in the room do the same work at the same time. Every new mesh or stitch that is introduced is first illustrated by the teacher before the class, on a frame which is high enough for all to see. It is rectangular, two feet by eighteen inches. Heavy threads or cords are drawn through its sides, crossing each other at right angles. After the seventh year, crocheting of loose, open, and close meshes, with one-colored yarn, is introduced. Next party-colored yarn is used, from which various beautiful figures are made, which gradually leads them to crochet articles of many beautiful patterns.

From the twelfth to the fourteenth year (the last year in the public schools), sewing is the chief branch. The patching and mending of torn garments is most thoroughly taught. In the last school-year the cutting and making of underwear is taught.

The specimens of work that come from those young hands are simply wonderful in points of neatness, skill, and taste. Any generous-minded person will be at once convinced that the capacity for happiness in those young girls is far superior to that of the class who have never been taught any thing else than mere book-knowledge.

SEBASTIAN THOMAS.

THE TEACHING OF ALGEBRA.

AMONG the papers lately presented to the Education society of London, is one on the teaching of algebra, by W. H. H. Hudson. It contains a great many passages of universal application, and such deserve to be reproduced in this country for the benefit of our teachers of mathematics. Mr. Hudson first answers the question, Why teach algebra at all? and, while fully recognizing the utility of algebra, he maintains that algebra is not to be taught on account of its utility, nor to be learnt on account of any benefit which may be supposed to be got from it, but because it is a part of mathematical truth, and no one ought to be wholly alien from that important department of human knowledge.

The next question is, When should algebra be taught? The answer is, At an early period of intellectual development. The reason for this is that algebra is a certain science, it proceeds from unimpeachable axioms, and its conclusions are logically developed from them: it has its own special difficulties, but they are not those of weighing in the balance conflicting probable evidence which requires the stronger powers of a maturer mind. It is possible for the student to plant each step firmly before proceeding to the next; nothing is left hazy or in doubt: thus it strengthens the mind, and enables it better to master studies of a different nature that are presented to it later. Mathematics give power, vigor, strength, to the mind. This is commonly given as the reason for studying them. This is also the reason for studying algebra early, that is to say, for beginning to study it early. It is not necessary, it is not even possible, to finish the study of algebra before commencing another. On the other hand, it is not necessary to be always teaching algebra: what elementary teachers have to do is to guide pupils to learn enough to leave the door open for further progress; to take them over the threshold, but not into the innermost sanctuary.

Children younger than nine will rarely be fitted to take up algebra; and, on the other hand, it is seldom advisable to defer its commencement until after twelve years of age. Certain preliminary acquisitions are essential for this study. The first of these, in Mr. Hudson's opinion, is the power of listening.

"By this I mean the habit of attaching an idea to what is said. Some pupils — I hope no teachers — consider it sufficient if the pupil can reproduce the words that have been used, without attaching any idea to them. Such pupils will not learn algebra. A pupil who has the habit of listening will not allow a teacher to use unintelligible language, and will be of great use in a class by stopping the teacher and asking for things to be repeated and strange words explained. It is difficult for a teacher to realize that sometimes he is using a vocabulary beyond his pupils. Interruptions of this kind, which show that the pupils are listening, are of great help to the teacher.

"This leads to the next essential preliminary: the student should be able to speak. I do not mean that a deaf-and-dumb person cannot learn algebra, but he can only be taught under great disadvantages. Thinking of the ordinary run of boys and girls, I say that they cannot learn algebra until they have learnt to speak. By speak, I mean can ask questions and can answer questions, can say what they know, and can point out what to them is obscure. It has been well said that a pupil who cannot ask a question in his natural voice is unteachable: my own experience confirms this. Some pupils put on a lecture voice, in which they answer questions put to them. I do not call this speaking. It is unnatural and artificial, and is a serious bar to progress. It arises from timidity, fear of the teacher, or fear of the rest of the class; and the latter is far more difficult to be got rid of than the former.

"Moreover, a pupil must have a sufficient command of language to be able to frame a complete sentence. I have heard of teachers who are satis-

fied with a single word as an answer, and who habitually put their questions so as to admit of such an answer. This does not encourage the art of speaking in the pupil; in fact, it destroys it, and is not to be commended.

"A third preliminary is the power of reading: this is far more difficult, and far more usually absent, than the preceding. Many a boy who can listen and speak has no idea of reading. He can, it is true, form the sounds appropriate to the words he sees, but he has not the habit of using a book as a mine of information, of reading in order to get the sense: his main idea too frequently is that of learning the sound of the words, like a parrot.

"There are few more valuable lessons that can be given to a boy than to teach him to read a book, and extract the sense out of it. This is what young children naturally do with their fairy-tales; but when they become school-boys and school-girls, their natural reading seems somehow to give place to a mechanical lesson-reading.

"Now, mathematical reading differs from most other reading in this: that it requires writing. This is the fourth essential preliminary. It is possible, no doubt, for a great genius to carry on all the steps of a piece of algebraical reasoning in his head. The ordinary school-boy cannot do this, cannot pass from one statement of the book to the next without inserting an intermediate step. The boy who has learnt to write, who always, while reading, has a piece of paper and pencil at hand to work out details as they arise, will learn algebra: the one who tries merely to remember the words and symbols of the book will make no real progress.

"These preliminaries of listening, speaking, reading, writing, do not properly come under the head of teaching algebra: they are so obviously essential, that I scarcely need have mentioned them, but in so many cases absent, that I implore those who have the early training of children not to lose sight of them in the vain hope that without them any progress in higher studies is possible.

"Another essential preliminary more distinctly bears on the subject. The teaching of algebra must be based on, and naturally arises out of, a sound knowledge of the principles of arithmetic. In return, the knowledge of algebra will enable a student concisely to express these principles, and to understand them more clearly. On this account, it is necessary that those who undertake the teaching of arithmetic should have a sufficient knowledge of algebra. This is another lower reason for studying algebra; namely, in order to be able to teach arithmetic.

"It is a mistake to teach a pupil any thing that he has subsequently to unlearn; the persistence of first impressions is notorious, therefore arithmetic should not be taught in such a way that it needs correction when algebra is studied. The two are naturally and historically connected; and one who is wholly ignorant of either is apt, also, to be unfamiliar with the other. The teacher should be above his subject, not in the sense of despising it, but as one who looks from a height upon a plain can see the topography of the country more distinctly than one on the lower land.

"Therefore, in the interest of algebra, I protest against the practice of despising arithmetic, of setting it to be taught in schools by persons ignorant of algebra, and, it may be, contemptuous of the subject they have to teach. A teacher of algebra ought to find the ground prepared for him by a sound knowledge of arithmetic; and it would be better, therefore, that the mathematical masters should undertake arithmetic.

"This leads to the next question, Who are to teach algebra? It may, perhaps, be thought by some that a teacher requires to be very little ahead of his pupil, and that one who has slight knowledge is good enough to teach a beginner. On the contrary, the proper teaching of the elements of any subject requires a teacher who has a knowledge considerably in advance. I do not hesitate to say that it would be well that a teacher of algebra should know something — and that something soundly — of the method of co-ordinate geometry, of trigonometry, and of the differential calculus. Teaching should be anticipatory. The algebra taught should be such as to prepare for these higher subjects, and this can only be effectually done by one who is acquainted with them. Moreover, the elementary teaching requires more care and more knowledge than more advanced. Nothing is worse than to lay foundations imperfectly. A necessary qualification for a teacher of algebra is, therefore, a sound knowledge of mathematics considerably in advance of the subject he is teaching.

"Next let us ask, How is algebra to be taught? It is fashionable nowadays, and I do not say it is a bad fashion, to attach importance to the training of teachers in methods of teaching. But I think too much importance can be attached to method. Methods that seem good, and are good when first introduced, seem to lose their virtue after a few years. An energetic teacher will be constantly changing his methods, and adapting them to the various characters of his pupils. Freshness and vigor are far more important qualities. Nevertheless, an unmethodical teacher, who would do very well for a single pupil, is incapable

of conducting a large class. My own personal predilections are in favor of a Socratic system of teaching, by asking questions, and so drawing out, — educating, — the mind of the pupil. I do not regard it as good to tell the pupil every thing. It is our object to train him to exercise his own powers. A child who is always carried will never learn to walk. But a child who can walk cannot get over a stile, and requires a lift now and then. It is a matter of tact to decide, in any particular case, whether the assistance is to be given or withheld. I do not feel competent to lay down general rules. With a pupil who can listen and speak, understanding these words as I have explained them, there is little difficulty in ascertaining whether the supposed inability to proceed arises from want of power or from laziness. It very often arises from want of will, not exactly a downright shirking of work, but a certain deficiency in determination. In such cases a guiding hand is better than a lift.

"That method of teaching is best which most stimulates the mental activity of the pupil, and that is the reason why methods after a time cease to be good: it is just because they are methods, and become mechanical, and so fail to stimulate activity.

"Algebra should be taught as if to an intelligent person. Unfortunately, all the pupils in a class are not equally intelligent. Still, people turn out very much as you treat them: draw out the germ of intelligence, and it will grow. A style of teaching that is based on the supposition that the class is unintelligent, is apt to end in making them so. To this end no slovenly work should be allowed. It is a mistake to look only at the answers of a set of exercises, and not to care about the orderly setting forth of the argument that leads to the answer. This is a practical detail that requires some skill to adjust: the mode of adjustment depends on the size and character of the class. Too much of the teacher's energy is in danger of being absorbed in examining exercises. The benefit of the exercise consists chiefly in doing it, and in so doing it that it needs no subsequent alteration: consequently the correctness of the answer is a most important point. But a practice of merely looking at the answer allows the boys to fall into slovenly habits, and may lead them into the unsound habit of working up to an answer.

"Considerable difference of opinion is expressed as to just how the first steps in algebra should be taken. It may be taken by using letters as general symbols for numbers, treating algebra as a generalized arithmetic; and there is much to be said in favor of this. In this way algebra presents itself as a language, and this is a view of algebra that ought to be put before the student at an early period. Some of the most instructive of the early exercises in algebra consist in translating general arithmetical statements into symbolic language, and in forming the equations which are the algebraical statement of problems. Simple equation problems can hardly be begun too early.

"On the other hand, the notion of the negative number can be acquired without the use of any fresh apparatus of symbols beyond those that the student has been accustomed to in arithmetic; and, as this is one of the greatest of the early difficulties of algebra, I have sometimes thought it wise to begin with it, so that the difficulty of the negative quantity may be mastered without the complication which the use of letters seems to give to the matter. I think myself that it is more logical to begin with the letters, but that it is, on the whole, easier for the student to begin with the negative quantity. To talk about and explain $5 - 8$ is simpler to a beginner than the use of a and b.

"But, whatever sequence of the parts of the subject is adopted in teaching, there should be no departure from a logical development. Algebra is built up on certain few axioms, and certain not very numerous conventions. A pupil should be led to see from the first the distinction between what is axiomatic and what is conventional; though, in the latter case, he may be unable, at an early stage, to see the convenience of the convention: he is not a sufficient judge of this, in many cases, till his studies have proceeded much further. But he should be encouraged to see for himself that the propositions of the science are correctly deduced by means of the axioms of which he admits the truth, and no matter should be taught which cannot thus be put before him.

"The gradual extension of meaning which such a term as 'multiplication' receives — first in arithmetic, when it is extended to a fractional multiplier; then in algebra, when the multiplier is likely to be negative; and finally in applied mathematics, when we contemplate a concrete multiplier — is a matter which should form part of the teaching of algebra to all, who should thus be led to see that in mathematics 'impossible' is a word of only temporary significance. A student who knows only arithmetic is justified in saying that $5-8$ is impossible; but the impossibility is a stile to be gotten over.

"In looking over exercises, it is often more important to look over those that are wrong than those that are right. When an example has been done right, correct in reasoning and accurate in

process, the teacher may look at it to see where the form might have been improved, how it might have been curtailed, what steps were superfluous, and so on. So long as any fault in reasoning has to be corrected, it is premature to examine inelegancies. I do not advise correcting too many mistakes at once. It disheartens a pupil to have too many faults found at once. One mistake in each example is ordinarily enough. The faults of reasoning are to be first corrected, then mistakes in work, and, last of all, mere matters of arrangement. I know that this order is distasteful to some pupils, who like first to be told how to put their work down. I recommend the other order: let them first reason out the proposition in the way which they can follow by themselves, and make no mistake about it; then they are able to appreciate the advantage of particular modifications of their process that a more experienced mathematician may suggest to them.

"As an example of what I mean, I may refer to division by a binomial factor, such as $x - a$. A pupil will at first naturally imitate long division in arithmetic; he may then be shown how the abbreviated, or synthetic method, as it is called, is a mere re-arrangement and curtailment of what he has done before; whereas, if he had been taught the shorter method as a rule from the first, it would have been a mere un-understood rule of thumb.

"It has been for a long time my practice, due to a hint from the late Mr. Todhunter, always to require to see an attempt and an exact statement of his difficulty from a pupil, of any problem that he says he is unable to solve, and which appears to me to be within his reach. The reason is, first, that I may see where the precise difficulty is, and so know what it is that I have to explain; and, still more, because in the act of setting forth the difficulty the obscurity has a habit of disappearing. A student may think he is unable to solve a problem because he cannot see his way from the beginning to the end; but he can generally draw some conclusion from the data of the question. I can then give him just the help he needs, whereas otherwise I am liable to explain to him what he really understands, not knowing what it is that stops him.

"The influence of examinations is not wholly bad, as at first sight one might be tempted to think. A teacher who has not the prospect of an examination of his pupils before him is apt to think that it is sufficient if his pupils understand the subject, and that requiring them to reproduce it is superfluous. In this they are liable to lose the great advantage which the necessity of writing out would have given them, and the teacher is extremely likely to credit them with a knowledge that the examination would have shown that they do not possess. As a test of knowledge, then, an examination is useful; nay, it is most valuable. But when the examination is made an end in itself, and when the object aimed at is to produce a semblance of knowledge to deceive an examiner, where the reproduction is made a primary object instead of a secondary one, in subservience to the mental education, then the influence of the examination is mischievous.

"However intelligent and teachable a pupil may be, he will occasionally make mistakes. The commonest forms of these annoying but comparatively innocent mistakes are miscopying either the question or their own work, arithmetical slips, and mistakes with the signs + and −. These mistakes do not always imply ignorance or inattention, and a teacher is unwise to attach too much importance to them: a few of them are quite consistent with a sound appreciation of principle. The effort should be made to undermine the causes of these faults, rather than to correct them when made. The chief of them is hurry. This is a growth of our age which sends down the fibres of its rootlets even to the minutest arrangements of school-life. Set before your pupils that accuracy is preferable to pace; accustom them to the habit of exact speaking and writing, even to the dotting of *i*'s and crossing of *t*'s, — and such faults will largely disappear."

THE STUDY OF LANGUAGE.

HUMAN language is wholly a psychological process. As von Humboldt long ago pointed out, it is nothing innate, but a function; it is no concrete object, but exists only in the soul of the indi-

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