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A Ninth Grade General Mathematics Program

Berlen Flake

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Dr. Van Deventer
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CHAPTER I

INTRODUCTION

In the past three centuries many changes have taken place in the fundamental philosophy and practices of our American schools, which are reflected in the mathematics curriculum. Arithmetic found its place in the curriculum in the eighteenth century due to the demands of business and industry for competency of their workers in this field. Algebra, geometry, and trigonometry later were added to the curriculum of the academy because of their practical and cultural values. Later their value as mental discipline was stressed.[1]

By 1860 the program of the public high school began to prevail over that of the traditional academy. In an effort to meet social demands numerous courses were set up, sometimes not well constructed or organized. The recognition of the limitations of the existing programs of elementary and secondary schools led to a movement for reform.[2]

In the early decades of the twentieth century important studies were made of personal, social, and industrial needs in the field of mathematics for the purpose of determining the minimum essentials of arithmetic. These investigations led to the elimination of numerous topics and processes that were demonstrated to be of little value. Algebra was the only course offered in the ninth grade prior to this time. General mathematics was first

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1 H. Alberty, Reorganizing the High School Curriculum. Macmillan Company 1947. Chapter VI.

2 William Betz, "Five Decades of Mathematical Reform - Evaluation and Challenge." The Mathematics Teacher 43: 377-387.

proposed, during this period, as an integration of material in algebra, geometry, trigonometry, into a course labeled simply Mathematics I for ninth grade, Mathematics II for tenth grade, etc. Thus, during the early 1900's, grew what this writer calls the "white elephant" in the teaching of ninth grade general mathematics.

The subject now termed "general mathematics" is not considered here to be a college preparatory subject and has been considered by most people as an extension of arithmetic. It is perhaps better to consider it as an extension of elementary mathematics aimed at the better understanding of mathematical concepts. It is one year of mathematics offered for those who are not concerned with studying mathematics beyond the high school.

The high school general mathematics was an outgrowth of the idea that high school is for all rather than the intellectual elite who were going to college. (For the college preparatory student there always was and still is algebra.) There has been among administrators and teachers alike the growing idea that general mathematics should include some college preparatory material. How much and how little varies from school to school. Whether the general mathematics should be strictly a remedial course or how many mathematical ideas should be included also varies from school to school. This is, perhaps, as it should be since the school should serve its community; yet, on the other hand, the school must serve the nation as a whole. A credit in mathematics must have something of the same meaning in Los Angeles as it does in New York -- in Mississippi as it does in Washington. To give this subject called general mathematics, or practical mathematics, exactly the same meaning in all situations and all places is far from the purpose of this paper. The ideas which are advanced are applicable in Illinois and more especially in East Central Illinois. We feel, however, that some of the ideas can be used in ninth grade mathematics in any part of the United States.

THE PROBLEMS - THE STUDENTS

Who shall take general mathematics? The answer to this question depends upon many factors: First of all, in view of the complexity of the traditional algebra course offered to ninth grade, the profit which the student can gain from its (algebra's) study must be considered; in the second place, the seventh and eighth grade training must be considered; and in the third place, the desires of the students must be taken into account.

Many good mathematics students have been lost from the field because some guidance person has depended entirely on a particular mathematical achievement test to separate the general mathematics students from the algebra students. In the same manner, many students have been guided, much to their regret, into algebra classes as a result of their scores on such a test. In no case, should the line between the students of general mathematics or algebra be drawn on the basis of a single test. The guidance person, whether he is the eighth grade home room teacher or a specialist in the guidance field, should present the facts (the results of achievement tests, the grades in the eighth grade mathematics, and future plans of the student) to the student for him to make the choice.

Students who choose general mathematics rather than algebra made up two classifications: (1) those who would not be able to comprehend the algebra computation required in an algebra course; (2) those capable mathematics students who are not interested in continuing their study of mathematics.[3]

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3 Dyer, Kalin, and Lord. Problems in Mathematical Education. Educational Testing Service. Princeton, New Jersey. 1956. Page 10.

THE PROBLEMS - THE TEACHERS

It can be readily seen that the problems of teaching such a course can be great and varied. The typical class consists of students who do not understand the subject or, for one reason or another, are outrightly opposed to it.

Largely because of the nature of the material which is taught and of the types of students who elect the subject of general mathematics, teachers are reluctant to accept the teaching of this course.[4] Thus, with reluctant teachers and with reluctant students, the school is faced with the task of teaching another year of mathematics in which the students are not interested; hence, discipline becomes a problem to add to the sorrows of the administrators and teachers alike.

Need this be the situation? Our answer is - not at all. Since the interest of the student would add to the enjoyment of the teacher and enhance the desire to teach the course, the best approach would be for the teachers to begin by an honest attempt to make the course more interesting. This, then, becomes our problem: How can the course be made more interesting, meaningful, and worthwhile?

The solution to the problem of what to do with the ninth grade general mathematics can be simply stated. The simple solution is to get a "good" teacher. Here,no attempt is made to define what is meant by a "good" teacher since the term has so many connotations. A teacher, however, like any other normal human being, can do his best work when he is happy and finds

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4 In the survey of high schools of the Eastern Illinois area not one of twenty teachers would choose general mathematics to teach.

his work interesting. Many ideas in mathematics cannot be presented properly unless the teacher understands them himself. Hence, we say that the general mathematics teacher should be one of the best trained teachers on the staff, not only in the teaching of mathematics, but also in more advanced fields of higher mathematics. On the other hand, a teacher who would prefer to teach some other subject and is not happy in his work will not present the material to the students in an interesting manner. Thus, the first consideration, if the general mathematics program is to be successful, is to find a teacher who is interested, regardless of his training, in attempting to make the course interesting to the student. The more training and experience of such a teacher the greater the chances for a successful program. As has been pointed out before, few if any teachers are interested in teaching this course. It only follows that most of their students will not be interested in it. The course becomes a bore to the teachers and students alike. There seems to be no answer to this phase of our problem and most of the literature in the field takes no notice of the fact that the general mathematics teachers are not interested in the subject.

How long will it be before communities and professional groups recognize that the junior high school and ninth grade teachers are important links in the training of mathematics students? Only when the leaders in the field of mathematics begin to put pressure for better junior high school and ninth grade teachers can this occur; then, over a period of years, teachers of general mathematics can begin to feel that their work forms an important part of mathematics education.

THE PROBLEMS - THE MATERIALS

The materials which could be taught in general mathematics are almost limitless. The standard courses, as they are generally offered in textbooks, usually give a great variety of material varying from simple computation to trigonometry. Most texts include many chapters of a social nature dealing with insurance, interest, taxes, and other "commercial" topics. The knowledge of how to solve problems of this kind is imperative in the present day modern civilization; yet, it is this writer's contention that these are merely the application of mathematics and not mathematics itself. We feel that the purposes of general mathematics are: (1) to give the learner leads that he may or may not follow toward further liberal or special education; (2) to give the learner the language skills and operational techniques which he needs to be a well-informed member of his social group.

In the work preceding the ninth grade, the practical needs of the student should be the important consideration. The work of the ninth grade should be designed to give the student an idea of the significance of mathematics as a science. By the end of this year, the student who desires to proceed further in school, with the aid of his teacher and counselor, should be able to decide whether he can profit by a continued study of mathematics.

The organizing and unifying principle of the general mathematics course in the ninth grade should be the idea of functional relation -- the dependence of one quantity upon another. In the ninth year the function furnishes the central idea of the course, and the simpler truths and constructions of geometry help to rationalize some formal aspects of arithmetic, which have been too often missed in the junior high school, and also add to the knowledge of the student concerning mathematical concepts.

Quite often the high-sounding terms, "mathematical concepts," "function," and "functional relationships" may be taught by the most skillful teachers and yet, in our opinion, it is doubtful that, if these students discontinue their mathematical education, not more than one third of the class will be able to comprehend or retain these concepts for any length of time. This does not mean that we should not use this approach in preparing our materials to be taught. We feel that many junior high school teachers do not use this approach to the materials. Hence, they fail to interest or to teach the studentsmuch mathematics. By the use of a functional approach to the materials some of the students may be able to master (or learn) more mathematical concepts.

CHAPTER II

A PSYCHOLOGY FOR GENERAL MATHEMATICS

Every psychology has an explanation of how learning takes place. In mathematics Thorndike's connectionism theory was widely accepted for a period of years. This inevitably led to the learning of mathematics as the outcome of much practice and drill. Recent theories tend to discount the importance of drill and emphasize understanding and insight into the relationships existing in problem situations.

The Gestalt School of psychology advances the "field theory" of learning, which provides an explanation of how learning takes place in mathematics that reflects the experience of teachers of mathematics as they observe students in learning situations. In problem situations, the student finds his environment (or field) unstructured with the interrelationships that exist in the problem field unseen. The student considers the elements of the field and seeks to find some pattern among the elements that will bring the goal (solution of the problem) closer or make its attainment possible. Typically, the pattern is seen (or the field becomes structured for the student) as a flash of insight after a period of consideration and/or manipulation of the elements of the problem situation. Once this insight is attained, the route to the goal becomes clear and the problem situation is resolved.

The field theory does not deny that practice improves the retention of learned material, but it emphasizes understanding of the number system and its uses in number operations and problem solving in a variety of situations, rather than learning through intensive drill. It also points out the importance of organization of learning through the discovery of relationships and generalizations among facts and processes rather than through the study of isolated elements set up in unrelated form. According to the field theory the student should not practice a skill to develop proficiency until he knows the meaning of the process and understands how it operates.

Meanings are basically the outgrowth of experience. Thus, the student must develop concepts by experience. The steps in the development of concepts are: perception - abstraction - generalization. As meaningful goals emerge from activities the students move through the three steps. The slower students are not able, of course, to proceed as rapidly as the more able but in the end the student should understand what he is learning.

Every effort should be made to make the meaning of mathematical concepts understood by the student. Often this will involve laboratory work, drawings, sketches, board work, as well as many other devices.

As the student improves in solving problems he becomes more interested. He "learns how to learn" and as he does so, he tends to set higher goals for himself or to raise his level of aspiration.

THE "MODERN" APPROACH - PROBLEM SOLVING

The modern approach to mathematics, at least in the ninth grade, would not be an attempt at drill and more drill.[5] The elementary teachers and the junior high school teachers have already done this with some success for the students. Most students are "able to do computation" by the time they reach the ninth grade. Yet they often do not understand the technicalities of multiplication, division, addition and subtraction. If, then, becomes the problem of the general mathematics teacher to add meaning to the computation, to add meaning to problem solving, and to create worthwhile activities which will give interest and desire to continue the study of mathematics.

The basic role of problem solving in mathematics is our primary consideration. The underlying principles are:[6]

(1) Formulation and solution

(2) Data

(3) Approximation

(4) Function

(5) Operation

(6) Proof

(7) Symbolism.

The first step in the problem-solving procedure is the identification of a difficulty and the formulation of the problem in clear, concise, meaningful terms. Then a plan of action for resolving the difficulty can be laid out. The plan may be, for example, a statement of procedure, the recall and appli-

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5 W. A. Brownell, Meaningful vs. Mechanical Learning. Duke University Press. Durham, North Carolina, 1949, pp. 249-260.

6 From a report Mathematics in General Education. Appleton-Century Company. New York, 1940.

cation of a rule or formula, a drawing, a construction or an algorithm to be used.

The next step is the collection of the data for arriving at a solution. The data should be representative, relevant, accurate, and reliable. It is necessary to collect, record, and organize the data in ways that are appropriate to the solution of the problem.

All measurements involved in problem solving are approximate. The fundamental notion of approximation is indicated by such terms as precision of measurement, accuracy, rounding off, and significant digits. A clear recognition of the approximate nature of measurement not only helps the student to exercise any necessary precautions in recording and reporting data, but also makes it possible to compute with approximate numbers with considerable economy of time and labor in making estimations or checking solutions.

The notion of some sort of correspondance or relationship between two or more sets of data underlies the entire process of solution. For example, the student who discovers through experimentation the relationship between the length of the radius of a circle and its circumference is dealing with the function concept.

Problems cannot be solved without some kind of operation -- computation, experimentation, or mental procedure. Finding the square root of a number, estimating, making approximations, and checking computations are all illustrations of operations.

The concept of proof enables the student to draw upon his initial assumptions and upon defined and undefined terms to work through a solution upon which he can rely with assurance.

Words, signs, marks and other symbols that can be used to represent concepts make many forms of reflective thinking possible. Symbols are essential for the communication of ideas to others. Symbols also facilitate the manipulation of ideas.[7]

It is possible to think of all mathematics as problem solving. This is the modern approach. When we think, for example, 4= __% of 17 we attempt to formulate the problem, collect the data, approximate the answer, etc. to find the per cent rather than to memorize a way of doing it.

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7 Brueckner, Grossnickle, Reckzeh, Developing Mathematical Understanding in the Upper Grades. The John C. Winston Company. Philadelphia, 1957, Chapter IX.

CHAPTER III

THE PLAN OF A YEAR'S WORK

Introduction

The teacher is the key to a successful general mathematics program. A teacher without a plan, however, no matter how enthusiastic or well trained, cannot develop an adequate program without an understanding of the underlying principles and concepts in the teaching of mathematics. The remainder of this paper is devoted to outlining a plan (not the only one) to fulfill the requirements of the course as well as inspire the more able students to begin the study of college preparatory courses.

This program is not profoundly different from many offered in this field. If a modern approach is made to each unit of work, however, the program will be much more successful than those which have been seen in the past.

UNIT 1 - INFORMAL GEOMETRY

Geometry is the vehicle of a large body of mathematics and is both practical and interesting. Informal geometry is the point of beginning.[8] The students should begin by drawing angles, making constructions, bisecting angles, making measurements, constructing bisectors, copying angles, constructing congruent plane figures, as well as dozens of other constructions.

All things must have a purpose. What is our purpose for these constructions and measurements? First of all, the students become interested. Here they find something which they can do with their hands - something which requires

8 William Betz, "The Teaching of Intuitive Geometry." The Teaching of Mathematics in the Secondary Schools. Eighth Yearbook of National Council of Teachers of Mathematics: Bureau of Publications, Teachers College, Columbia University, 1933. pp. 55-164.

some thinking but is different than multiplication, division, other forms of computation, and verbal problems. When a line is to be bisected, for example, the problem is there as surely as if stated in so many words. The word "bisected" must be defined, perhaps not in words at first, but its full meaning must be understood. The concept of loci makes its appearance here also. When the construction has been completed, the student then must verify (prove to himself) that his answer is correct by measurement. This opens the field of approximation, at first to see if his answer is reasonable. Later the concepts of approximate numbers and approximate measurement are encountered.[9]

Almost surely the student soon becomes involved with common fractions and the clever teacher will present the student with rulers which are divided into tenths and hundredths. This, of course, emphasizes the importance of the decimal system and the need for being able to compute accurately and meaningfully with both common and decimal fractions.

As we run the gamut of the most common constructions, the abler students often become interested in trying more constructions. Frequently a suggestion from the teacher for such a problem as, "How would you divide a line segment into five equal parts?" can begin a search for the correct way to proceed with this construction. The teacher should leave much of this so-called laboratory work to be done as home work. Too often this writer has found that only a few of the more interested students do the actual work while the disinterested and less able students watch, talk, or create disciplinary problems.

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9 H. Van Engen, "The Formation of Concepts," Learning of Mathematics. The Twenty-First Yearbook of the National Council of Teachers of Mathematics. Washington, D. C. The Council, 1953. pp. 69-99.

During the teaching of informal construction and measurement the teacher should use every opportunity to add understanding to the meaning of addition, subtraction, multiplication, and division.[10] All too often students use things which are not meaningful to them. As an example of adding meaning to division, the student who divides the line segment into five equal parts has then used five as his divisor. This time the quotient was exact. If he were to apply this line segment (1/5 of the original segment) as a divisor to another segment, of a different length the quotient might or might not be exact. If it were not exact, then he would have a remainder which would be a fractional part of the divisor. Thus, the student sees, in concrete form, the meaning of dividing.[11] It is true that this should have been shown much earlier in the student's education, but this writer has found that only a very small portion of his general mathematics students have been able to illustrate this. (As an experiment this problem was presented to 135 general mathematics students last September and only 7 gave anything like a satisfactory answer.)

We have used this illustration to point to the fact that so many of our students came to the ninth grade with little mathematical understanding. To them mathematics seems to be a series of tricks that for some reason always work.

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10 Leo J. Brueckner and Foster E. Grossnickle, Making Arithmetic Meaningful. The John C. Winston Company, 1953. p. 348.

11 Ibid, p. 88-92

Rolland R. Smith, "Meaningful Division", The Mathematics Teacher, 43:12-18.

Ralph Beattey, "Reason and Rule in Arithmetic and Algebra", The Mathematics Teacher, 47: 234-244.

The key to all mathematics is "why?" In our proposed unit on geometry we are interested in releasing the natural curiosity of the students which has so long been stifled. No question should be considered ridiculous. No answer should be given without due consideration to the problem of whether the student with some thought can answer it for himself. This points up the reason for the statement made earlier concerning the fact that the general mathematics teacher should be one of the best trained teachers on the staff.

To give all the details of this unit or any of the subsequent units, would not be worthwhile at this time. The program must be pliable enough to fit any school, yet the teacher must set certain limits on the amount of time spent on any particular unit. It would be quite possible to build the entire year's work around the informal geometry since most elementary mathematical ideas could be transmitted in this manner, but such a procedure is not advisable.

After a certain number of construction concepts have been studied and connected with the idea of approximate measurement, fractions, and computation, another unit should be started. Occasionally returns to the field of geometric constructions for more advanced work would provide a review of the material learned in the construction unit.

UNIT 2 - RATIO AND PERCENT

The next important area would involve the concept of ratio. This can follow naturally from the measurement of lines and the more thorough understanding derived from the work in the first unit.

Connected closely with the concept of ratio is the concept of percent and its related social problems. Often the ideas of percent are not tied in to the concept of ratio — that one percent, for example, means 1:100. This gives the students, quite often, a new conception of what to them was a tiresome type of problem.

Too many times we have heard our students say, "When finding percentage, do we multiply or divide?" and too often have we answered, "Change the percent to a decimal and multiply." With the ratio approach to the problem the student has a new tool for thinking through the solution -- a tool which is really mathematical and not just a rule. Again here we see the need for well trained junior high school teachers, and why the seventh grade teacher should have been well trained in mathematics and mathematical thinking. Students who missed this concept in the seventh grade and eighth grade will be able to gain it in the ninth grade, if the teacher is skillful.

The social problems dealing with percent cannot be overlooked. It must be remembered that most of these students are taking their last year of mathematics. Because percent has become so much the language of everyday affairs and so much of our thinking is built around per cent, it becomes a must that students master the use of percent in its many and varied forms. A few of these social uses are interest, advertising, ball scores, taxes, profit and loss, percent of error, etc.

As highly important as these social problems are to living in present-day America, many general mathematics programs have been ruined by spending too much time on these social problems. The better students get bored once they have mastered the process; the poorer students were never interested in (or never able to comprehend) the significance of these problems. Then, as important as social problems are and the application of percent to them, it would seem inadvisable to spend as much time on them as most textbooks and prearranged programs plan. It is better to move on to some other topic in mathematics.

UNIT 3 - GRAPHS AND FUNCTIONS

The teaching of graphs and graphing seems the next logical topic to consider. Here, if presented properly, the ideas of ratio can be combined with a new concept of functions.

In the general mathematics course the principal objectives of the teaching of graphs can be listed as:

(1) Developing an appreciation of neatness, accuracy, and adequate labeling, as essentials to worthwhile graphing;

(2) Developing an understanding of the importance and wise use of graphs in daily living;

(3) To develop skills and abilities in construction of graphs, identifying good graphs found in newspaper and magazines, rounding off numbers, use of coordinate systems, and solving of verbal problems graphically.

The details of collecting data and translating this into graphs of various kinds (component graphs, line graphs, picture graphs, and bar graphs) will not be given here. These are given in almost any textbook.

The phase that is so often overlooked by general mathematics teachers is that graphs are an excellent way to improve the concepts of function. Also, graphs introduce the notion of a coordinate system to the student.

Finally, a word of caution in the drawing graphs is in order. The students have usually drawn many graphs in their junior high school training and become bored with the topic quickly if no new ideas are presented.

UNIT 4 - GENERAL NUMBER AND FORMULAS

Assuming some success with the teaching of the concepts of function, the students are prepared to begin the study of the uses of general number. Junior high school teachers have often mistaught the idea of general number. The students have learned to expect a formula to be given to them and they have acquired no understanding of the meaning of the formula, nor do they exhibit much desire to learn the background of the formula. When the study of formulas is begun, the student reaction has always been the same -- "Must we go through that again?"

To go through all the steps in the developing of the various formulas ordinarily used is beyond the scope of this paper. For each formula the procedure would be similar to that of finding the perimeter of a rectangle which is used here as an example. First, the perimeter of a rectangle is defined. (Definition is such an important part of mathematics that it should be emphasized as the starting point of any topic.) After finding the perimeter of several rectangles, the question should be asked, "What in <u>general</u> is true?" Eventually the students, themselves, will state in words that two times the length added to two times the width will give the perimeter. It is then time to introduce letters to stand for the words length, width, and perimeter; finally, the students will state the formula $p = 2\ (l + w)$. Since these are ninth grade students who have had this formula before, sometimes it is well to introduce different letters for length and width.

In general, the process is to state the definition, give several examples, inference of general statement by the student, and finally the reduction of the general statement to a statement which is written in symbols. The students, if properly taught, find this a fascinating part of general mathematics. Here they are taught that all formulas are developed by some means, which may be beyond their understanding, but developed nevertheless as general statements.

The teacher has many excellent opportunities to insert general sentences such as: $8 + 3 > 3 + \square$; $8 + 3 < 3 + \square$; and $8 + 3 = 3 + \square$ to further develop the concept of general number. Dr. Max Beberman and his associates call these general numbers "pronumerals" - (meaning instead of arithmetic numbers). Perhaps the introduction of this concept would add to the meaning of literal numbers.

From these types of general number letters can be substituted for the symbol $\square$. The students can proceed from here to the simple operations with general numbers such as: $a \times a = a^2$; $3n + 4n = 7\ n$; etc.

The application of formulas gives the teacher an excellent opportunity to review computation, approximation, and measurement. An excellent type of problem to present to the students here is a figure with no name or no measurements given and ask them to find the area. Because of limited time and materials, it is not economical to have the students work entirely with these problems but many should be included.

UNIT 5 - SOCIAL PROBLEMS

Social pressure created the subject of general mathematics in the first place to take the place of algebra in the ninth grade. Social pressure (i.e. the desires of the community) will cause the administration and the mathematics departments to retain the social or practical mathematics.

General mathematics has a real purpose in furthering the concepts of mathematics for some high school students but, on the other hand, these concepts are not necessarily the teaching of so-called social problems, but rather how to solve social problems. If the student has the underlying concepts of (1) formulation, (2) data, (3) approximation, (4) function, (5) operation, (6) proof, and (7) symbolism, then he knows much more about the solution of the social problems than he would by working column upon column of interest problems, writing bank statements, etc.

Since one purpose of general mathematics is to redirect students into the college preparatory sequence, it is perhaps better to end the year with some unit other than that of social problem mathematics. The reasoning behind this is that those who will succeed in algebra, geometry, and the other fields of mathematics will become bored with the social problems and will reject all mathematics if these problems are given last; but if the algebraic equations, signed numbers, and concepts of trigonometry (which will be given later) are presented last, then the possibility of the student continuing his mathematics education is greater.

The social problems should not omit credit buying. This, to this writer, makes this unit worthwhile if no other phase. The teacher should most certainly include the interest rates of time payments, income tax, social security, overtime pay, etc. The major topics to be taught in this unit of study are four: (1) computing earnings; (2) managing money; (3) using credit wisely; (4) saving and investing money.[12]

If the teacher uses his mathematical knowledge properly, this part of the course can be saved from becoming a course in commerce. Each day and each part of the period, however, the teacher must be alert to point out the mathematical implications; otherwise, the course can be a bookkeeping course and have little more connection with mathematical concepts than typing or social science.

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12 Op. cit., Brueckner, Grossnickle, Reckzeh, *Mathematical Understandings in the Upper Grades*, Chapter VIII.

UNIT 6 - SIGNED NUMBERS, EQUATIONS AND SIMILAR TRIANGLES

The last unit of study to be included in the ninth grade general mathematics course is usually called an introduction to algebra. A different name, at least for the students, is preferable. The unit might be called signed numbers, equations, and similar triangles.

Many general mathematics teachers, as well as eighth grade mathematics teachers, lead students to believe the simple equations with which we work in general mathematics and eighth grade mathematics are the same as the equations in algebra. Far too often the students are misled and rush into algebra because they find this part of general mathematics so easy. It is not the purpose of any part of the course to misrepresent the facts.[13] The equations which we would hope to teach are general statements which are true or false, depending upon the value of the unknown. The signed numbers takes us into the field of all real numbers. Similar triangles are established by definition and the sine, cosine, and tangent ratio are introduced. This unit ties together the year's study of mathematics (not just arithmetic).[14] It is to be hoped that if the Pythagorean theorem is introduced, the students will see it as part of the geometry started at the first of the year, and if square root is defined, they will attempt on their own to find the two equal factors. It will not be surprising if some of the students are not able to do all of these things, but all students should be able to do some of the things and a small group of better students should be able to master the principles of all the units.

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13 Charles H. Butler and F. Lynwood Wren, The Teaching of Secondary Mathematics. McGraw-Hill Book Company, New York, 1941. pp. 278-288.

12 Lucien B. Kinney and C. Richard Purdy, Teaching Mathematics in the Secondary School. Rinehart and Company, 1952. pp. 59-99.

CHAPTER IV

CONCLUSION

In this brief paper a curriculum consisting of six major units has been proposed: (1) informal geometry, (2) ratio and percent, (3) graphs and functions, (4) general numbers and formula, (5) social problems, and (6) signed numbers, equations, and similar triangles. It has been emphasized that the key to a successful program is an interested, well-trained teacher. The plan must fit his or her interests and the teacher in turn must think each day and each class of each day, "How can I improve my teaching next period, tomorrow, next week, next semester, next year?" If this is not done, the subject of general mathematics becomes humdrum. In short, this more than any other subject is dependent upon the teacher for its success.

As has been mentioned before, the proposed plan and method of teaching, are not original. On the other hand, the modern approach to teaching of mathematics has seldom been used. There has always been too much drill and not enough emphasis on concepts and understanding.

This brief paper thus far has not, we are sure, settled or finally solved the problems of general mathematics. We have attempted to clarify our position on this subject. It is a worthwhile course if taught properly; if it is not, then it should be removed from the course of s tudy.

In this day of whirling satellites and atomic energy, our nation needs all the mathematical resources at its command. We are not so naive as to think it possible to make mathematicians of all who come into our general mathematics class, but we do feel that a large number of capable students are lost from mathematics because they have lost interest in the subject. These capable students may not be engineers or statisticians, but they can and probably will be in some field where their mathematical training may serve them as well as the population as a whole.

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