That Pure and Applied Mathematics Ought to Be Taught and Developed *Pari Passu* in Boys' Secondary Schools

Author(s): A. Dakin

Source: *The Mathematical Gazette*, Vol. 11, No. 157 (Mar., 1922), pp. 51-54

Published by: The Mathematical Association

Stable URL: <http://www.jstor.org/stable/3603939>

Accessed: 24-06-2016 05:04 UTC

Your use of the JSTOR archive indicates your acceptance of the Terms & Conditions of Use, available at
<http://about.jstor.org/terms>

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact support@jstor.org.

The Mathematical Association is collaborating with JSTOR to digitize, preserve and extend access to *The Mathematical Gazette*

THAT PURE AND APPLIED MATHEMATICS OUGHT TO BE TAUGHT AND DEVELOPED *PARI PASSU* IN BOYS' SECONDARY SCHOOLS.

By A. DAKIN, M.A., B.Sc.

It is now a commonplace of History, that Pure Mathematics had its origin in the practical needs of man, and that at intervals it has renewed its vitality by turning to its practical application. It has, during recent years, become increasingly recognised that the bases of mathematical education are the concrete and the practical; and this Association, by the Reports and Papers published in the *Gazette*, has emphasised the view that "the utilitarian aspect and application of Mathematics should receive a due share of attention in the mathematical course." This increasing respect for the concrete and practical has not only led to considerable changes in the teaching of Arithmetic, Geometry and Algebra, but has brought into the Schools closer co-operation between the teachers of Mathematics and Science, and has resulted in a very desirable correlation of the syllabuses in these subjects.

We have in one branch of Applied Mathematics, viz. Mechanics, a subject which, though based on experiment, is particularly well adapted to Mathematical treatment, and which should prove especially valuable as a link between the Mathematics and Science Departments of any school. The object of this paper is to suggest that alongside of the Pure Mathematics Course in every Boys' Secondary School there should be a Course in Mechanics starting at about the age of twelve or thirteen, and continuing throughout the school life. This is no new idea. In fact, when I received the invitation from the Council to open this discussion, my first impression was that the topic was ten or fifteen years out-of-date. Ten or twelve years ago the study of Mechanics was commenced in the schools at the age of sixteen years or after, and many boys left school without any knowledge of the subject beyond that obtained in a short and totally inadequate course taken in the Physical Laboratory in the III. or IV. Forms. It is, however, within the experience of the Members of this Association, that there has been a great improvement in this respect during the last ten or fifteen years. The Report on the Teaching of Mechanics issued by this Association in 1918 recommended that the teaching of this subject should be begun early. About thirteen was the age suggested; and, attached to that report is an Appendix giving four alternative schemes in Elementary Mechanics, arranged by well-known and experienced teachers for pupils between the ages of twelve and sixteen. Some of these schemes, at first sight, appear to be based upon an unduly optimistic estimate of the genius of the teachers and of the capacity of the pupil, but experience proves, that with the average teachers and the average pupil, a fair proportion of the work outlined in the most ambitious of the four schemes can be profitably taken before the age of sixteen.

Again, in December, 1919, the Committee of this Association published a "Report on the Teaching of Mathematics in Public and Secondary Schools," in which occur the following Recommendations:

"That the Mathematical course in the earlier stages should not be concerned exclusively with Arithmetic, Algebra and Geometry; that such subjects as Trigonometry, Mechanics and the Calculus should be begun sooner than is now customary, and developed through the greater part of the boy's school career."

"That no boy should leave school entirely ignorant of Applied Mathematics (e.g. Mathematics relating to the Stability of Structures, Motion of Bodies, Electrical Plant, Astronomy, etc.)."

The report further emphasises the value of "lapse of time," in dealing with

any subject in order that the ideas peculiar to that subject may be thoroughly assimilated.

It would thus seem that in opening this discussion, I am whipping a willing horse, but enquiry shows that there are still Secondary Schools giving little or no instruction in Applied Mathematics, and even now, as Mr. Fawdry told us two years ago, many boys leave school without any knowledge of the subject at all. Examination statistics show that in the various First Examinations (School Certificate and Matriculation Examinations), the ratio of the total number of candidates taking Pure Mathematics to the number taking Mechanics is very nearly 8 to 1. This means that in many schools, the subject is either neglected altogether, or postponed until the age of sixteen, when the pupils have taken their first examination. For, owing to the present overcrowded state of the curriculum of Secondary Schools, any subject not required for the first examination, is bound to suffer some measure of neglect in the years when pupils are preparing for that examination.

This neglect in the past has been largely due to the difficulty of the subject. The subject of Mechanics, based as it can be on surprisingly few principles, is admittedly difficult both to learn and to teach.

Even when based upon the large body of intuitional knowledge that every boy brings to its study, and upon experiment, which alone makes it a school subject suitable for boys of thirteen or fourteen, it still remains a difficult subject. But this difficulty is counteracted by the interest that every boy brings to its study, an interest which is partly inherent to the subject, and which partly arises from the fact that three out of every five boys at the age of thirteen or fourteen hope to become engineers or draughtsmen. Every boy has an interest in things mechanical, and unless you draw out from his intuitions and experience correct and accurate mechanical principles, he will evolve for himself principles which are likely to be erroneous and inaccurate.

Every teacher of Dynamics in a town must at times have marvelled at the detailed knowledge of motor-cars and motor-bicycles possessed by the average boy. A certain and speedy way to improve the teaching of Dynamics in the schools would be for the State or the Local Education Authorities to present every teacher of the subject with a motor-car! However, we must look for less direct but more probable remedies, and the one method open to us is for this Association to press, both in season and out of season, for more attention to the subject in the schools.

The subject will be developed under different circumstances in different ways, and it is, of course, essential that liberty should be left to each school to develop it on its own lines, but it may possibly give "reality" to this discussion if I briefly outline a method of which I have had experience, but for which I claim no novelty. Many pupils enter the Secondary School from the Elementary School at the age of twelve, and for the purpose of this description, I will take that as the beginning of the normal school life. For the first year there is no formal treatment of Applied Mathematics, but the pupils take a course in weighing and measuring, finishing with the Principle of Archimedes, and its simpler applications. The next year, after in many cases only one year's teaching of Algebra and Geometry, a course in Mechanics is begun, consisting mainly of experimental work and numerical examples on Springs (both in extension and compression), Levers, Moments, Parallel Forces, Simple C. of G.'s, Work, Machines, and finally the Triangle and parallelogram of forces. The fact that this preliminary course ends instead of begins with the parallelogram of forces, is, of course, not novel, but it is worth noting because, in my opinion, the fact that Statics is no longer based on the parallelogram law makes the introduction of the subject possible at an earlier age than hitherto.

During this experimental course, "talks" are given at intervals on the principles involved and also occasionally on the history of the development

of the subject. During this year proportion and easy numerical trigonometry are taught simultaneously with the statics, and continual cross-references are made between the Pure and Applied Mathematics.

The following year, Dynamics is treated in a somewhat similar manner, except that in this subject more appeal is made to intuition and fewer opportunities arise for experimental work. (Fletcher's trolley, of course, supplies most of the experiments at this stage.) The main aim is to develop the principle that variation of motion, both *in* straight-line motion and *from* straight-line motion must be explained in terms of "force." After a general talk intended in the main to guard against the possible misconception that rectilinear motion is the only possible one, the pupils discuss such motion, obtaining both acceleration and distance from a speed-time graph; they then pass to the case of uniformly accelerated motion, to motion under gravity, and then to the relation $\frac{P}{W} = \frac{f}{g}$, and finish with some easy examples of the Principles

of Energy and Momentum. During the year occasional talks are given on Astronomical subjects (*e.g.* on the motion of the planets and of comets), and these help to build up the idea that variation *from* straight-line motion must also be explained.

During the fourth year of the school course, both Statics and Dynamics are taken; topics omitted from the preliminary course are discussed and the whole subject consolidated. At the end of this fourth year, the pupil normally takes his first examination, and then either leaves or passes on to an advanced course. Pupils, proceeding to an advanced course in Mathematics and Science, can now discuss, in the first term of that course, Dynamics of Rotation.

The value of such a course both to the pupil and to the school cannot be over-estimated. The pupil has his appetite for things practical and useful at any rate partially satisfied, he finds a new interest in the lives and work of Galileo and Newton; the body of his mathematical knowledge is enlarged and new life is given to the whole.

The advantages to the school are evident: "Reality" is given to all the mathematical teaching; artificial examples in Algebra and Numerical Trigonometry are replaced by natural and directly useful ones; the Dynamics teaching supplies a stock of ideas which form an invaluable introduction to the Calculus; in addition the course provides a link between the Mathematics and Science teachers of the school, which ensures true correlation and real co-operation.

There is one other point—so far, I have restricted my remarks, in accordance with the terms of the motion, to Boys' Schools. When I was invited to open this discussion it was, I think, intended to cover both Girls' and Boys' Secondary Schools. I suggested the insertion of the word "Boys" before "Secondary Schools," because I am far from convinced that Mechanics should form part of the general school course for girls. My somewhat limited experience of teaching girls leads me to the conclusion that the subject makes but little appeal to them, and that consequently its teaching does not produce the same profitable results as in the case of boys. The scheme outlined is intended to meet the needs and satisfy the requirements of the average boy, and it would be a mistake to assume that it suits the average girl.

The time is approaching when Mathematics will no longer be a compulsory subject for examinations of Matriculation standard, and when that time comes there is a danger that the subject will play only a subordinate part in the education of girls. That danger will not be diminished, but will certainly be increased, by any endeavour to force upon Girls' Schools a scheme of work drawn up and arranged in the interests of boys. It may be that the question of Applied Mathematics for girls may best be solved by a course more descriptive and less computative, more historical and less experimental than the corresponding scheme for boys.

There is, however, in every Girls' School a small minority who have a very special aptitude for Mathematics, and we ought to press for opportunities for these girls to acquire some knowledge of Mechanics during their school life. From this "small but distinguished minority" come the future teachers of the subject in Girls' Schools, and it is important that all specialists and future teachers should have some knowledge of the applications of Mathematics. University Honours Courses should always comprise a compulsory minimum course in Applied Mathematics; it ought not to be possible for a girl to take up the teaching of Mathematics, having spent months or years doing "dreadful things with dreadful conics," and yet knowing nothing of the work of Kepler, Galileo and Newton.

To sum up, the suggestion is that in all Boys' Secondary Schools courses in Mechanics should be organised to continue practically for the whole of the boy's school life, and that in Girls' Schools opportunities should be provided, by the introduction of alternative courses of study, to enable those girls who have special aptitude to take an adequate course in Mechanics while at school.

A. DAKIN.

112. Specious. *Vieta* used *Species* when letters were used for numbers in general. 'Logistics' was used for calculation in general. This introduced *Specious*. His first tract on easy algebra was *De Logistica Speciosa*. Hence the language of algebra for some time was called the *Specious notation*.

113. Wordsworth went to St. John's, Cambridge, Oct. 1787. "When at school, I, with the other six boys of the same standing, was put upon reading the first six books of Euclid, with the exception of the fifth; and also in Algebra I learnt simple and quadratic equations; and this was for me unlucky, because I had a full twelvemonths' start on the fresh men of my year."—Wordsworth's *Autobiography*.

114. "By all means do not neglect your duodecimals. I was Senior Wrangler by knowing my duodecimals."—Turner, 1767. v. Neale's *Senior Wranglers*, p. 8.

115. As to mathematics [for her boy], the best plan is to start with practical work—surveying, practical geometry, etc., which can always be taught by the local schoolmaster.—*Taine*, advice in letter to Madame Francis Ponsot.

116. Up from High Elms with Henry Smith. As we were crossing London Bridge, the conversation turned on the importance of encouraging the study, at Oxford, of some of the less read Classical authors. . . . So we came round to the *Anthologia*, and he quoted the epitaph on Zosime, one of the most touching which antiquity has bequeathed to us.—Grant Duff's *Notes from a Diary*, March 4, 1878. [H. J. S., Savilian Prof. Geom., Oxford, 1861-1883.]

117. Of Winchester in 1822. Of Arithmetic I knew nothing—and of all that arithmetic should be the first step to, *a fortiori*, still less.—T. A. Trollope.

118. "Have we not now a geometrick school,
To teach the cross-legged youth—to snip by rule?"

(A taylor has lately informed the publick, in most of the newspapers, that he fits his customers by geometrick rules.) *Gent. Mag.* 1782, p. 37. Epilogue intended for *The Count of Narbonne*, written by Edward Malone, Esq.

119. I am told that Sir Isaac Newton foretold a great alteration in our climate in the year '50, and that he wished he could live to see it. Jupiter, I think, has jogged us three degrees nearer the sun.—Walpole to Mason, Feb. 25, 1750.

120. *Square* originally applied only to corners of a figure or at most to right angle corners. v. *P.C.* xxii.