made to operate successfully. He says that "school trustees elected to supervise the schools, and serving without any compensation, naturally object to being turned into constables and police officers for the purpose of apprehending delinquent children or the children of delinquent parents. Moreover, the schools are full. In most of the cities, the accomodations are taxed to the utmost. Any effectual execution of the law would at once create the necessity for additional buildings in every city of the state. But, notwithstanding these considerations, the problem cannot safely be treated with indifference by the state."

The normal-school work in the state seems to be in excellent condition. There are nine normal schools, employing 128 teachers, and having a total enrolment of 5,608. While these schools are in good hands, and doing excellent work, yet they are inadequate, for as now operated they do not fill one in ten of the vacancies occurring in the ranks of the thirty thousand common-school teachers of the state. The superintendent urges that the normal schools might accomplish larger results should they spend less time in foundation work, and confine themselves to special training and practice. Moreover, some scheme should be devised to bring the normal schools to a substantial uniformity, instead of leaving them so subject to local demands and influences as they now are.

After treating of the various other subjects that have come under his supervision, Mr. Draper concludes his report with some general observations and suggestions of more than local or state application. He inquires whether, since the state of New York is now spending $14,000,000 annually in support of its public school system, it would not be a good idea to spend a few thousand dollars, once in a while, in determining how to spend this vast sum to the best advantage. "Is our education as practical as it might be? Do we reach all the children we ought? In our ardor over the high schools, which nine-tenths of our children never reach, have we not neglected the low schools? Is there not too much French, and German, and Latin, and Greek, and too little spelling, and writing, and mental arithmetic, and English grammar being taught? Have we been as ambitious of progress in the lower grades as in the advanced? Are not our courses of study too complex? Are we not undertaking to do more than we are doing well? Is not the examination business being overdone? Are we not cramming with facts, which will soon be forgotten, in order to pass examinations, rather than instilling principles which will endure? Is not our education running on the line of intellectuality alone? Are we educating the whole man? Are we not giving up moral training more than we ought, because of the danger of trenching upon sectarianism? Is there no way of adhering to the one, and avoiding the other? Are we doing what we might in the way of physical culure? Ought not the state to do something at least to encourage industrial schools? Would we not secure better schools in the country if the township was the unit of government rather than the present school district? Does not the present arrangement help the well-to-do and leave the poor to get along as best they may? Should not the law which fixes five and twenty-one years as the limits of school age be changed to six and sixteen years? Is it not time to forbid the diversion of library moneys from their legitimate uses, or to provide that they may be expended for school apparatus instead of teachers' wages? Is our system of apportioning public moneys the wisest and the best? Is there no way of specially aiding the small, remote, and poor districts? Do our different classes of educational work supplement each other and fit together so as to make a symmetrical and complete system, and do they co-operate as they might and ought?"

As Mr. Draper adds, these are live questions, and appeal to educators the world over. To answer them, he makes the suggestive recommendation that a council of say thirty eminent educators, representing college, normal school, high school, and common school alike, be called, to meet at Albany to discuss these questions and make such recommendations and suggestions concerning them as it sees fit. In New Jersey, a state council of this sort is in process of organization, in pursuance of President Meleney's recommendation, made to the state teachers at their annual association meeting in Trenton last December; but there, it is unofficial, the first move having been made by the teachers. If it is wisely constituted, it should become an educational factor of great force in the state; and if Superintendent Draper's plan is carried into effect, New York state will have a similar body of representative advisers on educational subjects.

THE TRAINING OF THE FACULTIES OF JUDGMENT AND REASONING.[1] — *II.*

I now proceed to show how some of our school subjects may be employed in the systematic training of the judgment and the reasoning powers. I shall follow, as nearly as possible, the order laid down in the previous article.

The lessons which I have described under these

[1] From the *Journal of education*, a paper read before the Education society, Oct. 25, 1886.

heads, when illustrating the training of the faculty of conception, will serve admirably for exercising the child in forming implicit and explicit judgments, and in making statements concerning the striking attributes of things. For material objects, chalk, salt, coal, and the common metals will afford us numerous lessons; and so will the series of inquiries into the nature, properties, and action of water, so admirably described in Huxley's 'Introductory science primer.' For form, we may use the regular solids, surfaces, and lines; while botany and natural history will provide an inexhaustible supply of lessons on life.[1] The main thing will be to make sure that the child states, in clear, unambiguous language (which he understands), only such facts as he has really observed. Classification will inevitably introduce the formation of judgments, and definition will involve the putting of them into words.[2] But better, at this stage, than classification or definition, will be a simple narrative, given by the child, of what he has seen in the above lessons, or of what has happened to him during the past week or on some specially marked occasion.

Later, propositions may be presented to the child for acceptance or rejection, those being the best which can readily be shown to be true or false. Perhaps the easiest of such propositions will concern number and magnitude. For number, the simplest problems of arithmetic are ready to hand: even such as the old catch, 'which would you rather have, six dozen dozen, or half a dozen dozen?' will be useful. For magnitude, we may take such a problem as the arranging of a number of fractions in the order of their value, or a comparison of incomes derived from investments in different stocks, every step in the proofs being clearly indicated and explained. If we desire to be more concrete, we may choose such a problem as the finding of the shortest distance between two points, — placing the two points on the blackboard and letting a piece of string hang in a loop between them, showing how it projects beyond them when pulled straight; and then beginning with it straight, and showing how its ends must approach one another in order to allow the string to hang in a loop; and so on through the many simple problems of practical geometry. But the opportunities for exercising judgments are too numerous to need particular mention. Let us only bear in mind the order of their difficulty, and very soon introduce reasoning side by side with them.

At an early stage, you will remember, the child is to be encouraged to search for causes. Here, again, a wide field lies before us. The only difficulty is what to choose. Again, our only guide is the order of nature and simplicity. The reason why fire burns the hand, or why a book, when let go, falls, is difficult and complicated. But it is simple to discover why, if I divide a sheet of paper into four equal parts and take three of them, I get the same amount as when I divide it into eight equal parts and take six of them. At a much more advanced stage, we may attempt to find the reason why, if a number is divisible by nine, the sum of its digits is also divisible by nine; while all the simpler theorems of abstract geometry will supply the young inquirer with numberless examples fairly within his power — the theorems being put in the form of questions (why is a certain fact true? or, is it true or not true?). The main difficulties about causes lie in there being more than one of them at a time at work, and in their being hard to find. At first, therefore, the cases we choose should involve only single causes, and those very evident. Later we may proceed to such lessons as those on the forms of water, in Huxley's 'Introductory primer,' which I have already referred to, and which introduce more than one cause, — change of temperature and change of pressure, for instance, in the cases of evaporation and condensation. But even here we may make things much simpler by taking one agent at a time and noting its effect, instead of seeking for all the causes of some phenomenon. So we may note the effect of heat and of cold on water separately, the nature of steam, the effect of sudden change of density on moist air in the bell of an air-pump. A most interesting lesson may be given by gathering from our pupils, and discussing, all the instances we can of the disappearance of water — apparently into the air: clothes hung up to dry, wet pavements after a shower, water in a kettle boiled away, etc., etc. Again, the re-appearance of moisture from the air: the cold plate held over the steam from the spout of a kettle, the moisture on the outside of a glass of iced-water, dew when the sky is clear and the night fine, the washing-house, etc., etc. Then, the experiment with moist air in the bell of the air-pump, — the formation of the cloud due to the sudden lessening of pressure, the cloud depositing its moisture on the glass, and so on. We note the frequent, if not unvarying, concomitant in each

[1] See the admirable list of lessons under the heads of 'Form and space: Material and force: Life and organic products,' given by Dr. Wormell, in his paper on 'The teaching of elementary science,' in the *Educational times*, March, 1886.

[2] By *classification* and *definition*, I, of course, do not mean here the complete, full-grown acts of the adult, but the imperfect gradually-growing acts of the child. We are too often given to ignoring that there must be a growth and progress in these processes as in every thing else which a child *himself* does.

case, assume it as a cause, make further experiments on this assumption, in the way described in the 'method of experiment,' given above.

Causes may also be dealt with in our history lessons in numberless ways,— especially when the children are encouraged to bring their practical knowledge of modern things to bear on things of the past. The causes of the English settlement in Britain, of the invasions of the Norsemen and Danes, can be made fairly clear by the light of modern emigration and immigration. Why the English chose John for king, and their fellow-subjects on the continent (at least some of them) chose Arthur, will not be difficult for the children to discover; while, starting from our modern agricultural troubles, we may attempt a more elaborate chain of reasoning and accumulation of causes in explanation of the peasant revolt in the latter part of the fourteenth century. I do not think it will be needful for me to go into detail, — the demands of the peasants, the actual occurrences of the rebellion, and the events which immediately preceded and followed it, will suggest sufficient causes to the teacher and his pupils, and into these, investigation may then be made. Nor need I point out how strikingly suggestive of an explanation recent events have been, — distress of a general character, agricultural distress and disagreements, political discontent, the introduction of the element of rowdyism, socialism, wanton destruction of property by the regular London mob: even the guardians of order appear to have been as paralyzed and useless in this town of London on the one occasion as on the other. The analogy is strikingly complete. But we must be careful. Analogies are dangerous things, and are wont to carry us too far, and to make us read into a case evidence not really there. They should *suggest* the direction and nature of our inquiries, rather than be taken as in themselves sufficient explanations. But, after all, the great thing in work of this kind is to choose our subject-matter from common every-day events and things, or to bring what we choose at once into as close a relation as is possible with every-day experience and modern doings; moreover, we need not exhaust, or attempt to exhaust, all the causes for our phenomena. Provided that the children are made and *kept* keenly aware that there are other causes besides those we are considering, we shall do no harm in confining ourselves to the most prominent.

In the work we have been describing, we shall gradually have advanced from individuals to classes, — the statements at which we have been arriving will have contained predicates more and more general, and more and more abstract. Now we may begin to check and correct misstatements, to curb exaggerations, and to encourage the child to make more marked distinction between fancy and reality. We may begin some simple deduction, consisting of the application of some simple general principles, or general conclusions, to the explanation and solution of particular cases. Arithmetic and algebra — and, later, some of our language work — will be found of great assistance here. We could hardly begin with any thing better, perhaps, than the deduction of the rules for the multiplication and division of vulgar fractions from the general principles that regulate the nature of a vulgar fraction, and from the general principles of multiplication and division.

The ways of doing this are numerous, and familiar to every one: we, of course, generally begin by establishing the rules referring to those changes in the form of a fraction which do not affect its value, and in making clear the fact that the numerator and denominator of a fraction may be treated as the dividend and divisor of a sum in division; or, to put it concisely, such an expression as $\frac{2}{3}$ of 1 is the same as $\frac{1}{3}$ of 2. But whatever plan we adopt, of this we should take the greatest care, — that our reasoning is strictly and honestly deductive, and that its wording and its cogency are both thoroughly understood and appreciated by our pupils. This, however, is just the very thing that teachers, as a rule, will not take the trouble to do. They are in too great a hurry to get to the working of sums, — the mechanical manipulation of figures or symbols. This they seem to look upon as the great end of arithmetic work; and, when their pupils have applied a rule, never clearly understood, to some hundred perfectly mechanical examples, the teacher will lead them on with the utmost complacency to another mechanical exercise. Shall I be exaggerating if I say that more than half the teachers of arithmetic to children are unable to explain clearly to any one, when the time for explanation comes, the principles of, say short division? Not because the matter is abstruse and difficult, but because they have never thought it necessary to understand those principles.

The principles of the method of deduction, however, will come out more clearly in some of the problems of algebra, — such as the theory of indices, — and in simple propositions of theoretical geometry. It is lamentable how seldom one gets so easy a piece of reasoning as the theory of indices clearly and correctly set forth by pupils whom no diabolic complication of quantities and signs and brackets can dismay. They can manipulate almost any thing; they can reason out nothing.

The former is good enough in its way; but to omit the reasoning is, to my mind, to omit the most valuable part of the training. The text-books are, in a measure, to blame for this. We want the stages of the work more clearly marked, — the first assumption with regard to a^2, a^3, etc.; the more advanced assumption with regard to a^n, with the involved assumption that n is a positive integer; the first deductions as to the results of $a^n \times a^m$, and $a^n \div a^m$; the desirability of extending our notation, and introducing indices of *any* value; the necessity for a further assumption; our right to assume that $a^m \times a^n$ shall equal a^{mn+} for *all* values of m and n; the results of this assumption when applied to explain the meaning of a^n when n is zero, negative, and fractional. All these should be clearly marked, and clearly discussed; and, so treated, I know of no piece of elementary deduction more invigorating and satisfactory to the young learner. In geometry we usually fare better, — at least, in the text-books the reasoning is well linked and clearly set forth. The deductions are simple, and they have this great advantage, that they can be immediately put to use and be made to produce further deductions, while their value in practical work can be constantly exhibited. All this gives the child a sense of increased ability, progress, life, — which is so fascinating to him, and to all of us. It dispels the depressing feeling of futility which spoils so much of our work, and makes the school-room a tread-mill. But even in geometry the nature of the reasoning, and its limitations, are rarely sufficiently brought home to the learner. He is allowed to go on without an idea of how much, or how little, he has proved. How many, for instance, can explain why the induction of Euclid, i. 4, is a general truth, not limited to the case of the two particular triangles? Again, in language, analysis and parsing may afford excellent examples of the application of general principles to the explanation of particular cases, as may the correction of sentences in which the grammar or arrangement is faulty. But then we must be careful not to introduce distinctions which the language itself has never observed, or has long ago discarded. (The new Eton Latin grammar is a terrible sinner in this respect, with its aorist, and its array of tenses in the infinitive.) And we must abandon all such rubbish as that 'the second of two nouns is put in the genitive.' As to how the grammar of the mother-tongue, or of any other tongue, may be built up inductively, I need say nothing here. I have already more than once enlarged on the topic. Those who are still inquisitive as to my views and plans will find them fully set forth in my 'English grammar for beginners'[1] and my 'First lessons in French.'

Our next stage consists of the criticism of the statements of others, complex reasoning, and chains of demonstration. With regard to the two last, I have already somewhat anticipated myself, in what I have said about geometry and algebra. With regard to the first, I cannot do better than recommend exercises in the logical conversion of propositions and immediate inference. The rules are simple, and can be readily understood. They will be found, clearly set forth, in Mr. Jevons's little book, lesson x. From these we may pass to exercises in the detection of logical and material fallacies, which will be found both entertaining and highly useful. Mr. Jevons gives all the help that will be needed in lessons xx. and xxi., and likewise supplies us with many excellent examples — which may be supplemented from the well-chosen examples in Dr. Ray's hand-book of 'Deductive logic' (published by Messrs. Macmillan & Co.). Those which touch upon the personal experience of the learner will be the best. With regard to algebra and geometry, I will merely add that I think the first lessons in each should be much more carefully treated than is usually the case. In beginning algebra, we pass from the particular instances and particular symbols of arithmetic to general cases of number and general symbols; and we should be at the pains of making quite clear the nature of the change, the enlargement of limits, and the practical value of the new treatment. All this is far too much hurried over, as a rule; and an excellent opportunity for exercising the reasoning powers, and for what is even more important, exciting the curiosity of the pupils and displaying the practical utility of the work about to be attempted, is lost. As professor De Morgan pointed out, there is much to be learned from contrasting the proofs of $\frac{a+b}{2} + \frac{a-b}{2} = a$, or of $(a+b)(a-b) = a^2 - b^2$, with similar propositions in arithmetic; while the early introduction of problems involving simple equations is far more valuable and stimulating to the beginner than all the clearing of brackets, and simplifying of fractions and the rest, with which he is usually indulged. The corresponding work in geometry is the passing from the particular cases and inductions of practical, to the deductions and general truths of theoretical work. We should dwell upon the limitations of our earlier work; the reasons why a practical proof, such as that in

[1] In especial, I would refer to the carefully graded lessons by means of which I arrive at the definitions of the parts of speech, and to the lessons which show how, by *induction*, we may, and should, arrive at the rules relating to the order of words in a sentence, and to the use of stops.

Euclid, i. 4, holds generally, while we need something more than practical experiment to prove, say, that vertically opposite angles are equal, or that the three angles of any triangle are always together equal to two right angles. The need for proofs that are generally true may be brought out very clearly in such a matter as the consideration of the best practical methods for measuring plane surfaces, or some other similar work. In any case, let us bring home to the learner the need for more general proofs, and the nature of the method adopted for obtaining them ; while, all through our geometrical work, let us keep in mind how refreshing it is to be allowed to see and appreciate the bearing of theory on practice, — the practical utility of the results of our theoretical work. Once again, what better means can we have for exercising pupils in mixed inductive and deductive reasoning than political economy? We may begin with a story from Miss Martineau's collection, — or, to be more precise, we may take 'The shipwrecked sailors,' from Mrs. Fawcett's 'Tales in political economy,' and work up to the question as to whether luxurious expenditure and waste are good for trade, or to the great problem of demand and supply, and the price of commodities, — making deductions from the principles at which we arrive, and testing them by comparison with the results of practical experience.

I will conclude by reminding you, that, for pure induction, you will generally have to rely on the physical sciences, — of which botany, energetics (if I may use the word), and chemistry will be the best for school purposes ; while, for deduction, the whole field of mathematics lies before you. I may add that you will find an excellent model lesson in induction on the 'pile-driving machine' in Professor Payne's 'Lectures on education.' In mathematics, perhaps the best and simplest example of induction suitable to beginners is the well-known 'binomial theorem' for positive integral indices.

H. COURTHOPE BOWEN.

MODERN BIOLOGY AS A BRANCH OF EDUCATION.

A GLANCE at our higher educational institutions to-day shows a tendency toward an increase in the importance of biological science. Everywhere biology is being separated as a distinct department, and at least one school is founded for the express purpose of pursuing this study. An increasing stress is being placed upon this science as a part of a liberal education, and its number of students is growing rapidly. We wish, in a few words, to show why this is so, and to give the grounds upon which biology is every year demanding more recognition.

Biology is sometimes called a *new* science. This is not because the subject-matter treated of is new, nor because living nature is a new subject for study, but rather because the method of study has so changed in the last twenty-five years that the study of life appears under an entirely new aspect. As material for a descriptive science, animals and plants have been studied for centuries, but biology as a dynamical science is of comparatively recent growth. Modern biology is neither zoölogy nor botany, though it of course includes the study of both animals and plants. The terms 'zoölogy' and 'botany' usually convey to the mind the idea of long names and tedious descriptions, with an overwhelming abundance of uninteresting details, and the student well asks what is their value to him. If biology offered to its students to-day no more than a description of animals and plants, it would be well questioned whether it should in justice demand any greater attention than has been allotted to zoölogy and botany for fifty years past. But scientific teachers are beginning to see that the learning of names and descriptions should bear about the same relation to biology that the learning of dates bears to history. Some dates must be learned in studying history, and some names and descriptions must be learned in studying biology ; but the former does not constitute history, nor the latter biology. The rapid extension of observation on vital phenomena, and the more careful thought thereon, have been teaching scientists to comprise large groups of facts under general forms, and thus to deduce general laws regulating life. It is the study of these principles which is coming more and more to constitute the science of biology. The enormous multiplication of species is making zoölogy and botany unwieldy subjects to be treated in any general way. Classifications have, by reason of recent discoveries, grown so intricate and complicated that they can no longer be taught to the general student with any degree of satisfaction. But this very increase in discovery is adding to science new laws, is rendering intelligible the older ones, so that the material for the study of biology, as separate from zoölogy and botany, is becoming more abundant. Biology is thus rapidly freeing itself from the dry bones of detailed classification, and becoming of more and more interest and significance to the general student. Biology is growing to be more the study of life-principles as illustrated by animals and plants ; is becoming, therefore, more a study of life, and not so much as it has been a study of living things.

It is biology with some such scope as indicated above, that is now claiming to be recognized as a necessary part of a liberal education. Education