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Author(s): Ralph Mansfield
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## MATHEMATICS FOR PROSPECTIVE TEACHERS IN ELEMENTARY SCHOOLS

RALPH MANSFIELD, Chicago Teachers College

Courses for prospective teachers of secondary school mathematics have been discussed frequently in this journal. The present paper is concerned with a course in mathematics for prospective teachers in the elementary grades. This is not a course in methods of teaching, but one which has been designed to acquaint prospective teachers with the methods, applications, and social values of mathematics.*

Since this course has been designed for students who do not intend to take a major sequence in mathematics, the only prerequisites are the usual one and one-half units of high school algebra and one unit of high school geometry. No text is employed, but an extensive bibliography has been compiled for the use of students who may wish to carry on independent investigations into some of the topics discussed.

The course opens with a discussion of some limitations existing when the results of theoretical mathematics are applied to physical situations. For instance, in high school geometry, the student learns that at a point has no dimensions, that a line has only one dimension, and that through two points only one line can be drawn. However, every point that the student has ever drawn certainly is of measurable size, even though he may require the aid of a magnifying lens to discern the dimensions of it. Also, every physical line he has seen certainly has a detectable width. And, if the student uses a pencil with a very fine point, with the aid of a magnifying lens, he may be able to draw several lines through the same pair of points.

Again, the student may have learned that in elementary algebra the commutative law holds for certain operations, but perhaps he has never stopped to examine a case where the commutative law does not hold. It does not require any great amount of mathematical knowledge on the part of the student to find out that in considering the class of positive integers, subtraction and division are not always possible and that the commutative law does not apply to these two operations. Proceeding from this introduction, the structure of the number system reveals to the student properties of numbers which were too subtle for his earlier comprehension.

Once the student has been led to consider these questions as an introduction to the methods of mathematics (the above statements do not do full justice to the various questions falling under this topic), he is asked to consider some things of social significance in which mathematics plays a rôle.

The next topic of study examines the evolution of our present concept of the physical universe. The student is shown that the mathematical theories underlying these concepts are valid only insofar as actually observable phenomena fit in with the theory. This does not preclude the fact that it may be possible to

* This course has been in operation for two years now and the results have been very gratifying to the students and faculty of Chicago Teachers College.

develop another theory which may fit the observable phenomena in far better fashion, and if such a theory is developed it will displace the older ones.

The development of our accepted theory of the solar system illustrates the general situation. A study of the theory of the solar system brings the student to the conclusion that, insofar as observed phenomena are concerned, the Ptolemaic and the Copernican systems are equally valid. However, from the standpoint of mathematical interpretation, the Copernican system is easily seen to give a better working hypothesis than previously accepted systems. In this connection, an examination of Newton's work proves very valuable. It is pointed out that Newton's Law of Universal Gravitation must be superseded by Einstein's Theory of Relativity when we come to consider the inequalities in the orbital motion of Mercury. Space does not permit a complete discussion of all the work done with this topic, but any college instructor who has studied astronomy will be able to fill in the details for himself.

Next, the student is shown how man has been able to determine the size of the Earth (Eratosthenes' method of measuring the Earth), and how he locates points on the surface of the Earth by determining their latitude and longitude. This involves the construction of a coördinate system on a sphere (and, digressing, many students are at first amazed to learn that a triangle may contain more than 180 degrees, but this amazement turns to a keener appreciation of the applicability of euclidean geometry to a non-euclidean world). It is interesting to point out, in connection with this topic, how the ancients were able to determine latitude by the use of the gnomon, and also by the determination of the angle of elevation of the pole star. The use of the sextant, chronometer, and ephemeris are demonstrated so that the student may better appreciate the mathematical problems of navigation. Again we curtail this discussion, leaving it to readers to supply details.

At this point the student has not only oriented the Earth in space, but he has also oriented himself with respect to the Earth and he is now prepared to examine some of the applications of mathematics to the daily activities of man on his planet. Naturally, many possibilities present themselves. Extensions of the preceding work may be examined here or postponed somewhat. The policy I have followed is first to examine man's commercial activity, postponing his arts and sciences to a later stage.

The uses of statistics in many social endeavors are pointed out—*e.g.*, polls of public opinion, population problems, cost of living, *etc.* The considerations of percentage, simple and compound interest are brought in at this point. A very good topic in connection with this is the study of the mathematical principles of life insurance, since from the work mentioned in the first sentence of this paragraph the student may easily be led to the statistical construction of mortality tables. The study of insurance proves to be full of interesting social situations, especially if one stops to point out some of the problems connected with teachers' pension systems and social security. Not only does the student learn to discount bills, invest principal at different rates of interest to obtain desired

amounts, and determine the probability of winning on chance events, but he also learns to compute the premiums on the various types of insurance he carries and why some forms cost more than others.

Following the discussion of financial problems comes cultural activity, art and music. Many excellent sources of information are now available in these fields, and the students are urged to make their acquaintance. Perspective, and dynamic symmetry are brought into the course in this connection, and the student is introduced to some basic art forms. The study of music is one that abounds with mathematical relationships, most of which fall within the students' limited mathematical abilities. The structure of major and minor scales, the ratios of the fifth, third, fourth, *etc.*, prove to be of more than passing interest to the student.

The nature of sound waves and their transmission, studied in connection with music leads to the final consideration of the course, mathematics in science. Here mathematics is applied first to the study of sound; and sound waves lead to questions about light waves. Then we introduce some ideas about electron theory and quantum mechanics, remembering always that we do not wish to steep the student in mathematics or physics, but only to give him an appreciation for mathematics. Finally, the student is asked to conceive of society in non-euclidean space, in communities where the velocity of light, the gravitational constant, and the quantum constant have been altered from our accepted values of these quantities,* and to compare such societies with our present society.

This type of course is exceedingly rich in what I have termed "the social aspects of mathematics." There is more than enough material to satisfy the students' need for an orientation course in the use and interpretation of mathematics—and few people can doubt the beneficial effect of such training upon persons who are going out to teach, for it enriches their knowledge and leads them out of the dangerous rut from which similar prospective teachers have looked out in the past and asked, "Why study mathematics?"

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* Suggested by Gamow's little book, Mr. Tompkins in Wonderland, Macmillan, 1940.