<table>
<thead>
<tr>
<th></th>
<th>Sophomores</th>
<th>Juniors</th>
<th>Seniors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>231</td>
<td>217</td>
<td>174</td>
</tr>
<tr>
<td>Girls</td>
<td>276</td>
<td>240</td>
<td>186</td>
</tr>
<tr>
<td>Dropouts</td>
<td>50</td>
<td>53</td>
<td>27</td>
</tr>
</tbody>
</table>

There are at present 51 teachers working in the high school. Of these 51 teachers, six have one or more classes in mathematics.

The student taking a course in mathematics has no choice as to his teacher. There is no set system of placing students with the different teachers. The placement is instead determined by the schedule of the student. This scheduling takes place in the offices of the Dean of boys and the Dean of girls.

TABLE II shows the daily schedule of the mathematics teachers and the periods available to the student for his mathematics courses. In the table the teachers are designated by letters from A to F. Letter F is the advanced
### TABLE II

**DAILY SCHEDULE OF THE SIX BILLINGS HIGH SCHOOL MATHEMATICS TEACHERS**

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Period</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Audio-</td>
<td>Plane</td>
<td>Audio-</td>
<td>Plane</td>
<td>Plane</td>
<td>Plane</td>
<td>Elem.</td>
</tr>
<tr>
<td>B</td>
<td>Plane</td>
<td>Geol.</td>
<td>Geol.</td>
<td>Study</td>
<td>Hall</td>
<td>Geol.</td>
<td>Geol.</td>
</tr>
<tr>
<td>C</td>
<td>Elem.</td>
<td>Driver</td>
<td>Civics</td>
<td>Hall</td>
<td>Duty</td>
<td>Elem.</td>
<td>Civics</td>
</tr>
<tr>
<td></td>
<td>Alg.</td>
<td>Train</td>
<td></td>
<td></td>
<td></td>
<td>Alg.</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Elem.</td>
<td>Study</td>
<td>Elem.</td>
<td>Study</td>
<td>Plane</td>
<td>Plane</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Plane</td>
<td>Plane</td>
<td>Plane</td>
<td>Plane</td>
<td>Driver</td>
<td>Driver</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Inter.</td>
<td>College</td>
<td>College</td>
<td>Study</td>
<td>Inter.</td>
<td>Inter.</td>
<td></td>
</tr>
<tr>
<td>2nd</td>
<td>Solid</td>
<td>Plane</td>
<td>Plane</td>
<td>Study</td>
<td>Solid</td>
<td>Solid</td>
<td></td>
</tr>
</tbody>
</table>

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mathematics teacher; A to E are the algebra and geometry teachers.

In the office of the principal, figures were available to show the number of sections in the different mathematics courses and the enrollment in each. (TABLE III).

Results of questionnaires for the mathematics teachers. The opinions of mathematics teachers may be influenced by their experience and by the mathematics courses they are teaching and have taught in the past. TABLE IV shows the years of experience of the six mathematics teachers.

The following is a list of the textbooks used in the mathematics classes in Billings High School:


### TABLE III

**THE NUMBER OF SECTIONS AND THE AVERAGE ENROLLMENT PER SECTION OF EACH OF THE MATHEMATICS COURSES IN BILLINGS HIGH SCHOOL**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Number of Sections</th>
<th>Average Enrollment Per Section</th>
<th>Total Subject Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary Algebra</td>
<td>5</td>
<td>27</td>
<td>135</td>
</tr>
<tr>
<td>Plane Geometry</td>
<td>10</td>
<td>26</td>
<td>260</td>
</tr>
<tr>
<td>Intermediate Algebra</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>Solid Geometry</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>College Algebra</td>
<td>2</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>Plane Trigonometry</td>
<td>2</td>
<td>15</td>
<td>30</td>
</tr>
</tbody>
</table>

### TABLE IV

**YEARS TEACHING EXPERIENCE OF THE SIX BILLINGS HIGH SCHOOL MATHEMATICS TEACHERS**

<table>
<thead>
<tr>
<th>Years Experience</th>
<th>Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
</tr>
<tr>
<td>Billings</td>
<td>2</td>
</tr>
</tbody>
</table>

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The elementary algebra teachers, the past two years have used the textbook by Walter W. Hart. This year two of the three teachers have changed to the textbook by Welchons and Krickenberger. The elementary algebra teachers were asked to comment on the book they were using:

Hart, Walter W. *A First Course in Algebra.*

Comment: This is a fair algebra textbook. However, there are not enough exercises. A good book for the poorer student but it has no problems or exercises to tax the better student.


Comment: A very good textbook. It contains a good many problems and exercises well explained. It also contains very well thought out reviews and chapter tests. It has enough problems to keep the better student interested.

By the next school term all three of the algebra teachers will be using the text by Welchons and Krickenberger. The comments given on the two textbooks seem to favor the Welchons, Krickenberger book over the one by Hart.

The four plane geometry teachers all use the same textbook. For the past five years the Billings geometry teachers have used the textbook by Seymour and Smith. These teachers were asked to comment on the book.

Comment: A sound text. Not the best but very adequate. It has a lot of good problems that require the knowledge given by the propositions, axioms and postulates.

A change in geometry textbooks will probably be
made for the next school term. Two of the four teachers believe they will use a later edition of the text by Seymour and Smith. The other two prefer the plane geometry textbook by Welchons and Krickenberger.

The advanced mathematics teacher uses a different textbook for each of the advanced courses which are: intermediate algebra, solid geometry, college algebra, and plane trigonometry. A listing of these books in the order given and the teacher’s comment on each follow:

Edgerton and Carpenter Complete Algebra.

Comment: Probably not the best and certainly not one of the latest intermediate algebra textbooks. This book is very adequate, however, when used with a few aids.

Welchons and Krickenberger Solid Geometry.

Comment: An excellent book, the best I have ever used. Very complete in itself; a teacher needs no other aids with this book.

Hart, Walter W. College Algebra.

Comment: A good text as for problems and exercises. These examples are well graded—easy to difficult. A very adequate text for a small class.

Hart, Walter W. Plane Trigonometry.

Comment: An old book but still a very good trigonometry textbook. It is very concise and to the point, possibly too brief for high school use.

Practically all mathematics teachers use some other books or workbooks as aids to their instruction. The Billings teachers were asked to list some of their better aids. The following books and workbooks are those listed,
starting from elementary algebra and continuing through trigonometry.


The mathematics teachers have classrooms adjoining. When one teacher finds a topic or an aid that he thinks is very good he will pass it on to his associates. Methods of instruction on different topics and test ideas are interchanged. Interclass competition among the students
sometimes develops over some of the harder problems that come up during class work.

The elementary algebra teachers believe the best ways to justify their course to the students are to stress its value as an arithmetic review, and to stress the fact that it is a foundation for higher mathematics. One of these teachers believes that the less said to the average student about algebra's practical economic value to him the better. The better student can see the value for future courses and for future college work.

The plane geometry teachers, it seems, had a much harder time justifying the course to the inquiring student. These teachers stress the idea that everything that is done in life is connected with various phases of mathematics. Building a house, a fence, a garage, and most any other form of building requires some knowledge of geometry. It is not too hard to point out examples: carpenter work, plumbing, architecture, and engineering all involve the use of some form of geometry. Every object has some geometric shape. Many farm and city problems hinge on geometry. These teachers also agree that geometry has values in the methods of proof, types of reasoning, and derived facts to everyday social behavior.

The advanced mathematics teacher answered the question this way:
The course in intermediate algebra and solid geometry is taught as a basic college preparatory course. Most colleges require those as a minimum entrance requirement in the fields of science and engineering.

The courses in college algebra and plane trigonometry are taught for seniors with a rather high level of achievement required. The course furnishes an excellent background for the student going into technical studies. I have never believed that it was necessary to justify or defend the subjects I am teaching. However, as we go along, there are numerous opportunities to point out the value of the course.

Results of questionnaires to seniors. The seniors enrolled in the mathematics classes were questioned to get their attitudes on the mathematics being taught in Billings High School. Of the seniors in Billings High School this year, 44 boys and six girls were registered in the mathematics classes.

Practically all of these seniors indicated that they intended to go to college. Forty-six of these 50 students questioned had picked out their college and the course they were going to pursue. TABLE VII shows the courses mentioned and the number of seniors who indicated each course.

Engineering was the first choice of the greater number of these students, while business administration was second. Most of the boys mentioned the possibility of being called into the service either before or during their college careers.

The four students who indicated no interest in college, named the following as their future plans:
TABLE VI
NUMBER OF SENIORS ENROLLED IN MATHEMATICS
CLASSES IN BILLINGS HIGH SCHOOL

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>4</td>
<td>3</td>
<td>12</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE VII
COLLEGE COURSES PLANNED BY THE SENIORS STUDYING
MATHEMATICS IN BILLINGS HIGH SCHOOL

<table>
<thead>
<tr>
<th>Course</th>
<th>No. Indicating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
<td>16</td>
</tr>
<tr>
<td>Education</td>
<td>3</td>
</tr>
<tr>
<td>Business Administration</td>
<td>9</td>
</tr>
<tr>
<td>Theology</td>
<td>2</td>
</tr>
<tr>
<td>Pre-Dental</td>
<td>1</td>
</tr>
<tr>
<td>Mathematics and Physics</td>
<td>2</td>
</tr>
<tr>
<td>Political Science</td>
<td>2</td>
</tr>
<tr>
<td>Sociology</td>
<td>1</td>
</tr>
<tr>
<td>Chemistry</td>
<td>2</td>
</tr>
<tr>
<td>Forestry</td>
<td>1</td>
</tr>
<tr>
<td>Law</td>
<td>1</td>
</tr>
<tr>
<td>Pre-Medical</td>
<td>1</td>
</tr>
<tr>
<td>Geology</td>
<td>1</td>
</tr>
<tr>
<td>Undecided</td>
<td>4</td>
</tr>
</tbody>
</table>
(1) work in a department store, (2) join the service, (3) work as a carpenter, and (4) work in an auto supply house.

The seniors who have taken only one or two years of high school mathematics couldn't see much value in their mathematics courses. The reasoning seemed to be that they wouldn't be able to use the mathematics because they hadn't had enough.

The seniors in the advanced courses could see a great deal of future value in these courses. The values these seniors placed on the mathematics they had studied were: everyday use, use in technical fields, use in navigation, reasoning processes, a background for college mathematics, problem solving, engineering, acquisition of useful formulas, use in business, use in communications, value in the field of geology, surveying, understanding of size, shape, and mass, study of science, understanding figures, review of arithmetic and mental discipline.

These seniors were asked how they figured present mathematics courses could be improved to be of more value to the student. Some of the changes recommended by these students were: to spend more time on word problems, to have more instruction on the slide rule, to use more practical applications, to have a longer time for half-year courses, fewer textbooks, more work on the understanding of processes, required homework, an increased amount of
work on logarithms, less review in required courses, a greater number of thought problems and cover more material in the advanced courses.

These students indicated that there were some mathematics topics they would like to have had instruction in. The seniors in the elementary courses did not have much to contribute along this line. The more advanced students did, however, have some well-thought-out suggestions:

1. A review of some sort for girls going into nursing.
2. Some preliminary slide rule work in the elementary courses.
3. Practical introduction to surveying.
4. A course in practical mathematics.
5. Mathematics applied to science such as chemistry mathematics or physics mathematics.
6. Mathematics of the farm.
7. Mathematics of the home.
8. Instruction in the mathematics of navigation.
11. The mathematics of astronomy.
12. Statistics (Interpretation of graphs and tables)

These students had a number of suggestions on how teachers could make mathematics courses more interesting and more beneficial. Some of these suggestions were: extra credit work, interclass and intraclass contests, more individual attention, stress on the value of the mathematics courses, more board work, use of visual aids, extensive use of practical applications and illustrations, less formality in instruction, problems for practice in reasoning, use of models and diagrams and more detailed explanation.
These students were asked what advice they would give to a student just entering high school as to his future study of mathematics. They agreed that every student should try elementary algebra. If the student then finds out that he is poor in mathematics, he should leave the rest alone. If the pupil thinks he can possibly make it through he should have the first two courses of elementary algebra and plane geometry.

The taking of advanced courses would depend on the student's ability, his interests and his future plans. The student, if interested, should start right away to get all the mathematics courses the school offers.

As a final item on the questionnaire these seniors were asked to list their pet gripes. This would allow for a good deal of repetition of comments already covered. Here, for what they are worth, are the "gripes": not enough time on hard items, too much time spent on unimportant items, slow, uninterested pupils are holding back the students really interested in their courses, problems assigned to be worked without explanation, too much time spent on proofs in the geometry courses, not enough practical applications, not enough explanation on uses and values of different mathematics topics, uselessness of some parts of courses, courses not made interesting enough, not enough review and too little attention given to individual differences in students. These students also mentioned that
they didn't have enough work on square root, graphs, the slide rule and formulas.

A study of the gripes and recommendations of the seniors studying mathematics in Billings High School can be summed up as follows:

Poor mathematics students should be discouraged from going beyond one year of high school mathematics. There should be some provision made to handle individual differences in the mathematics courses. Both the slow and better students are suffering because all the students are taught at the same rate.

The value of mathematics should be constantly stressed. Some courses should be introduced into the curriculum for the non-college student. Some practical mathematics for use in everyday life would be desirable.

In the actual teaching of the courses, the use of more practical applications is strongly recommended by these seniors. These students are also concerned with making the courses more interesting. Models, diagrams, demonstrations, illustrations and visual aids would help along these lines. They would like more instruction on the slide rule, and they also see value in a good deal of work on word or thought problems.

Mathematics topics used in other high school courses should be given some attention. The mathematics of chemistry, physics, science and business would come under
this category.

Each of these students would have liked more individual attention given him during his study of mathematics.

Finally it must be said that these people questioned were quite well pleased with the courses as they found them. Most of these students, somewhere in the questionnaires, expressed their satisfaction with the high school mathematics curriculum.

The remaining 50 seniors questioned were students who had one or two years of high school mathematics but were not at present enrolled in any mathematics course. None of these students went beyond the course in plane geometry. An attempt was made to determine why these students didn't go on with their study of high school mathematics.

Only two of these fifty seniors indicated that their mathematics grades had ever been higher than average. The rest of the group indicated having received average or low grades while taking mathematics. One reason, mentioned by these people, for not taking any higher mathematics course was that they figured they wouldn't receive a passing grade.

About half of these students indicated they disliked mathematics. The reasons for this dislike seemed to be that: (1) mathematics was too hard for them, (2) they couldn't seem to understand the processes, (3) too
much work was required, and (4) they couldn't get a better grade. A few of these students mentioned that they liked mathematics but figured that they just didn't have the ability to go on.

Most of these students complained that the material in their mathematics courses, was covered at too fast a pace. They had the feeling that if each topic had been allotted more time they would have gained more of an understanding. They also complained of not enough individual help during class time. Another complaint was that the better students seemed to get the greatest share of the teachers attention.

Realizing the shortcomings of the present mathematics program, these people came up with some well-thought-out proposals. The idea of "ability grouping" was most frequently mentioned. The thinking was in terms of having two different sections, one section for the better student and a second section for the slower student. About ten of these students also mentioned the possibility of changing the courses in algebra and geometry to make them more practical for the student without much mathematical ability. They agreed that the algebra and geometry as it is now taught would be all right for the better mathematics student.

A number of these students suggested that they
would have liked another course of general mathematics or practical mathematics at about a sophomore level. Over half of these 50 seniors indicated that they would have liked another course in mathematics before they graduated. They favored some form of senior review mathematics rather than any form of the regular advanced courses.

These students believed that algebra had some value for them for use in everyday living and also some value as a review of the mathematics or arithmetic that they had already studied. They could see no value in the study of geometry and the only reason they would give for taking the course was that they needed it for college entrance.

The attitudes of these seniors, who didn't go on in mathematics, indicate the following:

1. Some form of ability grouping would be desirable for the Billings High School mathematics classes.
2. The mathematics curriculum should include a course in senior practical mathematics.
3. The students should receive more individual attention. This would probably be achieved to some degree by ability grouping.

**Results of interviews with the mathematics teachers.**

The mathematics teachers in Billings High School are directing a college preparatory curriculum in mathematics. This curriculum contains courses in elementary
algebra, plane geometry, intermediate algebra, solid geometry, college algebra, and plane trigonometry.

The mathematics teachers recommend, if possible, the addition of two new courses to the curriculum. They believe a course in statistics and a course in senior practical mathematics would help a great many students.

As for the addition of any specialized mathematics courses, the verbatim quotation of one of these teachers expresses the feeling of the group. He said,

I see very little value in our secondary schools for specialized mathematics courses. For instance, more than half of the students who might take a course in the mathematics of farm management or in agricultural problems would in all probability never follow agricultural work of any kind. It seems to me that we need to get the basic ideas and principles across to our students and the special fields could then be mastered as the need for any particular type of mathematics developed.

The actual teaching of the mathematics classes in Billings High School is done in the traditional method. The Billings teachers claim that in their experience efforts to teach mathematics through such plans as activity program, socialized mathematics, and the core curriculum have met with very little success. Efforts to devise suitable courses of general mathematics above the ninth grade have met with little success.

The teaching method employed by the mathematics teachers seems to be a combination demonstration-recitation-supervised study method. None of these teachers believes
that a great amount of supervised study is advantageous in the learning situation. They do, however, feel that a lesson with part of the time devoted to supervised study and part of the time to recitation is advantageous. They all resort to explanation and demonstration when it comes time to bring out a new concept or topic.

The size of the class may in the teacher's opinion have some bearing on learning outcomes in their courses. The teachers disagree on whether an individual method or the group method shows the advantage in the learning outcomes. After all is said about methods of instruction the final opinion is that difference in pupil gain may depend primarily upon varying factors inherent in the pupil or his activities rather than in the teaching procedures.

Stimulating interest within the mathematics classes is a problem in Billings High School as in most secondary schools. Recreational materials are employed in the mathematics classes. Each teacher has a few of his own teaching ideas. These materials include short objective tests, number oddities, tricks, optical illusions, mathematical facts, and stories of interest to pupils. The following ways of using recreational mathematical materials were offered by the Billings teachers: materials presented to the entire class as a part of a daily lesson plan, material presented to individuals and small groups to stimulate
interest in mathematics, materials presented to individual pupils who have completed their assignments, materials presented to entire class to work on outside of regular class time such as in study hall or a home, materials placed on chalk board before classes assemble, to gain the attention of pupils and settle the class, materials presented to individual pupils who have expressed an interest in recreational mathematics to work on, outside of regular class time, materials placed on bulletin board in classroom and changed at regular intervals, materials presented during fill-in time, usually at the end of the period, and materials presented to classes on special days such as days before school holidays.

Other activities used by the mathematics teachers to keep the interest high are: the use of statistics of local community, bulletin board decoration, geometric projects, and assignment sheets.

The mathematics teachers believe that mathematics rests on these axioms:

1. That mathematics contain values that everyone needs.

2. That most people are capable of acquiring needed values from mathematics.

3. The worth of the individual justifies the effort required to give him or her these values.
Elementary Algebra. Three teachers handle the five sections of elementary algebra. These three keep in close touch with each other and usually manage to be teaching the same concept at about the same time. They agree that they just can't seem to cover as much of the course as they would like to in a year's time. Regardless of the textbook used, the topics covered in a year's work in elementary algebra are: literal numbers, formulas, positive and negative numbers, equations and problems, operations with polynomials, equations containing parentheses, equations containing fractions, multiplication and division of polynomials, graphs, systems of linear equations, special products and factoring, literal equations, fractions, fractional equations, powers, roots, and radicals. The classes are usually just beginning the unit on quadratic equations at the end of the school year.

A summary of some of the teaching ideas of the algebra teachers follows: reduce the manipulation of symbolism (nests of parentheses, four story fractions and difficult cases of simultaneous equations.), emphasize the notion of dependence of functions, teach with great care the meaning of a formula, apply graphic techniques widely, use a sensible program of drill, based on the fact that a pupil learns more quickly and remembers longer the things that he understands fully, use a few simple
interesting and practical applications to motivate each new principle and topic, and strive to improve the problem material by selecting functional applications.

The algebra teachers average about 35 minutes of explanation and demonstration per class period. The remaining 25 minutes are usually used for supervised study. The student then leaves the class with at least a half an hour's work left to do. These teachers consider homework assignments an important part of the teaching and learning process.

**Plane Geometry.** Four teachers handle the ten sections in plane geometry. These teachers all use the same textbook and cover the topics of the course in the same sequence. They do not agree on the speed at which the course should be conducted. Two of the teachers cover a unit more during the year's time. The topics covered during a year's work in plane geometry are: basic concepts in geometry, constructions, perpendiculars and parallels, parallelograms and trapezoids, angle sums and related propositions, circles, measurement of angles in a circle, loci and constructions, proportional line segments, similar polygons, numerical trigonometry, area or surface measurement, regular polygons and the measurement of the circle. The two teachers working at the slower rate skip the unit on numerical trigonometry in order to
finishing the others. The other two teachers cover all 14 of these units.

These teachers believe that one of the primary purposes of geometry is to teach the nature of mathematical thought. They believe that plane geometry should help the student to understand the nature of, and develop an appreciation for deductive proof. The concepts of the nature of proof as well as the logical structure exhibited in a chain of propositions are essential objectives in the teaching of formal geometry.

The geometry teachers believe that book propositions should receive less and less attention and that the emphasis should be placed instead on original exercises and the development of analysis. A geometry classroom equipped with learning aids, models and instruments, is the ideal of the geometry teachers.

One of the teachers believes that geometry should be taught more as an experimental course with drawings and diagrams and constructions rather than as a purely demonstrative course. He maintains that problems based on student discovery have more educational value than those assigned from a text. Pre-stated theorems and prefabricated exercises may be artificial, superficial and dull.

The geometry classes are a little more pupil-centered than the algebra classes. There seems to be
more working together by pupils and also more teacher-pupil discussion. There is more recreational material used in the geometry classes than in the algebra classes. A good deal of work that might ordinarily be homework is done in the class. These teachers do, however, see a great deal of value in the assigned lesson. The students usually leave the classroom with between one-half an hour and an hour's homework to do.

Advanced Mathematics. One teacher handles the advanced mathematics courses. These courses are intermediate algebra, solid geometry, college algebra, and plane trigonometry. These are all one-semester courses. The intermediate and college algebra courses are taught the first semester and the solid geometry and plane trigonometry courses the second semester.

The students in these courses are for the most part high level individuals. These students must show a great deal of interest and a willingness to work at the course. Students not having such a desire are soon eliminated. The students who successfully complete the first year or the courses in intermediate algebra and solid geometry will, in all probability, take the second year of advanced mathematics consisting of the courses in college algebra and plane trigonometry.

This teacher, having the student in all four
courses, is able to tie together the phases of the student's mathematical education. The teacher uses a check list to determine how well he is covering the desired topics in the four courses. His claim is that when the student finally completes plane trigonometry he has been subjected to every topic on the check list. This list was obtained from an article in a copy of "The Mathematics Teacher."

The items of the list are much too numerous to mention here.

These courses are taught as college preparatory courses, and in the same manner as they would be taught in college. These students want mathematics and this teacher believes in giving them just that. He gives them the material as fast as they can absorb it. The classroom procedure is composed of lecture, explanation, supervised study and a homework assignment. He doesn't think the homework has any value unless there is a chance to go over it and help the student on the difficult parts.

The main plan in the classroom is board work when the class is small enough or desk work with help when it is too large. Getting a certain amount of work done is good training in responsibility according to this teacher.

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Providing for individual differences. In recent years, according to the mathematics teachers, their work has been further complicated by the fact that a much larger number of pupils of lesser ability have been continuing their studies in secondary mathematics. A summary of the thoughts on this situation follow:

1. Try to improve the teaching of high school mathematics.

2. Dilute the high school course to fit a lower student mentally. This is facing the facts. It may have to be done.

3. Discourage the poorer student from taking mathematics. This, however, too often leads the shortsighted student into unforeseen difficulties. It often makes him feel that there is a premium on stupidity and it deprives him of valuable training that he should have.

4. Finally, delay the student's training in mathematics throughout his entire course for a year or two, to the end that his mental development may progress to a point where it will be somewhat easier for him to cope with the difficulties he is going to encounter.

Too often the mathematics taught seems to be too difficult for the students. The teachers think that
perhaps the courses are misplaced in the curriculum.

The Billings mathematics teachers have a problem with the slow pupils. The classes can't be held back by these students, and yet these students can't just be lost either. There is no form of homogeneous grouping for the classes, neither is there any special course for these slow students offered in the curriculum. The teachers were asked what they thought of installing another track in mathematics for the slow pupils. Two of the teachers have this to say:

Opinion of teacher:

In general, I have not been in favor of a second track in mathematics in Billings High School. However, due to social promotions, there are some students who come to the tenth grade with what appears to be a total lack of mathematical ability. I feel that these students should not be allowed to ruin the opportunities of those who are ready to progress successfully in functional mathematics. Therefore, I believe that such students must be provided with special remedial or refresher courses.

Opinion of teacher:

I am convinced that we need three track programs in mathematics, one for college preparation (of science, mathematics, and engineering majors) one for the low group and one for the relatively large middle group who may or may not go to college but who will carry on the real work of the community in the future. These students need a broad basic block of mathematics that is not covered by shop math, by consumer math, or by commercial arithmetic. They should be offered a strong sequential course planned for students with average or more than average ability who will have no need for the specialized, traditional mathematics courses.

The slow student is not the only problem. The teachers believe they are inadequately serving the gifted student. These teachers propose special classes for the
gifted pupil. These classes would provide the extensive study of mathematical topics adapted to the ability of the student and presented at a challenge rate.

Two important tasks face the teacher regarding the superior student: that of developing his enthusiasm for the subject, and providing appropriate activities to enrich his experience and challenge his efforts.

The teachers believe that a good deal can be done for the gifted student even without grouping of any kind. Supplementary problems or topics are readily found for practically every unit being studied. Those requiring superior ability are assigned as a challenge to better students. Supplementary work is carefully handpicked for them. Topics allied to their hobbies or special interests would be preferable.

The main effort should be directed toward the entire class first. Assuming the majority are thus challenged, the teacher then pushing the topic further, reaches manifestations to which only the better students react. This response by the abler students in the form of spirited discussions, and blackboard demonstrations also invites the slower students to improvement. These extras are roots from which talented efforts should spring and serve as beginnings of superior achievements by abler students.

The teachers were asked what they considered the
most effective means of providing for the gifted. The most frequently mentioned were: mathematics clubs, special projects and problems, some work in helping other students, time for individual conferences, different and more effective instructional materials, special courses and a testing program that measures growth.

The teachers were then asked what materials of instruction they considered most effective in providing for the gifted. Those mentioned were: the same materials available for good instruction but to be used a much shorter time, stimulated subject matter which challenges the gifted, good textbooks, supplementary books, and library materials for special reports.

The next question was to find out what activities and projects the teachers considered most effective in providing for the gifted. Those mentioned were: mathematics contests, assembly programs, projects dealing with applications and vocational uses, supplementary topics, activities which demand a great deal of productive thinking, readings in mathematics literature, challenging mathematics problems and making models to demonstrate a mathematical concept.

These suggestions handle the situation for the gifted student, but for the class in general, what practices are the teachers using for providing for individual differences? TABLE VIII shows some of these practices.
TABLE VIII
PRACTICES FOR PROVIDING FOR INDIVIDUAL DIFFERENCES
IN THE BILLINGS HIGH SCHOOL MATHEMATICS CLASSES

<table>
<thead>
<tr>
<th>Practice</th>
<th>No. of Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Differential assignments</td>
<td></td>
</tr>
<tr>
<td>Special lessons for weaker students</td>
<td>2</td>
</tr>
<tr>
<td>Special lessons for stronger students</td>
<td>3</td>
</tr>
<tr>
<td>Special reports on current topics</td>
<td>2</td>
</tr>
<tr>
<td>Small groups within the class</td>
<td></td>
</tr>
<tr>
<td>Working on same assignment</td>
<td>4</td>
</tr>
<tr>
<td>Working on different assignments</td>
<td>2</td>
</tr>
<tr>
<td>Projects</td>
<td></td>
</tr>
<tr>
<td>Construction of visual aids</td>
<td>1</td>
</tr>
<tr>
<td>Demonstration of mathematical principles</td>
<td>6</td>
</tr>
<tr>
<td>Notebooks on mathematics</td>
<td>4</td>
</tr>
<tr>
<td>Scrapbooks on uses of mathematics</td>
<td>1</td>
</tr>
<tr>
<td>Bulletin boards</td>
<td>5</td>
</tr>
<tr>
<td>Working almost entirely individualized</td>
<td>1</td>
</tr>
<tr>
<td>Supervised study within the classroom</td>
<td>6</td>
</tr>
<tr>
<td>Uses of games or other recreational topics</td>
<td>4</td>
</tr>
<tr>
<td>Uses of much supplementary work</td>
<td></td>
</tr>
<tr>
<td>Duplicated materials</td>
<td>4</td>
</tr>
<tr>
<td>Different sets of books</td>
<td>1</td>
</tr>
</tbody>
</table>

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Only one teacher works his classes entirely individualized. This teacher handles two elementary algebra sections. Each student works at his own rate of speed with the teacher helping each with his own topic. The daily paper work and testing work that this teacher encounters are immense. By his own assertion, "never again!"

Summary. The mathematics teachers of Billings High School believe that the college preparatory mathematics curriculum is not in itself a sufficient mathematics program.

The mathematics teachers agree that the math classes present a problem in the slow student. If any new mathematics courses are added to the high school curriculum in the near future, the teachers hope that these courses will provide for the slow student better than algebra and geometry have.

The teachers feel that they are doing a fair job with the gifted student. There is more opportunity to push the gifted than to pull along the slow pupil. They believe that some form of grouping for the mathematics students is needed in Billings High School.

These teachers believe in the recitation-demonstration-supervised study method of conducting a class. They all use homework and believe it valuable in the learning situation.
Results of interviews with the administrators. The opinions of the administrators coincided very closely with those of the teachers on these topics: methods of teaching mathematics, teaching for individual differences, the value of the college preparatory curriculum, tests and homework, group method over individual method, the value of supervised study, the impracticality of adding any special math classes, the value in a proposed course of statistics, and the value in a proposed course of senior or practical mathematics.

As for the idea of homogeneous grouping of any kind for our mathematics classes the administrators disagree with the teachers. They believe the value of the grouping is far over-ruled by the many undesirable factors, social and otherwise, that would enter the picture. The best solution is a good method of teaching for individual differences in the classroom.

The administrators believe that two years, at least, of high school mathematics, are essential so that too many doors won't be closed to the graduate. These two years would be the general mathematics course of the junior high school and the course in elementary algebra.

For anyone going to college, regardless of the course, the administrators recommend at least elementary
algebra and plane geometry. The administrators suggest that if a student is interested in mathematical fields and has the ability, he should take all the mathematics he can get.
CHAPTER V

THE BILLINGS HIGH SCHOOL MATHEMATICS PROGRAM

The following subjects have been offered, in the field of mathematics.

<table>
<thead>
<tr>
<th>Year</th>
<th>Subject</th>
<th>Grade</th>
<th>Semesters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1952-53</td>
<td>Elementary Algebra</td>
<td>10-11-12</td>
<td>2</td>
</tr>
<tr>
<td>and</td>
<td>Plane Geometry</td>
<td>10-11-12</td>
<td>2</td>
</tr>
<tr>
<td>1953-54</td>
<td>Intermediate Algebra</td>
<td>11-12</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>College Algebra</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Solid Geometry</td>
<td>11-12</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Plane Trigonometry</td>
<td>12</td>
<td>1</td>
</tr>
</tbody>
</table>

The same courses have been offered the past two years. According to teachers of longer duration in Billings High School these same subjects have been offered for the past ten years.

The elementary algebra classes consist primarily of sophomores or tenth grade pupils. This same algebra course is offered in the ninth grade in the Junior High School. The sophomores taking the course are either repeaters who failed the course in the ninth grade or those who had taken general mathematics in the ninth grade. The elementary algebra classes also contain a few juniors and seniors taking their first high school mathematics.

The plane geometry classes consist mostly of
sophomores. These sophomores are those who received their elementary algebra in the ninth grade. About one third of the plane geometry students are juniors. These juniors received their elementary algebra as sophomores or in the ninth grade and have decided to take at least one more year of high school mathematics. There is also one, two, or three seniors in each plane geometry class. These few seniors are in most cases merely working for a credit.

The intermediate algebra classes consist mostly of juniors. By the time the student gets to this course he finds himself a part of a select group. They are the students who have by now decided that they like mathematics and feel that they may have use for a knowledge of mathematics. Solid geometry is taught the second semester to the same students. These two courses are taught as basic college preparatory courses as most colleges require these as minimum entrance requirements in the fields of science and engineering.

The courses in college algebra and plane trigonometry are taught, a semester each, to a select group of seniors. These seniors, usually all boys, have a genuine interest in the study of mathematics. A rather high level of achievement is required in these courses. The courses furnish an
excellent background for the student going into technical studies. The students in these courses need no convincing as to the value of the courses they are studying. These people are going to college; they have investigated their future and figure they will have need for this mathematics.

Summary. In brief then, during the past two years, Billings High School has offered its students a six course mathematics training program. Elementary, intermediate and college algebra, plane and solid geometry, and plane trigonometry make up the program. This is a very complete college preparatory curriculum in high school mathematics.
CHAPTER VI

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary. Mathematics education is one of the major divisions of the total curriculum of Billings High School. Practically every student who enters the high school takes at least one course in mathematics before he graduates. The following questions arise concerning the mathematics program of Billings High School.

1. What mathematics courses are being taught in the high school?
2. To what degree is the Billings mathematics program meeting the needs of the community and its students?
3. Does the mathematics program conform to mathematics objectives in the high school as outlined by the mathematics teachers and administrators in Billings High School?
4. What standards have been set up in the field of mathematics education concerning the mathematical training needs of Billings High School?

In general, the purpose of this study was to evaluate the mathematics program in Billings High School in terms of (1) the attitudes of the seniors and (2) the attitudes of the mathematics teachers and administrators of the high school.
The mathematics teachers and administrators of Billings High School were presented with questionnaires as a means of gathering the basic information concerning the high school mathematics program. The seniors of the high school, who were enrolled in mathematics classes this year, and fifty seniors who had previously taken one or two years of mathematics were presented with questionnaires in order to determine their attitudes on the present mathematics program. The mathematics teachers and administrators were interviewed in order to determine their attitudes on the present mathematics program.

The mathematics program was presented as follows:

1. Subject offerings in the light of the recommendations from authoritative study.

2. A more general evaluation of the mathematics (goals, content, methods) based on criteria from authoritative study.

3. The mathematics program in the light of the findings and results from the questionnaires answered by the seniors, in Billings High School.

4. The mathematics program in the light of the attitudes and recommendations of the mathematics teachers.

5. The mathematics program in the light of the attitudes and recommendations of the administrators.
Conclusions. The following conclusions may be drawn from the forgoing study of opinions: the college preparatory curriculum should be supplemented by other courses designed for the non-college student, every pupil should have at least one year of high school mathematics, college-bound students should have at least two years, no student should be graduated from high school not knowing how to do simple arithmetic, provisions for individual differences should be made in classroom work, and most people are capable of acquiring needed values from mathematics and mathematics contains values that everyone needs.

Recommendations. The following recommendations are made concerning the mathematics program of Billings High School: that a study be made of the high school curriculum toward making it more practical for the non-college student, that something be done along the line of ability grouping in the mathematics classes, that a more thorough study be made on teaching methods in the mathematics courses, the addition of some practical mathematics courses starting with statistics and senior general mathematics, and that a study be made to determine what additional mathematics courses Billings High School could add to the curriculum.
BIBLIOGRAPHY
A. BOOKS


B. PERIODICAL ARTICLES


C. OTHER SOURCES


APPENDIX
Mathematics in Billings High School  
Questionnaire for Seniors

Name (optional) M or F Age Standing in Class (Upper 4th)  
(Middle) (Bottom 4th)

1. What do you intend to do after you graduate?

2. If answer to No. 1 is to go on to college, what course do you plan to pursue?

3. What mathematics courses have you taken in high school?  
Course

<table>
<thead>
<tr>
<th>Course</th>
<th>How did your grades run?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
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<tr>
<td>3.</td>
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<tr>
<td>4.</td>
<td></td>
</tr>
</tbody>
</table>

(High A-B, Average C, Low D-F)

4. What value for the future do you see in each mathematics course you studied? Do you believe you will use this mathematics. Explain.  
Course

<table>
<thead>
<tr>
<th>Course</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
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<tr>
<td>2.</td>
<td></td>
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<tr>
<td>3.</td>
<td></td>
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<tr>
<td>4.</td>
<td></td>
</tr>
</tbody>
</table>

5. Do you have any convictions on how the present mathematics courses in your high school could be improved so that they would be of more value to the student.  
Course

<table>
<thead>
<tr>
<th>Course</th>
<th>Improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
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<td>2.</td>
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<td>3.</td>
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<td>4.</td>
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</tbody>
</table>

6. How about new mathematics courses? Are there any courses in the mathematics field you would like to see in your high school?

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1In the original questionnaire space was provided for the answers.
7. What advice could you offer to mathematics teachers as to methods whereby they could make the mathematics courses more interesting and more beneficial? Mention the specific courses.

8. What advice would you give to a beginning Sophomore as to the mathematics courses? Which to take, which to let alone. Explain why in each case.

9. Have you ever asked yourself: "Why am I studying this stuff?" Put yourself back in the mathematics courses you have studied and try to answer this question.

10. You're on your own. What "gripes" have you? What additional information about your mathematics courses? What did you like and dislike about the study of mathematics? What parts of courses didn't you like? Get it off your chest. This will not be held against you; your name will not be used. I want your honest opinions and attitudes. Your help will certainly be appreciated.
Mathematics in the Billings High School
Questionnaire for principal's office

1. Enrollment in high school:
   | Senior | Senior | Junior | Junior | Soph. | Soph. |
   | boys   | girls  | boys   | girls  | boys  | girls |

2. Number of teachers in high school: __________

3. Number of teachers teaching mathematics: __________

4. Future of seniors
   a. Approximate per cent of seniors who go to college: __________
   b. Approximate per cent of seniors who stay in the community: __________

5. Number of drop-outs during school year:
   | Sophs | Juniors | Seniors |
   | ______ | ______ | ______ |

6. Mathematics courses offered this year (each hour period-even if it is the same course.)

<table>
<thead>
<tr>
<th>Course</th>
<th>No, in class</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td></td>
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<tr>
<td>e.</td>
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<tr>
<td>f.</td>
<td></td>
</tr>
<tr>
<td>g.</td>
<td></td>
</tr>
<tr>
<td>h.</td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td></td>
</tr>
<tr>
<td>j.</td>
<td></td>
</tr>
</tbody>
</table>
1. Years Experience teaching mathematics

2. Different mathematics courses taught during this time

3. Experience teaching mathematics in Billings High School

4. Courses you are teaching this school term:
<table>
<thead>
<tr>
<th>Course</th>
<th>Boys</th>
<th>Girls</th>
<th>Soph.</th>
<th>Jr.</th>
<th>Seniors</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td></td>
<td></td>
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<td>c.</td>
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<tr>
<td>d.</td>
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<tr>
<td>e.</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

5. What textbook do you use:
<table>
<thead>
<tr>
<th>Course</th>
<th>Name of Book</th>
<th>Author</th>
<th>Copyright date</th>
<th>Publisher</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>b.</td>
<td></td>
<td></td>
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<td>c.</td>
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<td></td>
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<td>d.</td>
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<tr>
<td>e.</td>
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</tr>
</tbody>
</table>

6. Teacher's Comment on Textbook
<table>
<thead>
<tr>
<th>Course</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td></td>
</tr>
</tbody>
</table>
7. Do you use any extra books or workbooks?

<table>
<thead>
<tr>
<th>Course</th>
<th>Name of book</th>
<th>Author</th>
<th>Copyright date</th>
<th>Publisher</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
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<td>c.</td>
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<td>e.</td>
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</tbody>
</table>

8. Would you write a little of your personal attitude on the worth of the courses you are teaching? (More or less along these lines.) If a student spoke up, in one of your classes and asked, "What good is this stuff ever going to do me?" How would you answer in each of the courses you are teaching?

<table>
<thead>
<tr>
<th>Course</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td></td>
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<td>c.</td>
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<td>d.</td>
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<td>e.</td>
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</table>