THE WORK OF THE COMMITTEE ON REAL APPLIED PROBLEMS IN ELEMENTARY ALGEBRA AND GEOMETRY.

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At the meeting of the Mathematics Section of the Central Association of Science and Mathematics Teachers, November 27-28, 1908, a committee was created to investigate the possibilities of gathering up the real applied problems of elementary algebra and geometry in life and of using them in teaching the subjects in the secondary school.

COÖPERATIVE EFFORTS OF ALL TEACHERS NEEDED.

It must be evident to all teachers of secondary mathematics that in the present strong tendency toward a practical and rational education, there is no work greater needed in secondary mathematics to-day than the investigation assigned to this committee. It must be evident also that the nature and magnitude of the undertaking are such as to demand the coöperative efforts of all teachers, and of others if possible. To collect and place in the hands of teachers for class room use a large and valuable body of the real applied problems of elementary algebra and geometry that are found in the various vocations, industries, sciences, and arts, must be the work of many hands. The committee must of necessity serve as a sort of clearing house in the investigation.

SIGNIFICANCE OF THE REAL PROBLEM MOVEMENT.

This movement to vitalize secondary mathematics by teaching in the school the applications of the subjects to the problems actually encountered by people in everyday life, in the various trades, in science, etc., is an attempt to make school work function in a practical way in the life of the individual. It is a phase of the present general reform movement in the teaching of secondary mathematics that is really fundamental to the others. It must be considered in the elimination and choice of subject-matter of mathematics in the school. The selection of subject-matter must to an extent be determined by its relative importance in the actual applications in life. It is a fundamental phase of the movement to unify secondary mathematics. Mathematics is unified in its practical applications. Some real problems involve both algebra and geometry. Such unification as exists in the practical applications will be preserved if these applications are brought into the school and used. Such unification is of the most genuine kind. *Mathematics as taught in the school should give a true conception of the mathematics that is actually used in the various human undertakings.*

Again, the old idea that education is a discipline of the general faculties of the mind, such as reasoning and memory, as a preparation for the future alone, is being abandoned. Formerly the motive and defense in teaching algebra and geometry was that of "mental dis-

cipline," looking primarily to the future. Geometry, for example, has always been taught as an abstract, deductive science in the secondary school, for the purposes of training the "reasoning powers," and sometimes in the hope that possibly in adult life, after leaving school, the pupil might find some practical use for it. It has continued all these years with practically the old Greek content. The pupil's present needs and interests have not been taken into account. But it is demanded to-day that in teaching secondary mathematics, as has long been the practice in teaching arithmetic, these present needs and interests shall be taken into account. In teaching algebra and geometry the selection of the subject-matter and of methods must be dependent upon both the pupil's present needs and interests and his future ones. The ordinary high school pupil is interested in algebra and geometry not as abstract sciences, but rather as *tools for solving the problems actually encountered by people in the various human undertakings*. He is interested in life itself, in how things are done in the practical world. This means that we must not keep algebra and geometry as abstract sciences, totally unrelated to human affairs, but must as far as possible *teach them in relation to their actual uses*. Let the pupil see that they are indispensable tools in doing the world's work.

To express the matter in a slightly different way, the true educative process not only begins with experience but ends with experience. It is here that the secondary school has failed to meet its obligations. It is the duty of the school not only to put the pupil into possession of the bodies of knowledge called algebra and geometry in a rational and interesting way, *but to teach him in the school how to make the applications of this knowledge in the solutions of real problems—to assist this knowledge to function*.

It is evident, then, that the work which the Association has undertaken to do, through this committee, is of fundamental interest to all teachers of secondary mathematics. And it is a work in which it is hoped that all teachers of mathematics will be anxious to assist.

WHERE APPLIED PROBLEMS MAY BE FOUND.

The fields in which the applied problems of algebra and geometry are to be found are many. Some problems, of course, will be encountered in other school subjects, such as manual training and physics. Problems will be found in the various building trades, such as carpentry and masonry, in bridge building and roofing, in civil engineering, in railroading, in machine-shop work, in navigation, in elementary astronomy, in architecture, in ornamental drawing, in manufacturing, in the principles underlying the use of measuring instruments, and in ordinary every day activities. In fact, they are apt to be discovered in most any corner, if one is on the lookout for them.

TYPES OF PROBLEMS, AND ILLUSTRATIONS OF THEM.

There are two types of applied problems in algebra: (1) those requiring an evaluation of a formula or function; (2) those requiring the solution of an equation or equations.

There are three types of applied problems in geometry: (1) those requiring a demonstration; (2) those requiring a construction to be made; (3) those requiring a computation based upon a geometrical fact. Of these types, the problems of the third are most easily found. It is urgent that teachers collect especially problems of the first two types in both plane and solid geometry.

An illustration of real problems requiring the evaluation of an algebraic formula is as follows:

1. The horse-power of a steam engine is obtained by use of the formula $H. P. = \frac{p \cdot l \cdot a \cdot n}{33,000}$, where p = the mean effective pressure in pounds per sq. in., l = length of stroke in feet, a = area of piston in sq. in., and n = twice the number of revolutions per minute. Compute the H. P. of an engine in which a test showed p to be 60 lb. per sq. in., n = 180, the area of the piston was 324.2 sq. in., and the length of stroke 28 in.

The following illustrates a type of applied problem in scientific dairy farming that may be solved by use of an equation:

2. A dairy cow requires 1 lb. of protein to 6 lb. carbohydrates in her food. Dry peas contain 10 lb. protein and 32 lb. carbohydrates per bu. (60 lb.) Hay contains 88 lb. protein and 880 lb. carbohydrates per ton. What should be the proportion of the quantities of dry peas and hay fed to a dairy cow, if these are to constitute her ration? (From the Stone-Millis Secondary Arithmetic.)

The following illustrates the type of geometry problem requiring a demonstration:

3. Justify the following method used in surveying a line AB beyond an obstacle, such as a building:

Measure off an angle of 60° at B, and measure BC sufficiently long to clear the obstacle, as in the diagram. At C construct an angle of 60° , and measure $CD=BC$, as in the diagram. Then at D measure an angle of 60° , giving DE. DE is the desired prolongation of AB.

The following illustrates the type of geometry problem requiring a construction:

4. To construct the pattern of a uniform-motion cam with a given throw and given maximum radius. (A wheel having its axis of revolution out of its center of figure. Cams are found in the printing press, sewing machine, etc.)

Let the given throw be AB , and the greatest radius OB . Divide AB into any number n of equal parts, at points C, D , etc. Through $A, C, \dots, B$, draw circles with centers at O . Draw rays dividing the angular magnitude about O into $2n$ equal angles. Beginning at A , mark the points where the consecutive circles and consecutive rays

intersect, and through these points draw a smooth curve, as in the diagram. Let the student draw the pattern of such a cam with throw equal to a given line l and greatest radius equal to a given line m .

HOW TEACHERS MAY AID IN THIS INVESTIGATION.

Individual teachers may find such applied problems as these, (1) by going into the machine shops, etc., where they are encountered; (2) by consulting men actively engaged in the various trades; and (3) by consulting trade journals and books on the building trades, sheet-metal work, applied mechanics, mechanical and industrial drawing, surveying, and the like.

In this work the committee have arranged to utilize this space in SCHOOL SCIENCE AND MATHEMATICS every month, to carry on the investigation for the Association. *Teachers everywhere are urged to send to the Committee every month all of the real problems that they can find. These problems, or as many as there will be room for, will be printed in SCHOOL SCIENCE AND MATHEMATICS each month, and proper credit given the contributors.* It is the hope of the Committee to print in pamphlet form for distribution with its report, at the next meeting of the Association all of the real problems thus contributed, giving credit to the contributors. It ought to be possible by such coöperative efforts of a large body of teachers working together to soon place in the hands of all teachers a valuable collection of the real applications of algebra and geometry for class room use.

It is earnestly hoped that every teacher of secondary mathematics will assist in this work. Do not wait until you get a large collection of problems before sending them, but begin at once. In all cases where problems are taken from trade journals or books, the contributor will please note the name of the publisher, etc.

Send all problems to James F. Millis, Francis W. Parker School, Chicago.

ARTICLES FROM CURRENT MAGAZINES.

American Naturalist: "Charles Darwin and the Mutation Theory," Charles F. Cox; "Juvenile Helps and the Recapitulation Theory," Robert F. Griggs.

Astrophysical Journal, January: "Notes on the Possibility of Fission of a Contracting Rotating Fluid Mass," F. R. Moulton; "Vertical Temperature—Gradients of the Atmosphere, Especially in the Region of Upper Inversion," W. J. Humphreys; "The Constitution of the Sun," J. F. H. Schulz; "Interaction of Sun-Spots," P. Fox and G. Abetti; "On the Absorption of Light in Space," J. C. Kapteyn; "Spectrum of Comet Morehouse" (1908c), E. B. Frost and J. A. Parkhurst; "Photographic Observations of Comet (c1908) Morehouse," E. E. Barnard; "On the Colors of some of the Stars in the Globular Cluster M 13 Hercules," E. E. Barnard; "On the Separation in the Magnetic Field of some Lines Occurring as Doublets and Triplets in Sun-Spot Spectra," A. S. King; "The Spectrum of Comet (c1908) Morehouse," W. W. Campbell and S. Albrecht.

The Auk for January: "Notes on the Occurrence of the Yellow Rail in Michigan," Norman A. Wood; "Nesting of the Bohemian Waxwing," R. M. Anderson; "Some Habits of the English Sparrow," C. W. Townsend; "Instinctive Stillness in Birds," William Palmer.

Botanical Gazette for January: "On Triple Hybrids," Hugo de Vries; "Periodicity in Spirogyra," W. F. Copeland; "On the Pollen of Microcarys Tetragona," R. B. Thomson; "A Vegetative Mutant, and the Principle of Homocosis in Plants," R. G. Leavitt.

Conservation for January: "The Joint Conservation Conference," "The Conference Proper," "The Rivers and Harbors Congress."

Industrial Education for January: "Relation of Industrial Education to National Progress," Booker T. Washington; "The Work of the National Society for the Promotion of Industrial Education," Carroll D. Wright; "Vocational Training and Trade Teaching in the Public Schools," James P. Haney; "Elementary Trade Teaching," Charles H. Morse.

Manual Training Magazine for February: "Engineering and Industrial Problems as Factors in Seventh and Eighth Grade Manual Training," Albert F. Siepert; "The Construction and Flying of Kites," Charles M. Miller; "Simplified Mechanical Perspective," Frank F. Frederick.

Physical Review for February: "The Coefficients of Gas Viscosity, II," Willard J. Fisher; "The Effect of Tension on Thermal and Electrical Conductivity," N. E. Smith; "A Study of Overcast Skies," Edward L. Nichols; "Note on the Short-Circuiting of Cadmium Cells," P. I. Wold; "The Dispersion of Electric Double Refraction," T. H. Havelock.

Popular Science Monthly for February: "The National Exposition at Rio de Janeiro," Professor Robert DeC. Ward; "A Biographical History of Botany at St. Louis, Missouri," Dr. Perley Spaulding; "The Latest Calabrian Disaster," Professor William H. Hobbs; "Jefferson Davis's Camel Experiment," Professor Walter L. Fleming; "Railroads and the Smoke Nuisance," Clinton Rogers Woodruff; "Account of a Trip in Southernmost Japan, with Early Records of its Discovery," Robert Van Vleck Anderson; "An American Contribution to the History of the Physiology of Digestion," Professor Lafayette B. Mendel; "The Instruments and Methods of Research," Dr. L. A. Bauer.

School of Review for February: "What the University Expects of the Secondary School," John M. Coulter; "Report of the Conference Committee on High-School English," John M. Crowe, Mrs. E. K. Broadus, James F. Hosc; "Elementary Science in the High School," Elma Chandler; "Making Botany Attractive," Willard N. Clute; "The Year's Progress in Mathematics in the University High School," G. W. Myers.