few special problems, nothing is gained by their use that is not as conveniently and effectively attained by the more natural and more general notation of matrices. Both notations aim at dealing with many quantities at once, but in the quaternion notation these quantities are bound together with chains which have to be broken by the introduction of clumsy adventitious symbols, whereas in the matrix notation there is nothing superfluous. For instance, $\sum p_s q_s$ is in matrix notation simply pq, but when p and q are quaternions we have to multiply one by the conjugate of the other, and then pick out the scalar part of the product, writing it Spq' or $Sp'q$.

The memoir under review falls roughly into two parts; the first half gives the theory of the four-rowed square matrix in the language of quaternions. We are introduced to the *linear quaternion function*, which has the same effect as the general linear substitution in four variables. If A is the matrix of the coefficients in this substitution, and A' is its conjugate, then obviously $A + A'$ is symmetric, and $A - A'$ is skew. Thus we are led to associate a quadric surface and a linear complex, which, with the invariant tetrahedron of the substitution, form the materials for a considerable amount of elementary geometry.

It is well known that the classification of linear substitutions A depends on the invariant factors of $|A - tE|$ where E is the matrix of the identical substitution, and that the type of intersection of two quadrics

$$\sum x_r A \quad x_s = 0, \quad \sum x_r B_{rs} x_s = 0,$$

depends upon the nature of the invariant factors of $|A - tB|$. All this is carried out in quaternion notation, with the appropriate geometrical significance. The latter part of the memoir is devoted to the *bilinear quaternion function*, which is a linear combination, with quaternion coefficients, of four ordinary bilinear forms in two sets of variables. These complicated expressions are manipulated with wonderful skill, and made to yield a vast number of important geometrical results. A particularly interesting application is to the general quadratic transformation of space, in which any plane is transformed into a Steiner's quartic surface.

<div align="right">R. W. H. T. H.</div>

CORRESPONDENCE.

18 BELGRAVE SQUARE, MONKSTOWN,
Co. DUBLIN, *November 9th,* 1903.

To the Editor of the "Mathematical Gazette."

DEAR SIR,—May I call the attention of your readers to the fact that a Committee of the Education Section of the British Association was appointed, with Sir Philip Magnus as Chairman, this year at Southport, "to report upon the courses of experimental, observational, and practical studies most suitable for elementary schools," and to solicit their assistance in the important work the Committee has before it.

It is very desirable that the Committee should be in possession of all available information as to schemes of work that come within the scope of its enquiry, and which are at the present time in operation. If teachers who are carrying out original schemes of instruction, or who are acquainted with particularly good efforts in teaching observational and practical subjects, will favour the Committee with full details of such courses of instruction, it will be of the greatest possible assistance.

The enquiry will cover the following sections, and will be particularly concerned with the coordination of these with one another and with the ordinary subjects of the curriculum of an elementary school :

1. Practical and Experimental Arithmetic and Geometry.

2. Elementary Experimental Science (fundamental principles of Chemistry and Physics).

3. Nature Study and its relation to Botany and Geography.

4. Domestic Science and Art, including Cookery, Laundry-work, Housewifery, Hygiene and Needlework.

5. Manual instruction other than in the forms comprised by preceding sections, *e.g.*, Kindergarten, "Hand and Eye" training, Drawing, and the use of tools.

Teachers willing to assist the Committee will best do so by sending as full details as possible of courses of instruction, conditions of work, time devoted to the subject, methods and organisation, and (if convenient), *average* samples of the work accomplished or note books produced by the pupils; such samples will be carefully preserved, and when examined will be returned to the source from which they came.

As there is little time in which to make such an extensive enquiry, I wish, on behalf of the Committee, to appeal to teachers, inspectors, and others interested in these matters, to send to me at the above address, before Christmas, contributions that may be of service to the Committee.

Thanking you, Sir, in anticipation for the privilege of using your columns, believe me, yours very truly,

W. MAYHOWE HELLER, *Secretary to the Committee.*

NOTICES.

Professor Hudson's Saturday morning Lectures, to Teachers on the teaching of Mathematics, are postponed till next term, beginning January 23, 1904, 10 a.m., at King's College.

The Librarian begs to acknowledge receipt of the Annual Report of the "South Australian School of Mines."

COLUMN FOR "QUERIES," "SALE AND EXCHANGE," "WANTED," ETC.

(1) **For Sale.**

The Analyst. A Monthly Journal of Pure and Applied Mathematics. Jan. 1874 to Nov. 1882. Vols. I.-IX. Edited and Published by E. HENDRICKS, M.A., Des Moines, Iowa, U.S.A.

[With Vols. V.-IX. are bound the numbers of Vol. I. of *The Mathematical Visitor.* 1879-1881. Edited by ARTEMAS MARTIN, M.A. (Erie. Pa.)].

The Mathematical Monthly. Vols. I.-III. 1859-1861 (interrupted by the Civil War, and not resumed). Edited by J. D. RUNKLE, A.M.

Proceedings of the London Mathematical Society. First series, complete. Vols. 1-35. Bound in 27 vols. Half calf. £25.

(2) **Wanted.**

Vols. I.-IV. *Mathésis.* 1881-1884.

The Messenger of Mathematics. Vols. 2, 15-20, 24, 25.

Tortolini's Annali. Vol. I. (1850), or any one of the first eight parts of the Volume.

(3) Dr. Muir, The Education Office, Cape Town, will give Vol. 109, *Crelle's Journal,* to any member of the Mathematical Association whose set is without it.