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ON THE PRINCIPLES

OF

ENGLISH

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ON THE PRINCIPLES
OF
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BY

THE REV. WILLIAM WHEWELL, M.A.,
FELLOW AND TUTOR OF TRINITY COLLEGE, CAMBRIDGE; AUTHOR OF
A HISTORY OF THE INDUCTIVE SCIENCES.

THE SECOND EDITION,
INCLUDING ADDITIONAL THOUGHTS ON THE
STUDY OF MATHEMATICS.



Λαμπάδια ἔχοντες διαδώσουσιν ἀλλήλοις.

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RECORDS

OF THE UNIVERSITY OF CHICAGO

1892

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RECORDS
FOR THE YEAR 1892

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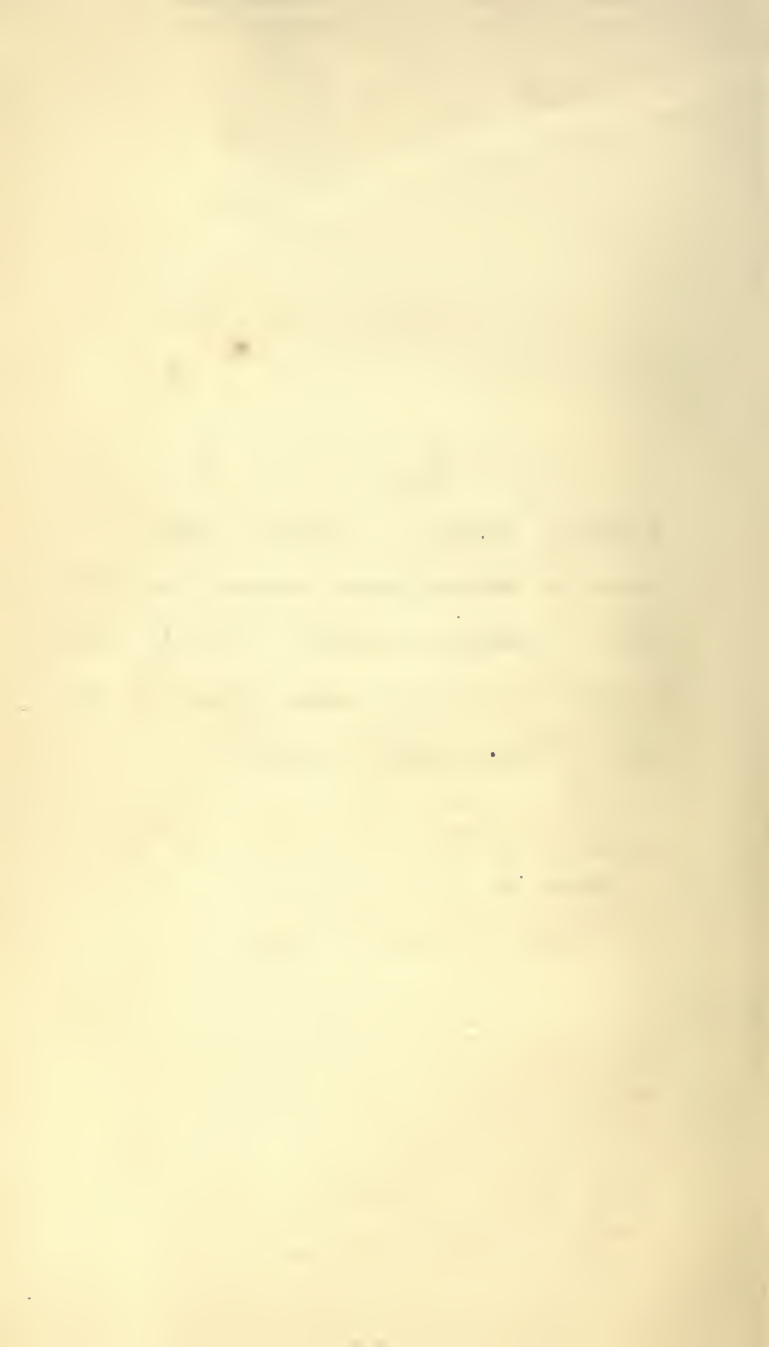
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IN this Edition, I have added a few Reflexions tending to illustrate further the nature of the intellectual training which the study of Mathematics supplies; and the mode in which it must be conducted, after the first stage, in order to answer its purpose.

TRINITY COLLEGE,

May 25, 1838.

W. W.



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ON
THE PRINCIPLES
OF
ENGLISH UNIVERSITY EDUCATION.

PREFATORY REMARKS.

THE considerations which I here offer to the public on the subject of Education, have been suggested by a long and somewhat laborious course of researches on the principles and history of science, and by many years' experience as a tutor in a principal College of the University of Cambridge. I trust, therefore, that I shall stand absolved from all suspicion of approaching so important a subject without due thought and preparation. I have for some time intended, on the first occasion of comparative leisure, to state my views on the points here treated of; and I should have done so, in the same manner, and probably nearly at the same time as I have done, whether or not other pamphlets on questions connected with the English Universities had appeared. I request the reader, therefore, not to mix me up in his thoughts with any controversies

on such subjects which may happen to be going on at this time. I mean not to express any disrespect to persons engaged in such controversies; but I must take the liberty of saying, that I have neither sought nor shunned the discussion of any questions on which they may happen to have touched.

There is another controversy, to which some part of the following pages may appear to have reference;—the question of the comparative value of *Mathematics*, and of certain other studies which have been termed *Philosophy*, as instruments of Education. An Edinburgh reviewer, in a criticism upon a former publication of mine, maintained that the study of mathematics is, for such a purpose, useless or prejudicial; and recommended the cultivation of “philosophy” in its place. In a letter to the Editor of the Review, (which I published,) I expressed my willingness to discuss the subject at a future time; and, referring to the mathematical course of this University, as my example of mathematical education, I requested to be informed, by description, or by reference to books, what that “philosophy” was, which the reviewer was prepared to contend for, as a better kind of education. I considered this as a proceeding, in the courtesy of literary combat, equivalent to sending my opponent the measure of my weapon, and begging to be furnished with the dimensions of his. When, therefore, the reviewer, in reply, flatly refused* “to perplex the question by a compliance with Mr Whewell’s misplaced request,” I certainly considered myself as freed from any obligation to continue the

* Edin. Rev. No. CXXVII.

controversy. No adherent of the reviewer could expect me to refute a proposition which the author himself did not venture to enunciate in an intelligible form. And, therefore, in the present book, I do not at all profess to discuss the question of the value of mathematics, and other kinds of philosophy, with reference to the reviewer's assertions, but simply so far as it is brought before me by the general course of my reflections.

I must also observe, that my remarks, at present, will be bounded within the limits of my title. I do not undertake to examine the subject of education in general, but the *Education of Universities*; nor again, of Universities in general, but of *English Universities*. Moreover, I am far from intending or hoping to treat the subject, even thus limited, fully and completely; my purpose is merely to offer certain Considerations, having reference to the general *Principles* on which the work of English Universities is and must be conducted, rather than to their actual condition and their proceedings in detail. I trust, however, that the Principles which I shall endeavour to establish, are so far substantial and practical, that their application to the real business of Universities will be obvious and immediate.

A formal division of my subject might appear as if I intended to exhaust it, and might mislead the reader, since, as I have said, such is not my purpose. But it will, I think, add to the clearness of what I have to say, to divide my Considerations into three chapters; of which, the *first* will refer to the *matter* taught, and mainly to the question of what may be termed Practical and Speculative

Teaching:—the *second* chapter will have reference to the *manner* of teaching, and to the relative value of the Direct and Indirect Methods of instruction:—the *third* chapter will treat of that superintendence and control, besides the mere teaching of the understanding, which, under the name of *Discipline*, has hitherto been considered a part of the office of English Universities. On all these subjects I trust I shall be able to point out certain large and weighty alternatives of principle, between which, in all our Universities, old or new, we must necessarily choose; and I hope I shall be able to give satisfactory reasons in favour of that choice which I venture to recommend. I now proceed to my task.

CHAPTER I.

OF THE SUBJECTS OF UNIVERSITY TEACHING.

SECT. 1.—OF THE DISTINCTION OF PRACTICAL AND SPECULATIVE TEACHING.

THERE are two modes of teaching, which, in a general view, may be broadly distinguished from each other. In the one mode the lecturer merely expounds to his audience the doctrines or results belonging to some branch of knowledge; he states the discoveries and speculations of antecedent philosophers, or his own, while the office of the audience is only to attend to him; they have to listen, to receive, think on, and treasure up what the speaker delivers, without being called upon themselves to take any active part; without being required to produce, to test, or to apply the knowledge thus acquired. In another mode of teaching, the learner has not merely to listen, but to do something himself; not merely to receive, but to produce his knowledge:—as when the mathematical student proves the proposition which is enunciated by his teacher, or solves a problem proposed by him;—or when the classical scholar renders Horace or Thucydides into English. The former I call *speculative*, the latter, *practical* teaching. And I must beg the reader to recollect the manner in which I use these terms; namely, with reference to the *mode* of teaching, not the possible application of the *subject* taught. It is

because geometry is taught thus *practically*, and not because it is what is commonly called "practical knowledge," that I designate the cultivation of geometry, in the manner which prevails in English Universities, as Practical Teaching. In their marked forms, these two kinds of teaching are very clearly distinguished. Lectures uncombined with any questions or practical demands on the learner, are familiar to us in our own Universities, in those of foreign lands, in the metropolis, and in the provinces; as modes of treating of physics and metaphysics, geology and political economy, taste and politics. All such lectures I speak of as speculative teaching, since they are employed in delivering to the hearer the doctrine adopted by the teacher, in a speculative form. Practical teaching, where the scholar, with voice, pen, or pencil, follows the track pointed out to him, and is constantly brought back into it when he deviates, are still more familiar; for by this method we learn every thing that, in the most peculiar sense, we learn at all. It is by such a process that we become able to read, to write, to cast accounts, to translate Latin and Greek, to speak French and German, to solve equations, to obtain our own results in the highest branches of mathematics. The teaching of mothers and fathers, of schools, and a great part of the teaching of our English Universities, has hitherto been of this practical kind.

Now we may observe, that when we come to such branches of literature and science as are likely to be selected for the matter of University teaching, some of these branches naturally and almost inevitably require to be taught practically, while others as

clearly are more fitted for the speculative mode of teaching. Languages and mathematics are of the former kind; but many of the sciences, and those especially which are wide and varied in their topics, those which involve doubtful or newly-established principles, those of which the foundations are constantly undergoing changes, can hardly be taught otherwise than speculatively. Such subjects are, for example, geology, political economy, and, as appears to me, metaphysics. In such subjects as these, the student may listen, and may acquire such knowledge as the teacher possesses; but he is not, and cannot be called upon, as a part of the teaching, to do something which depends on the knowledge thus acquired. He may follow with the clearest apprehension, and it may be with full and well-founded conviction, the views which are presented to him by the teacher; but still he is passive only; he is a spectator, not an actor, in the intellectual scene. He does not interpret and employ a peculiar acquired language, as he does in his classical reading, or his algebraical calculations.

What I have called practical teaching prevails in the Colleges of our English Universities. A large portion of the teaching, in those institutions, has always consisted, as it still does, of exercises, in which the pupil translates his Greek or Latin author, proves his proposition, or solves his equation, in the hearing or under the eye of his tutor; or answers interrogatories, in which he has to produce the knowledge which he has acquired. I believe this to have been the mode of teaching employed among us from the earliest times. In that College, at least,

of which I know most, such a method is enjoined in the statutes. Disputations are to be constantly held in the chapel; verses written and affixed in the hall; and the lecturers are to employ half an hour in expounding their author, but a whole hour in examining their class*. But besides these practical lectures, we have always had lectures of the speculative kind, delivered by the University professors. Such lectures on history, morals, political economy, law, medicine, anatomy, geology, botany, mineralogy, chemistry, the mechanical sciences, and other subjects, have constantly been going on in our Universities; and have, especially of late years, often excited very great attention. We may, therefore, distinguish our practical and speculative teaching, as *college lectures* and *professorial lectures*; — and such a distinction corresponds to the phraseology commonly in use among us.

It may be said, that with professorial lectures examinations may be combined, and that such lectures may thus be converted into practical teaching. Nor do I intend to deny that, under certain conditions, which I shall afterwards endeavour to determine, this effect may be produced. But without now entering into this subject, I trust that the main features of the distinction, which I am trying to point out, of the two kinds of teaching, are already sufficiently clear.

Now it must be observed that, though all branches of science and speculation, old and new,

* *Lectorum singuli horam in dies singulos quibus legere tenentur in classe suâ examinandâ consumant; dimidiatam vero in auctore interpretando. Stat. Trin. Coll. Cant. cap. 9^{mo}, De Lectorum Officio.*

fixed and moveable, may be made the subjects of exposition in lectures, practical teaching is applicable only to a limited range of subjects;—those, namely, in which principles having clear evidence and stable certainty, form the basis of our knowledge; and in which, consequently, a distinct possession of the fundamental ideas enables a student to proceed to their applications, and to acquire the habit of applying them in every case with ease and rapidity. The ideas of space, of number, of the general relations of grammar and the force of language, are necessary and immutable parts of the furniture of the human mind. And mathematics and languages, which are the development and working of these ideas, can be practically taught, for we can appeal to these ideas, and familiarize the mind with a series of vast and varied, yet certain consequences, to which they lead. But when we come to the wider physical sciences, we can only present the facts as a matter of observation, and the speculations as dependent on the facts. Here there is no room for acquiring habits of interpretation which can be tested by the teacher. And in sciences which are not physical, as morals or metaphysics, the philosophy of history, or of taste, the instruction is still more inevitably of the speculative kind. The teacher must be content to tell, and the learner to receive, what has been thought, or ought to be thought, on these subjects. He does not, by learning them, acquire a new faculty, which he must practically exercise. Such subjects as I have just described, may, perhaps, without impropriety, be distinguished by the collective title of “philosophy;” and if this be allowed,

it will, I think, appear, that *philosophy* is only fitted for speculative, as *mathematical and classical* studies are for practical, teaching. In saying this, I do not at all profess to know, whether I am employing the term "philosophy," in the sense attached to it by other persons, who may have written on the subject; but it may, I think, designate appropriately a large class of studies, all of which admit of the same mode of communication to the student.

In such studies, moreover, even if examinations be added to lectures, they can hardly constitute a practical teaching; for in such instances, the knowledge which lectures convey, is either merely retained in the memory, or is employed as material for further speculation by the student, and is not assimilated and converted into a practical habit of intellectual action. Examinations, therefore, in these cases, may test the goodness of the memory, and the clearness of the apprehension or general faculties; and we may also conceive examinations of a higher kind, that call out the powers of original thought, and detect the activity of talent and genius. But to require proof of mere memory and clearheadedness is not practical teaching, in the same sense as it is so to ascertain that a power of interpretation or calculation has been acquired; and the higher kind of examination which we have mentioned, in which the student is called upon to give evidence of his own speculative talent, presupposes that practical teaching of which we here speak, and is not to be confounded with it. And thus, even with the addition of examinations on subjects of general philosophy, there will still remain, between those studies

and the mathematical and classical pursuits of the English Universities, that difference which I describe by calling the former speculative teaching.

Thus the distinction of speculative and practical instruction, which at first sight appears to be a difference of the manner of teaching, is found, on examination, to imply a difference of the subjects taught. When we have determined that we will teach practically, we have decided that we must lecture, not on philosophy, not on metaphysics or speculative morals, or political economy, but on subjects of a different kind;—on the works of Greek and Latin authors;—the properties of space and number;—the laws of motion and force.

Of course, I mean only, that *so far* as we teach practically, we must select such subjects. Nothing prevents us, and as I have said, we have not been prevented, from giving, in addition to our college courses, professorial lectures on all the other subjects which I have mentioned. But it is not on that account the less important to my purpose, to keep the consideration of the two kinds of study distinct. It is obvious also, that, in many cases, the same subject admits of being dealt with in both ways. We may not only ascertain that our pupils can translate Sophocles, but we may present to them the widest speculative views at which critics have arrived, respecting the history and structure of the Greek language, or the Greek drama. We may enter into discussions respecting the metaphysical grounds of the axioms of geometry, the processes of algebra, the laws of motion. Such speculations and discussions are of the highest interest and value; but it is easy

to see that they are something in addition to the teaching of Greek and mathematics. They add immensely to the value of the practical acquisition of language and mathematical habits, but they presuppose the acquisition; and when these philosophical views are substituted for the practical instruction, they are altogether empty and valueless as means of education.

But I do not here insist upon this point. In the present section, my object has been to distinguish the two systems, before I compared them. Trusting that the distinction is now sufficiently clear, I proceed to the comparison. And this I shall consider with reference to such points as these:—the effect on the intellectual and on the moral character of those who are educated, and on the general progress of national culture and civilisation.

SECT. 2.—OF THE EFFECT OF PRACTICAL TEACHING
ON THE INTELLECTUAL HABITS.

THE advantages which belong to the study of mathematics, as an intellectual discipline, have been often stated by various persons. I may repeat language which I have already used:—“In mathematics, the student is rendered familiar with the most perfect examples of strict inference; he is compelled habitually to fix his attention on those conditions on which the cogency of the demonstration depends; and, in the mistaken or imperfect attempts at demonstration made by himself or others, he is presented with examples of the most natural fallacies, which he sees exposed and cor-

rected." My Edinburgh reviewer* expressed a wish, that these latter "novel assertions had been explained and exemplified;" and obviously, was really at a loss to understand them, although they refer to the daily occurrences of the lecture-room. This is a curious proof how entirely practical teaching is lost sight of, amid the speculations of his school. I may observe, too, as I have done elsewhere †, that reasoning, as a practical habit, is taught with peculiar advantage by mathematics, because we are, in that study, concerned with long chains of reasoning, in which each link hangs from all the preceding. "The language contains a constant succession of short and rapid references to what has been proved already; and it is justly assumed, that each of these brief movements helps the reasoner forwards in a course of infallible certainty and security. Each of these hasty glances must possess the clearness of intuitive evidence, and the certainty of mature reflection: and yet must leave the reasoner's mind entirely free to turn instantly to the next point of his progress. The faculty of performing such processes well and readily, is of great value;" and this faculty can hardly be acquired and cultivated in any other way, than by the study of mathematics.

I shall not pursue the consideration of the beneficial intellectual influence of mathematical studies. It would be easy to point out circumstances, which show that this influence has really operated;—for

* Review of Thoughts on the Study of Mathematics, p. 127.

† Mechanical Euclid, with Remarks on Mathematical Reasoning, p. 144.

instance, the extraordinary number of persons, who, after giving more than the common attention to mathematical studies at the University, have afterwards become eminent as English lawyers. It would be easy, also, to gather together a "cloud of witnesses," who have spoken with admiration and enthusiasm of mathematics as a discipline of the mind. But this would be a very idle mode of treating the subject; for it might be possible also, to adduce a large bulk of similar testimony on the other side. And what could be inferred from this array of cloud against cloud? Except we can get some clear insight into the subject ourselves, we can never know whether the authors we adduce, are not speaking from views as vague and confused as our own. When any one will point out any other study, as a mode of *practically teaching* reasoning, which he maintains to be preferable to mathematics, we may be tempted to make the comparison; but this has not been done, so far as I know.

It may be said, that mathematical reasoning is but one kind of reasoning, and that the study and practice of this alone, ought not to be spoken of as the cultivation of the reasoning power in general. To this, I reply, that the faculty of reasoning, *so far as it can be disciplined by practical teaching*, receives such a discipline from mathematical study. If, for instance, any one says, "Why do you not cultivate the habit of *inductive* as well as of *deductive* reasoning?" I answer, that the only cultivation of which inductive reasoning admits, is that which is supplied by deductive reasoning. For when we collect a new truth by induction from facts, what is

the process of our minds? We acquire a new and distinct view, or hit upon a right supposition; and we perceive that, in the consequences of our new notions, the observed facts are included. The former part of this process, the new and true idea suited to the emergency, the happy guess, no teaching can give the student. All that we can do is, to fix the idea when he has it, and to teach him to test his hypothesis by tracing its consequences. And this, the cultivation of deductive habits does. We cannot teach men to invent new truths; we cannot even give them the power of guessing a riddle. But those who have been inventors, have always had, not only that native fertility of mind which no education can bestow, but also a talent of clearly and rapidly applying their newly-sprung thoughts, in which talent half their power consisted, and which is precisely that faculty which mathematical habits may improve. And the distinctness of the fundamental ideas (a state of thought essential alike to sound reasoning from old truths, and to the discovery of new,) is not unprovided for by the study of mathematics; for though deductive habits do not *give* distinct fundamental ideas they *demand* them; and, by the constant appeal to such ideas, they fix and develop them. A perception of the truth of mathematical axioms cannot be conveyed into the mind by reasoning; but still, the mathematical reasoner usually sees more clearly than other men, the necessary truth of his axioms*. Other persons may have the idea of space, as well as the geometer;—the idea of force

* On this subject, see the Remarks at the end of the Mechanical Euclid.

and matter, as well as the mechanician; but these ideas shine with a clearer and steadier light in the minds of those who constantly work by such lamps, and therefore, carefully tend and trim them.

Since the study of mathematics is thus useful, not only in teaching habits of deduction, which are exemplified in its proofs, but also in leading men to the distinct ideas which are expressed in its definitions and axioms, we learn a lesson respecting the kind of mathematics which we may most advantageously introduce in our education. For since those clear ideas upon which the several mathematical sciences depend are a valuable mental possession, both on their own account, and as examples of such a class of elements of truth, we ought not to be content with one or two such ideas and their consequences, but should introduce the student to a wider range of mathematical proof. We shall thus succeed best in repressing the evil consequences which might arise from confining ourselves to one kind of reasoning. We ought, therefore, to include in our course, not only pure mathematical sciences, geometry, arithmetic, and algebra, the consequences of the fundamental ideas of space, number, and quantity; but we ought also admit the consequences of other ideas, which lead to rigorous mathematical sciences, such as the ideas of pressure and matter, of rigidity and fluidity, of velocity and force; of which ideas the developements are found in the sciences of Mechanics and Hydrostatics. This maxim I have already urged, in a former publication on this subject*.

* Thoughts on the Study of Mathematics; reprinted at the end of this volume.

And I rejoice to say, that a recent alteration in the examinations of the University of Cambridge, by which certain portions of Mechanics and Hydrostatics are introduced into the lower Examinations for Degrees, has made our system, what appears to me, on the grounds just stated, a better intellectual education than it was before.

I shall not here dwell upon the intellectual effect of the practical teaching of Greek and Latin, but proceed to consider the effect of the two systems of instruction in another point of view.

SECT. 3.—OF THE EFFECT OF PRACTICAL AND SPECULATIVE TEACHING ON THE PROGRESS OF CIVILISATION.

IF I were to begin by asserting that the progress of civilisation is essentially connected with the prevalent education, the assertion would probably be assented to; but at the same time, it would probably also be understood in so general and indistinct a manner, that no real use could be made of it in our argument. The connexion is, indeed, generally acknowledged; for instance, Dr Diesterweg's pamphlet, in which he so deeply deplors the present diseased condition of the German Universities, (a subject which has recently excited much remark in that country,) is entitled*, "The Vital Question of Civilisation." But some definite statement of the nature of this connexion is requisite, in order to enable us to draw any inferences from it. The subject is far too large to be treated generally here;

* Die Lebensfrage der Civilisation; oder: Ueber das Verderben auf den Deutschen Universitäten.

but there is one view of it to which I hope I shall obtain the reader's assent.

Among the elements and indications of civilisation, I think it will be allowed that a generally diffused faculty of *speculative* thought forms a leading point. Such a faculty, and its habitual exercise, forms a main distinction between the most refined and the rudest nations; as, in a broader sense, it does between man and lower animals. For even the brutes have *practical* powers of thought; they have a practical notion of space and force; a practical sense of things good and bad, of things which they may and which they may not do; but man alone has a geometry and a mechanics, an idea of happiness and of a moral law. And the clearness of the ideas which speculation requires and uses, is one of the most essential features of the progress of intellectual refinement. This appears in matters, which at first seem trivial, as, for instance, in the importance attached to correct speaking and writing. Why is it that a false spelling or wrong accent in our own language, is considered a mark of a vulgar, or, at least, unpolished, mind? Why is it that a false quantity, or a false concord, is looked upon with horror by the thorough scholar, as something offensive and ridiculous? Why is it that men are more angry at being accused of bad reasoning than of erroneous opinions? Clearly because all these faults imply an incomplete and ill-conducted cultivation of the speculative faculty, in reference to language or to reasoning. The errors may be trifling, but they seem to disclose faults of intellectual training: they are, in the world of literature and

thought, what violations of good breeding are in manners. A single fault of grammar may betray a want of perception of the analogy of language; a single fault of logic may shew that the speaker has no distinct apprehension of the force of demonstration; and when this judgment is formed of him, he immediately appears to sink below the standard point of cultivation and connexion of thought. He is less cultured than those who detect his deficiencies;—less refined in his intellectual character, because he is less distinct and connected in his intellectual habits. And thus we have, in the common judgments of mankind, an evidence that they consider distinctness and clearness of the speculative faculty as one of the elements of civilisation.

But we may take a larger view. Probably all persons will acknowledge, that those nations by whom great advances in knowledge are made, and among whom such advances are widely diffused and well understood, have the pre-eminence in civilisation. Great scientific discoveries, along with a general national interest and intelligence respecting such matters, are circumstances peculiar to the most highly cultured times. Now this consideration will lead us by a different road to the same element of civilisation which we have already pointed out. For by a history of each of the sciences in succession*, I have proved, I hope satisfactorily, that their progress depends upon the distinctness of certain fundamental ideas; and that these ideas, being first clearly brought into view by the genius of great

* History of the Inductive Sciences, from the earliest to the present Times.

discoverers, become afterwards the inheritance of all who thoroughly acquire the knowledge which is thus made accessible. In highly cultered nations, a large portion of society will thus attend to the progress of knowledge; so as to obtain a just view, at least of the general nature of the treasures which are thus placed within their reach, and of the triumphs which their intellectual leaders have achieved. And thus we are again brought to the principle, that distinct speculative ideas generally diffused, are an essential part of our conception of civilisation.

Having reached this point, we have to inquire whether practical or speculative teaching, distinguished as in the preceding section, be the best instrument for that kind of culture on which civilisation thus depends. I do not think it would be difficult to shew, from general considerations, that it is only by the practical teaching of mathematics, that the fundamental ideas of science can become distinct among men in general. But a more interesting mode of deciding this point will be, to look back at the history of the world; for the whole history of the world has been one grand experiment on this subject. Let us take a general view of the result. Our question is, whether practical or speculative teaching most promotes civilisation; which question, as we have seen, may be decided, by inquiring whether an education in *mathematics*, or in general *philosophy*, is most favourable to the progress of science, and to the general diffusion of the knowledge which this progress brings. A rapid survey of the history of education, with this view, will repay us.

Of the Greek education, up to the time of Plato, we know enough to be able to assert, that it was in the main practical teaching. The "music" (*μουσική*) which constituted the principal part of this, was taught unquestionably in a practical manner; and if the occasion admitted, it might be shown, both from the elements which it included, and from the way in which it was conducted, that it had nearly the same effect that the practical teaching of mathematics has, in giving distinctness to the ideas,—independently of its other and collateral influences. But in the time of Aristophanes*, a change took place in the instruction of the Greek youth. The sophists and philosophers were extraordinarily admired and followed; and to acquire an acquaintance with their doctrines and systems came to be considered as the most essential part of a liberal education. This was still more the case among the Romans, when they attempted to take a place among cultivated nations. Their youth listened to what "Chrysippus and Crantor taught," and were thus supposed to be filled with all learning†. The study of *philosophy*, in the general sense, that is, of the moral, metaphysical, and physical doctrines of the framers of universal systems, was, as we know, the highest conception of the Greeks and Romans in their aims at intellectual culture, till civilisation itself sickened and declined. It was so, too, among the Neoplatonists, the schoolmen, the theologians of the middle ages; till in the monasteries there again grew up a method of practical teaching from

* See *The Clouds*.† See the beginning of Cicero's *Offices*.

which the system of the English universities had its origin.

Such is the course of education ; now what is the corresponding course of knowledge ? The answer is well worth notice. *The progress of science corresponds to the time of practical teaching ; the stationary, or retrograde, period of science, is the period when philosophy was the instrument of education.* At the time of Plato, the Greek education had been for a long period virtually mathematical ; a fact, of which the very term *mathematics* is the record. At that time the greatest scientific discovery of the ancient world, —the resolution of celestial phenomena into circular motions,—was caught sight of by Plato, and soon after fully brought out by Hipparchus. At a similar stage of Greek culture, although at a later time and in a different country, the science of mechanics was established by Archimedes, on foundations fitted to endure to eternity. What might have been the history of civilisation if the Greek education had continued to be practically mathematical, we cannot tell. Speaking according to human views of probability, perhaps the Greeks might, in that case, have anticipated the discoveries of modern times by a thousand years ; and the places of Galileo, and Kepler, and Newton, might have been preoccupied by citizens of Athens and Alexandria. But the speculative study of philosophy prevailed. From that time no material advance was made in science. What great men had already taught mankind, was perverted or forgotten by their degenerate followers. The schools of the philosophers resounded with systems old and new, with wranglings and boastings ;

but this availed not to urge on the intellectual progress of man, or even to prevent his sliding backwards. The simple geometrical conceptions of the school of Plato were debased and weighed down by a cumbrous apparatus of crystalline spheres. The mechanical truths brought to light by Archimedes, were, like his tomb, overgrown with the rank and unprofitable vegetation of later days, till they were lost sight of; and were not resumed and pursued till a thousand years, and half a second thousand, had elapsed. It is a manifest mistake to ascribe the decay of science to the incursions of the northern nations. Science was dead, and literature mortally smitten, before the external pressure was felt. But the study of speculative philosophy, as the business of cultured men, survived. Still the intellectual world grew darker and darker. "Light after light goes out, and all is night." In vain do the schoolmen of the middle ages build system upon system, as the schoolmen of Athens and Alexandria had done before. The centuries roll on, and bring no day. But in the mean time the religious orders have established among themselves a system of practical teaching. They introduce mathematics into their course with especial attention. The principle of progress is soon felt to be again at work. A Franciscan friar lifts up his voice against the sway of Aristotle, and points to the far-off temple of science, declaring that *mathematics* is its gate and its key*. His announcement is found to be true.

* *Harum scientiarum porta et clavis est mathematica, quam sancti a principio mundi invenerunt, etc.*—Roger Bacon, *Specula Mathematica*, cap. i.

From the like mathematical schools proceed the luminaries of a new dawn,—Copernicus, Galileo, Kepler, Newton, are the founders of a fresh era of knowledge, because they are well-trained mathematicians. The universities of Europe assume a form in which such a training goes on; thus the cultured classes become capable of receiving and appreciating the great discoveries by which man's intellectual position is advanced; and we reach the present condition of the civilised world.

But we have not yet done with the survey of this great experiment. In one country of Europe the universities give up their habits of practical teaching, and return to the speculative method. They make *philosophy* their main subject. Their professors deliver from their chairs system after system to admiring audiences. The listener may assent or criticise; but he is not disturbed by any demands on his mind, such as the teaching of mathematics gives rise to. And what is the class of men thus produced, in their bearing upon the progress of sure and indestructible knowledge? They are such men as to be utterly incapable even of comprehending and appreciating the most conspicuous examples of the advance of science. Those who are universally allowed to be the greatest philosophers of our own day in the German universities, Hegel and Schelling, cannot understand that Newton went further than Kepler had gone in physical astronomy, and despise Newton's optical doctrines in comparison with the vague Aristotelian dogmas of Göthe respecting colours*.

* See Hegel's Encyclopædia, and Schelling's Lectures.

Thus, the experiment on education, which has been going on from the beginning of Greek civilisation to the present day, appears to be quite distinct and consistent in its result. And the lesson we learn from it is this ;—that so far as civilisation is connected with the advance and diffusion of human knowledge, civilisation flourishes when the prevalent education is mathematical, and fades when *philosophy* is the subject most preferred. We find abundant confirmation of the belief, that education has a strong influence upon the progress of civilisation ; and we find that the influence follows a settled rule : when the education is practical teaching, it is a genuine culture, tending to increased fertility and vigour ; when it is speculative teaching, it appears that, however the effect is produced, men's minds do, in some way or other, lose that force and clearness on which intellectual progression depends.

I cannot go on to the next point of my argument without an observation founded on the view which has been presented. It is impossible, after the survey we have just made, not to reflect of what immense importance the question of the two kinds of education is. The reform of the European universities, a subject which is now exciting so much interest in England, France, and Germany, is, in truth, what it has been termed, the Vital Question of Civilisation. Upon the decision of that question may depend, whether Europe, and America, which must follow the intellectual fortunes of Europe, shall, for the next thousand years, be in the condition of the later Greeks and Romans, having for their mental aristocracy, a class of philosophical system-builders, commentators,

and mere metaphysicians ; or shall go on to exhibit that healthy vigour and constant effort at real progress and improvement, which has characterized this quarter of the globe for the last three hundred years. This is no slight matter. And let no one attempt to make it less momentous, by persuading himself that civilisation must advance ;—that we cannot run back into an inferior condition of culture and thought. The history of the world shows that we have no such security. Civilisation, in its best sense, may too surely decline. Greece and Rome had wasted by their own folly almost all that was most valuable in their intellectual inheritance, before the foreign spoiler came. The civilisation of the eastern and southern shores of the Mediterranean, once the fairest spots in the world of literature and art,—where is it, and how is it vanished ? It is not enough to say that the barbarising storm of Mahommedan conquest has swept over and destroyed it. The Mahommedans did not barbarise Spain or Persia. And to whatever violent external causes we may ascribe this deplorable change, it shows, at least, that in some countries civilisation takes deeper root than in others ; and warns us to use our best endeavour, that, so far as we are concerned, our country and the world may lose nothing of that real civilisation which, combined with morality and religion, constitutes the brightest glory and most precious treasure of the human race.

It is difficult to mark out, even in conjecture, the path of the future progress of mental civilisation. Yet some light we may gather from the history of the past. One idea after another, of those which

constitute the basis of science, becomes distinct, first in the minds of discoverers, then in the minds of all cultured men, till a general clearness of thought illuminates the land; and thus the torch of knowledge is handed forwards, thousands upon thousands lighting their lamps at it as it passes on; while still from time to time some new Prometheus catches a fresh light from heaven, to spread abroad among men in like manner. Thus the opening of Greek civilisation was marked by the production of Geometry;—the *idea of space* was brought to a scientific precision. Of that step we still inherit the benefits; for example, all educated Europeans conceive the relation of the various parts and lines on the terrestrial globe with a distinctness in which the rude savage or uncultured boor has no share. The opening of the civilisation of modern Europe was distinguished, in the same way, by the production of a new science,—Mechanics, which soon led to the Mechanics of the Heavens. And this step, like the former, depended on men arriving at a properly-distinct fundamental idea. The *revival of the scientific idea of force* (an idea which had been brought to light by Archimedes, and extinguished again amid the mists of Greek philosophy,) was, as I have elsewhere shown, the essential condition to which this step was due*. This idea, too, has now been communicated to persons of education in general, as the general reception of the Newtonian theory of the universe proves; while, at the same time, the very indistinct views which men of considerable cultivation often entertain of the mechanism of the universe, proves that the fundamental ideas on which

* History of the Inductive Sciences, Book VI. chap. i. sect. 2.

a clear apprehension of the doctrine of universal attraction depends, have hitherto been very imperfectly diffused through the atmosphere of the literary world. And the cause of this remaining imperfection probably is, that elementary mechanics has not hitherto been made an essential portion of a liberal education, as for centuries elementary geometry has. Nothing forbids us to look forward to the time, when not only this deficiency shall be supplied*, but when men's minds shall have been carried much further in the same track. We may imagine a future period of mental culture, when the elements of chemistry and natural history shall be fundamental parts of a good education, as the elements of mathematics now are; and when consequently the ideas on which our knowledge of the composition of bodies, or our estimate of the natural classes of organized beings, depends, shall be as clear in cultivated minds, as the conception of universal attraction is now, in the mind of a thoroughly educated man; or as the conception of the circles of latitude and longitude, in the thoughts of a well-taught child. And if we add to this, the possibility that the ideas which are the bases of sound criticism, morals, and politics, may become equally distinct and equally diffused, by means of an appropriate education, we catch a glimpse of the grand and boundless vista of possible and probable intellectual refinement and civilisation which the future offers.

* Partly for the reasons here suggested, I have published a work on Elementary Mechanics (The Mechanical Euclid), such as I hope may fit that branch of knowledge for taking its due place in education by the side of geometry.

Whether or not the reader may assent to the view thus presented of the nature and prospects of civilisation, he will, I trust, sympathize with another reflection which offers itself to us at this point of our survey. If the destinies of the highest civilisation of man, be thus closely connected with the progress of truly liberal education; and if it depend upon the constitution and conduct of educational institutions, whether such civilisation shall continue to advance, or shall become retrograde: it is impossible not to reflect, how grave and weighty is the office of those, on whom it falls to found and to put in action new institutions of liberal education, intended to meet the requirements of present and future ages. To do this, is a great, and we may say, a solemn task. Those who are engaged in it, must act as men building for eternity. We see no reason to believe otherwise, than that this great nation, hitherto so highly favoured with outward and inward gifts, (and with it, its vigorous progeny, which, while peopling and civilising the other side of the globe, is involved in the intellectual fortunes of its parent,) is destined by Providence for an advance yet to be long continued, in civilisation and refinement of the best and highest kind. To what consummation the world is reserved by its Governor we know not, nor whether he has decreed, that, before the final close of all things, the brightness of civilised England must wane and become dim, as that of Greece and Rome has done before. But this we know, that it would be the most fantastical presumption of system-making, for any one to predict and reckon in centuries the calculated time and rate of the declension of Britain. We know,

too, that if such a declension menaced us, the wisest, as well as the noblest course, would be to seek and apply our remedies in the spirit of considerate and hopeful regard for the future. And surely, even if our final declension were certain, and if we could yet, by our exertions, so retard its progress, that, during the ensuing three hundred years, our condition should be no worse than for the last three hundred years it has been, this were a blessing, and a distinction among the nations of the earth, well worth the best resolves and exertions the nation can bring to the task. When, therefore, we attempt to construct institutions of education for the countless youth of centuries still to come, we enter upon a task full of solicitude and responsibility, but full also of hope and promise. And in this spirit should the office be discharged; all narrow interests, and little jealousies, and limited regards, being laid aside, and the great object itself, the transmission of the best portion of our own culture to the Britons of ages now far removed, being steadily kept in view. With this object we should guard especially against bringing down the standard of our system to the level which transient and partial circumstances, or popular prejudices, may suggest. That education which will secure to the future the civilisation of the past and present, is that which the country really requires; and modes of education which may attract for a moment, but can produce no effect of this kind, are of no value for the real purposes of education, and can satisfy none of the real wants of the age.

But a part of this subject requires a separate section.

SECT. 4.—OF THE LEARNED LANGUAGES AS SUBJECTS
OF UNIVERSITY TEACHING.

It has appeared in a preceding Section, that the decision of the question, whether our teaching shall be practical or speculative, in the sense already explained, in a great measure decides the subjects taught; since certain subjects only can be made the basis of practical education, and certain other subjects are peculiarly fitted for speculative discussion. But there are some other questions concerning the matter taught, which may be considered here; for instance, the proposal to include in it modern languages and their literature, instead of, or along with, the ancient authors of Greece and Rome; and to introduce the modern sciences, as general physics, chemistry, natural history, and geology, along with pure and mixed mathematics. I will say a word on each of these questions.

It is one of the characters of the present time, alarming to many persons, but, if we use the occasion well, a blessing rather than an evil, that doctrines which have hitherto passed unquestioned, and on which the frame of the institutions of European states is founded, are unscrupulously and rudely assailed. The propriety of the use of what are called the learned languages (Greek and Latin), among the main instruments of education, is a doctrine of this kind. And the question whether, in modern education, these languages are to retain their ancient supremacy,—or whether, on the contrary, the languages and literature of modern Europe are to be

placed by their side, or before them,—has been recently discussed with reference to educational institutions, both in this and other countries. In France, for example, this has been the subject of animated debates in the Chamber of Deputies; and that distinguished man of science, M. Arago, is reported, on such an occasion, to have expressed himself to the following effect:—

“ I ask for *classical* studies: I require them: I consider them as indispensable; but I do not think that they must necessarily be Greek and Latin. I wish that, in certain schools, these studies should be replaced, at the pleasure of the municipal councils, by a thorough study of our own tongue. I wish that in each college, it should be permitted to put, in the place of Greek and of Latin, the study of a living language. I require even, that this language may be different according to the situation of the place; that at Perpignan and at Bayonne, for example, it may be the Spanish; at le Havre, the English; at Besançon, the German.”

He then proceeds to answer certain objections, of which I shall only notice the one which more peculiarly concerns our subject.

“ It is urged,” he says, “ that Greek and Latin must be the principal classical studies, for they are *the true culture of the mind.*”

To this he makes the following reply:—

“ What does this mean? Are Pascal, Fenelon, Bossuet, Montesquieu, Rousseau, Voltaire, Corneille, Racine, Molière—the incomparable Molière,—are these writers deprived of the privilege which is so liberally granted to the ancient authors, of enlight-

ening, of unfolding the mind, of touching the heart, of putting in vibration the springs of the soul! God preserve me from insulting you, by refuting in detail a heresy such as this!"

In opposition to the opinion thus expressed, I maintain that Greek and Latin are peculiar and indispensable elements of a liberal education; and it is my business to shew, that the study of the modern authors just enumerated, and of others, however admirable their works may be, does not produce that kind of culture of the mind, which is the true object of a liberal education.

This culture of the mind consists in sharing in the best influences of the progressive intellectual refinement of man. The present age is not independent of those which have preceded it. On the contrary, it is the heir of all the past. Its wealth, intellectual and material, may have been improved in the hands of the present holders, but the value of what we have added is small, compared with the amount of what we found already accumulated. In thought and language, as well as in arts and the products of art, we inherit an inestimable fortune from a long line of ancestors. In literature, we are the children of the early Greeks;

Κάδμου τοῦ παλαιοῦ νέα τροφή.

But thoughts can be inherited, and words, in all their force, transmitted, only by those who are connected with their ancestors in the line of thought and understanding, as well as in the mere succession of time. And how is this connexion of generations, thus requisite to the transmission and augmentation of mental wealth, to be kept up?

The cultivated world, up to the present day, has been bound together, and each generation bound to the preceding, by living upon a common intellectual estate. They have shared in a common development of thought, because they have understood each other. Their standard examples of poetry, eloquence, history, criticism, grammar, etymology, have been a universal bond of sympathy, however diverse might be the opinions which prevailed respecting any of these examples. All the civilised world has been one intellectual nation; and it is this which has made it so great and prosperous a nation. All the countries of lettered Europe have been one body, because the same nutriment, the literature of the ancient world, was conveyed to all, by the organization of their institutions of education. The authors of Greece and Rome, familiar to the child, admired and dwelt on by the aged, were the common language, by the possession of which each man felt himself a denizen of the community of general civilisation;—free of all the privileges with which it had been gifted from the dawn of Greek literature up to the present time.

What can the best authors of modern days do in the way of filling such an office? Even if their language were universally familiar in cultured Europe, how do they connect us with the past? How do they enable us to read the impress which was stamped upon thought and language in the days of Plato and Aristotle, in virtue of which it is still current? How do they enable us to understand the process by which the language of Rome conveyed the culture, the philosophy, the legislation of

the ancient civilised world into the modern? How do they enable us to understand the thoughts and feelings to which they themselves appeal? If the Greek and Latin languages were to lose their familiar place among us, Montesquieu and Bossuet, Corneille and Racine, would lose their force and their charm. Those who read and admire these authors constantly make a reference in their minds to the works of the ancients, which they know immediately or through a few steps of derivation. If this knowledge were taken away, many of the strings would be broken in the instrument on which those artists played. And though, so long as a liberal education continues what it has been, the well-educated diffuse to others a general admiration of the "classical authors" of their own language; if Greek and Latin were to cease to be parts of general culture, the admiration of the classical authors of England and France would become faint and unintelligent, and, in a few generations, would vanish.

The same may be said of language. The languages of ancient Greece and Rome have, through the whole history of civilisation, been the means of giving distinctness to men's ideas of the analogy of language, which distinctness, as we have seen, is one main element of intellectual cultivation. The forms and processes of general grammar have been conveyed to all men's minds by the use of common models and common examples. To all the nations of modern Europe, whether speaking a Romance language or not, the Latin grammar is a standard of comparison, by reference to which speculative views or grammar become plain and familiar.

And then, as to the derivation of the modern European languages:—Those who are familiar with Greek and Latin cannot but feel, in every sentence they read and write, that the whole history of the civilised world is stamped upon the expressions they use. The progress of thought and of institutions, the most successful labours of the poet, the philosopher, the legislator, have, in thousands of cases, operated to give a meaning to one little word. Those who feel this, have a view of the language which they speak, far more intelligent, far more refined, than those who gather the force of words from blind usage, without seeing any connexion or any reason. What does intellectual culture mean, if it does not mean something more than this? What does it mean, but that insight, that distinctness of thought with regard to the terms we employ, which saves us from solecisms, not by habit but by principle, which shows us analogy where others see only accident, and which makes language itself a chain connecting us with the intellectual progress of all ages.

In what a condition should we be, if our connexion with the past were snapped;—if Greek and Latin were forgotten? What should we then think of our own languages? They would appear a mere mass of incoherent caprice and wanton lawlessness. The several nations of Europe would be, in this respect at least, like those tribes of savages who occupy a vast continent, speaking a set of jargons, in which scarcely any resemblance can be traced between any two, or any consistency in any one. The various European languages appear to us obviously connected, mainly because we hold the Latin thread which runs through

them; if that were broken, the pearls would soon roll asunder. And the mental connexion of the present nations with each other, as well as with the past, would thus be destroyed. What would this be but a retrograde movement in civilisation?

In nations as in men, in intellect as in social condition, true nobility consists in inheriting what is best in the possessions and character of a line of ancestry. Those who can trace the descent of their own ideas, and their own language, through the race of cultivated nations; who can show that those whom they represent, or reverence as their parents, have everywhere been foremost in the fields of thought and intellectual progress,—those are the true nobility of the world of mind; the persons who have received true culture; and such it should be the business of a liberal education to make men.

With these views, I cannot conceive it possible that any well-constituted system of University teaching, in any European nation, can do otherwise than make the study of the best classical authors of Greece and Rome, one of its indispensable and cardinal elements. But before I proceed, I cannot refrain from pointing out the evil of making such an element, or any one element alone, too exclusive or too large a part of our system of instruction.

SECT. 5.—OF THE NECESSITY OF COMBINING CLASSICAL AND MATHEMATICAL STUDIES AS SUBJECTS OF UNIVERSITY TEACHING.

THE arguments which we have urged in support of the necessity of the ancient languages as prominent parts of the teaching of our Universities,

proceed upon the ground of their usefulness as instruments of mental culture. And this effect has been contemplated, as resulting, not only from the familiarity which the student of classical literature may acquire with the works and style of the brightest periods of ancient civilisation; but also, from the clear views to which he may be led, by such studies, of the principles and history of grammar, language, and literary thought. Now it must not be forgotten, that in classical as in any other literature, the reader who merely flutters through a series of authors such as catch his fancy, who studies them only as a literary amusement, without severe thought, or steady perception of the principles of language and composition, cannot receive from them such a culture as we have supposed; any more than from any other line of reading, suggested and directed by mere caprice and personal taste. Indeed, since principles are disclosed and illustrated by the reading of poets and orators, far more obscurely and vaguely than by most other studies, classical literature so pursued is entirely inefficient for any purpose of genuine mental cultivation. It will only produce a taste, fastidious, indeed, but superficial and arbitrary, without any distinct and developed apprehension of analogies and reasons. And even if the classical authors be studied profoundly and thoroughly, as examples of language, composition, and thought, still they only supply one occasion among many, for the cultivation of the more exact operations of the mind; and in this, or in any other way, the adoption of one instrument alone, for such a purpose, will make the resulting culture extremely partial and deficient.

The mode in which this defect may most effectually be remedied, is by combining, with the study of classics, the study of the elementary portions of mathematics. For these severer studies will bring into play that class of intellectual faculties, which the pursuit of elegant literature alone leaves unexercised. We may add, too, that the mental powers so developed will react upon the study of classical authors; and the perception of general relations, of grounds and reasons, even in matters of grammar and taste, will be far more likely to arise in the mind of a student thus disciplined, than in that of the mere elegant scholar. Every person of mathematical cultivation is necessarily an analyst of conditions and connexions: the analytical power thus awakened will commonly exercise itself upon language, as well as upon mathematical quantity; and thus a familiarity with the best models of composition will become such a discipline of distinct ideas, with regard to the principles of language and thought, as, for our purposes, we require it to be.

The study of elementary mathematics, therefore, along with the study of classical authors, ought to be imperatively required by all Universities. To separate these two branches of study, and to allow students to neglect one of them, because some persons have a taste for one, and some persons for the other, is to abdicate the functions of education altogether. Universities and Colleges do not exist merely for the purpose of enabling men to do what they best like to do; or for the purpose of offering and awarding prizes for trials of strength, in modes selected by the combatants. Their business

is the general cultivation of all the best faculties of those who are committed to their charge, and the preservation and promotion of the general culture of mankind. And it is certain, that of all the persons who derive advantage from a University education, none are more benefited than those who, with a great general aptitude for learning, are prevented, by the requisitions of such institutions, from confining their exertions to one favourite channel. The man of mathematical genius who, by the demands of his College or his University, is led to become familiar with the best Greek and Latin classics, becomes thus a man of liberal education, instead of being merely a powerful calculator. The elegant classical scholar, who is compelled, in the same way, to master the propositions of geometry and mechanics, acquires among them habits of rigour of thought and connexion of reasoning. He thus becomes fitted to deal with any subject with which reason can be concerned, and to estimate the prospects which science offers; instead of being kept down to the level of the mere scholar, learned in the literature of the past, but illogical and incoherent in his thoughts, and incapable of grappling with the questions which the present and the future suggest. To neglect to demand a combination of these two elements, would be to let slip the only machinery by which Universities, as the general cultivators of the mind, can execute their office.

SECT. 6.—ON THE SCIENCES AS SUBJECTS OF
UNIVERSITY TEACHING.

FROM what has already been said of the use of mathematics in University education, it will easily be inferred, that we cannot find, in any of the more modern physical sciences, any thing that can fitly be substituted for that study. The effect of the clear insight of geometry or mechanics cannot be efficiently replaced by sciences which exhibit a mass of observed facts, and consequent doubtful speculations, as geology; or even by other sciences, as chemistry and natural history, which, though they involve philosophical principles, can only be learnt by presenting numerous facts to the senses. But though such sciences cannot do the work of mental cultivation, they are highly valuable acquisitions to the student, and may very beneficially engage his attention during the later years of his University career. For although they do not constitute the *culture*, they belong to the *information* of the well-educated man; though his habits of thought must be *formed* among other subjects, they may be beneficially *employed* on these. And it is advantageous for the general sympathy and mutual understanding of the cultivated part of mankind, that such persons should have many subjects of common interest.

But we may say much more than this. A considerable general knowledge of the modern progressive sciences, is as requisite to connect the educated man with the future, as a thorough acquaintance with ancient literature is to connect him

with the past. Except he know what has been done and is doing, in the way of extending our knowledge of earth, its elements, and its inhabitants, how can he judge what are the probable prospects of our knowledge? And if he be indifferent to this, how can he feel that interest in the future fortunes of his race, which becomes a person of his lofty extraction? Some insight into the progressive sciences is an essential part of a liberal education, in any large sense of the term.

This consideration is in some measure connected with the choice of our course of mathematical reading. For mathematics has been one of the great instruments of the progress of the physical sciences; and the constant use of this instrument, and the efforts to make it more effective, lead to frequent modifications of its form and expansions of its powers; and thus occasion, from time to time, changes in the current system of mathematics. This change, so far as the use of mathematics in education is concerned, is an evil rather than a good: for in our design we do not wish our pupils to possess mathematics principally as information, nor even as an instrument, although in that way it is of great advantage to many persons; but as an intellectual discipline; and this end is best answered by teaching the stable system of a demonstrative science. But at the same time we must recollect, that we cannot give to our mathematical studies their true dignity, without showing the place they hold in the progress of science; and, for the reason which we have mentioned, namely, in order to nourish in our more advanced pupils an interest in that progress, we do

not hesitate to introduce to them all new mathematical methods, which have a prominent and permanent importance. But this is salutary to the more advanced pupils only. No deviation from the plain instructive circle of ancient elementary mathematics is fitted for the first stages of the student's University progress. The mode in which his elementary mathematical studies best produce their effect upon him is, when they are presented in the luminous simplicity in which the Greek intellect contemplated them, not when they are disguised and obscured by being translated into the modern language of symbols. To learn this language, (a valuable lesson for the mind, if it be rightly taught,) is best made an ulterior step in the student's advance.

But the physical sciences are useful, not only as belonging to the information of the educated man, but also as supplying him with examples of Inductive Reasoning. The general rules and conditions of such reasoning have hitherto been very imperfectly pointed out; but a knowledge of the sciences gives any one the means of speculating for himself on the subject;—a subject of the strongest interest with reference to the future progress of knowledge. I have already said, that a practical instruction in Inductive Reasoning is not possible, except so far as it depends on the cultivation of the Deductive Faculty. We may lead men to feel the force of demonstration, but we cannot teach them to discover new truths. And I may repeat my observation, that the value of this practical teaching of the reason by means of mathematics may be much enhanced by a proper selection of our mathematical studies;—

namely, by not confining ourselves to pure mathematics, and, least of all, to the pure mathematics of symbols. On the subject, considered in this point of view, I, a little while ago, published a few remarks, under the title of "Thoughts on the Study of Mathematics, as a part of a Liberal Education;" and as these remarks may serve to illustrate further what is here said, I reprint them at the end of the present book.

It will be observed, that I intentionally omit, at present, all reference to professional education; and, consequently, to lectures, examinations, and degrees, in Divinity, Medicine, and Law. All such studies should be subsequent to the intellectual culture of which I now speak; and the professions to which these studies belong will derive the greatest part of their real dignity and refinement, from their being built on such a foundation. I omit, also, all consideration of what is called "practical knowledge," such as civil engineering, practical arts and trades, and the like; which are sometimes recommended as useful elements of education. If these are wanted as professional knowledge, they must be learnt, as, in fact, they are learnt, among professional men and practical applications. If they are wished for as information, they stand on the same ground as the higher physical sciences, of which we have spoken above, so far as the arguments there employed are applicable to them. But this "practical knowledge" can never stand in the place of a really liberal education, nor in the smallest degree supersede the necessity of the studies we have pointed out, if such an education be our object.

SECT. 7.—ON THE MORAL EFFECT OF PRACTICAL AND SPECULATIVE TEACHING.

BESIDES the communication to the student of the matter taught, there are certain collateral effects of the two kinds of teaching, which are well worthy of notice. I will speak briefly of a few of these.

Mathematical doctrines are fixed and permanent; no new system of geometry can supersede the old. The old truths will always be true, and always essential. Not only so, but even the old books remain in use. Euclid has never been superseded, and never will be so without great detriment to education. And if Archimedes had written a treatise on Mechanics, in extent and form similar to that of Euclid on Geometry, such a work would probably have been one of our best instruments of education at the present day.

In *philosophical* doctrines, on the contrary, a constant change is going on. The commentator supersedes the original author, or at least becomes equally important: the systematiser is preferred to him who first threw out the same thoughts in a less regular form. Or else a revolution takes place: the old system is refuted; a new one is erected, to last its little hour, and wait its certain doom, like its predecessor. There is nothing old, nothing stable, nothing certain, in this kind of study. Change is constantly taking place; change is constantly looked for. Novelty is essential, in order to command attention or approbation. The ship sails on; old objects glide back; the point of view changes. The

student knows, or at least cannot but suspect, that his teacher and his teacher's creed are but for a day; and that what is demonstrated to be true, will be found hereafter to be a truth so imperfect, that it is best put out of sight.

Now I conceive it cannot be doubted that the mind of a young man employed mainly in attending to teachers of this latter kind, must fail to acquire any steady and unhesitating conviction of the immutable and fixed nature of truth, such as the study of mathematics gives. This constant change in the system of received doctrines must unsettle and enfeeble his apprehension of all truths. He has no time, he has no encouragement, to take up the doctrines that are placed before him, and to study them till he is firmly possessed of them, secure that their certainty and value can never alter. He lives among changes, and has not the heart to labour patiently for treasures that may be ravished from him by the next revolution. The state of Germany, for instance, has of late years been as unfavourable to the intellectual welfare of its students, as the condition of the most unstable government of the East is to the material prosperity of its subjects. A great philosophical conquest is made by Kant, and a universal empire is supposed to be on the point of being established. But Fichte, who began with being a follower of Kant, ends by deposing him. Schelling carries away the allegiance of Germany from Fichte; and then Hegel becomes more powerful than any of his predecessors; and a younger Fichte raises the standard against all these rulers. And thus, with dire shedding of ink, revolution after revolution succeeds.

Now amid all this change and fear of change, how can any man eat tranquilly of the fruit of his own field, under his own vine and fig-tree? How can he cultivate his own thoughts, and possess in a tranquil and even spirit the knowledge and the habits of mind which he has acquired? He cannot feel or relish old and familiar truths, such as mathematical sciences deal with. He cannot be content with such conclusions as can be obtained by the way of demonstration. He becomes almost inevitably himself a wide and restless speculator; criticising what has already been done in philosophy; attempting to guess what will be the next step; and destitute, not only of those clear ideas, and those habits of exact thought, through which alone any real advances in knowledge can be appropriated by the student, but devoid also of that steady belief in the permanent nature and value of speculative truth, which is an essential virtue of the understanding.

Again; another mode in which this speculative teaching operates unfavourably, as I conceive, upon students, is this;—it places them in the position of critics instead of pupils. In mathematical and other practical teaching, the teacher is usually, and almost necessarily, much the superior of his scholar in the knowledge which they cultivate together; and the scholar cannot but feel this, and must consequently be led to entertain a docile and confiding disposition towards his instructor. On the other hand, when a system is proposed, as only offering its claims to him, and asking his assent, which he may give or refuse, he feels himself placed in the situation of an equal and a judge, with respect to his professor. And if,

as is very likely to be the case with active-minded young speculators, he goes through several phases of philosophical opinion, and gives his allegiance to a succession of teachers, he can hardly fail to look upon them with a self-complacent levity, which involves little of respect. He will probably think of his masters much as the poet speaks of the objects of his transient admiration whom he chronicles :

The gentle Henrietta then,
 And a third Mary next did reign,
 And Joan, and Jane, and Audria;
 And then a pretty Thomasine,
 And then another Katharine,
 And then a long *et cetera*.

Now this want of docility, confidence, and respect, when it prevails in the student towards his teacher, cannot, I think, be looked upon otherwise than as a highly prejudicial feeling, and one which must destroy much of the value and usefulness of the education thus communicated.

The difference of the subjects which are recommended by different persons as suitable for University teaching, does in fact depend upon an entire difference in the views and temper of the authors of the recommendations. In the teaching of universities, a spirit of *respect*, or a spirit of *criticism*, may be appealed to. According to the first system, we must select subjects which consist of undoubted truths, and works of unquestioned excellence, and must require the student to familiarise himself with these. Such subjects are mathematical studies, and the best classical authors. According to the other system, we

take subjects in which we endeavour to draw the student's attention by our mode of treating them, and to carry his conviction with us by our arguments. In this system, we invite him to inquire for himself; to accept or reject according to his best judgment; to examine all doctrines boldly and thoroughly. This *critical* system it is which rejoices to have *philosophy* for its subject, and has shown alike its vigour and its tendency by the rapid succession of prevalent systems.

I do not at all hesitate to say, that the *respectful* system appears to me the proper line of education. I conceive that the student ought to have, placed before him, something which is of a stable and permanent kind;—in which it is a good mental exercise to struggle with the apparent objections, because it is certain that by effort and practice they may be overcome;—and in which it has been ascertained that admiration is not the result of novelty, or of some transient bearing upon the feelings of the age. The *critical* system seems to me to be properly addressed, not to students who are undergoing education, but to philosophers who have already been completely educated. If this course educate a man for anything, it educates him to be a judge of philosophical systems;—an office which so few Englishmen will ever have to fill, that it does not appear wise or reasonable to make it the main object of our education. Nor can I believe, that to put young men in the position in which that system of teaching places them, at a period of their lives when they ought to be quietly forming their minds for future action, can have any other result than to fill them with a shallow

conceit of their own importance; to accustom them to deliver superficial and hasty judgments; and to lead them to take up new systems, with no due appreciation of the knowledge, thought, and gravity of mind, which are requisite for such a purpose.

I believe that this opinion of the effect of the two modes of university education has been confirmed by the actual result. The practical education of the English Universities has produced men fitted for practical life. I need not dwell upon this. I have already noticed how well the training of the college appears to prepare men to become good lawyers. I will add, that I conceive our physicians to be the first in the world, and that I ascribe their excellence mainly to the practical course of general culture which they receive in the Universities; which does what no merely professional education can do; and of which the effects are seen, when the professional employments bring into play the intellectual habits. Our clergy derive inestimable advantages from the cast of their university education; and if clerical education among us be capable of improvement, this certainly will not be brought about by the substitution of the philosophy of Schelling and Hegel for the mathematics of Euclid and Newton. That our Universities educate men to be legislators, statesmen, and magistrates of some practical power and skill, no one can doubt, except he who thinks that this little island has, for the last three hundred years, run an unprosperous course, and held an undistinguished place in Europe. For the fortunes of nations are determined, under Providence, by their practical leaders, and men are formed by their education.

In Germany and France, we are told that there prevails among the young men of the Universities a vehement and general hostility to the existing institutions of their country. I know not how truly this is said; but I conceive that such a consequence may naturally flow from an education which invokes the critical spirit, and invites it to employ itself on the comparison between the realities of society and the dreams of system-makers.

I shall not here prosecute this subject further, since my object is to hasten on to some principles which apply more intimately to that process of instruction which has hitherto existed in the English Universities. But I hope I have made it appear that, distinguishing the two systems of education as I have done, we may, with nearly equal propriety, treat of them as *practical* and *speculative* teaching;—or on the one hand *mathematics* combined with *classics*, and on the other *philosophy*;—or *college* lectures, and *professorial* lectures;—and may look upon them as exemplifying a *respectful* and a *critical* spirit. And I hope I have satisfied the reader that (allowing fully the value and use of philosophy and of professorial lectures in their due place, of which I may afterwards speak,) we could not abandon the practical teaching, the mathematical and classical studies, and the College lectures of our Universities, without great loss to the intellectual training of our youth, without destroying highly beneficial feelings which exist between them and their teachers, and without putting in serious and extensive jeopardy the interests of the civilisation of England and of the world.

CHAPTER II.

OF DIRECT AND INDIRECT TEACHING.

SECT. I.—OF EXAMINATIONS, AND OF COLLEGE
TEACHING.

By *indirect* teaching, I mean a course of education in which the student's exertions are directed mainly towards examinations, disputations, or some other public trial of his acquirements; and in which he is led to acquire knowledge, principally by the prospect of the distinctions, honours, or advantages, which attend upon success in such trials. I distinguish such teaching from that *direct* teaching, in which instructions are given as claiming the student's attention on the ground of their own value; and in which they are recommended to him by his own love of knowledge, by the advice and authority of his instructor, and the general sympathy of the body in which he lives.

In the English Universities, there has always, I believe, been a combination of these two kinds of teaching; and such a combination is, I conceive, the best scheme of education. In the selection and management of each of these elements, however, there are some considerations which appear to me of great importance, and which I will briefly state.

The College lectures, and other College instructions, appear to have been, till recently, of the nature

of direct teaching. The studies thus presented to the pupil were considered as sufficiently recommended by the injunctions of the College and the parental authority* of the tutors, without reference to ulterior objects. The public disputations and theses, which must be performed in order to obtain a degree, formed a scheme of indirect teaching; and the College teaching was consistent with this, but was far from being considered as merely ministerial to it. Several subjects were introduced in the courses of College instruction, and, indeed, are still, which have no reference to these public University trials, and which were selected by the authorities of the College, because they were considered as valuable for their own sake, and proper parts of a liberal education. But though this is the case, a strong disposition has manifested itself of late years, in the University of Cambridge at least, to give a great preponderance to the indirect system;—to conduct our education almost entirely by means of examinations, and to consider the lectures given in the Colleges as useful only in proportion as they prepare the student for success in the examinations. On this point I will offer a few remarks.

As I have already said, a combination of direct and indirect instruction appears to be desirable. The love of knowledge, and the love of distinction with the fear of disgrace, are the two mainsprings of all

* Pupilli tutoribus pareant, honoremque paternum et reverentiam deferant, quorum studium, labor et diligentia in illis ad pietatem et scientiam informandis ponitur. Tutores sedulo quæ docenda sunt, doceant, quæque etiam agenda, instituant moneantque.—*Stat. Trin. Coll. Cant. cap. x.*

education, and it does not appear wise or safe to try to dispense with either of them. Moreover the University must, in the discharge of its proper functions, have tests of proficiency, to be applied before her degrees and honours are granted. There must, therefore, be University examinations. On the other hand, it must always be recollected that examinations are a means, not an end;—that a good education, a sound and liberal cultivation of the faculties, is the object at which we ought to aim; and that examinations cease to be a benefit, where they interfere with this object.

That such a danger is possible, a very little reflection will show. The knowledge which is acquired for the purpose of an examination merely, is often of little value or effect as mental culture, compared with that knowledge which is pursued for its own sake. When a man gives his mind to any subject of study on account of a genuine wish to understand it, he follows its reasonings with care and thought; ponders over its difficulties, and is not satisfied till all is clear to his mental vision. On the other hand, when he studies for an examination only, he does not wish to understand, but to appear to understand; he cares not for unsolved difficulties in his mind, if the examiner detect them not; he wishes to see clearly, only in order that he may express himself clearly. He may thus lose much of what is best in the influence of those studies which, when more faithfully pursued, tend to educe distinct ideas and sound reasoning habits. Again:—what is acquired for an examination is likely to be soon forgotten: the mind is bent upon it with an effort, which, though strong

at the time, is felt to be temporary, and is followed by a relapse into comparative apathy and obliviousness. The student soon lets slip what he has thus collected for a special purpose; just as the busy advocate forgets the circumstances of his client's case almost as soon as he has pleaded it. Again:—the habit of preparing for examinations makes the studies which are not recommended by an obvious reference to such an object, appear flat and insipid. The mind craves for the excitement to which it has been accustomed: it becomes restless and volatile; loses the appetite for quiet thought and patient study, and the trust in advantages which must be waited for. Again:—if examinations become too frequent, all good courses of study are interfered with. For it is impossible to arrange public examination so as to point out a succession of subjects which forms a good system for all. That which must be required of every one is far too little to employ and exercise the more powerful and active minds. They, therefore, when they have to conform their studies to requirements constructed for smaller intellects, are thwarted and interrupted in their more genuine pursuits.

I urge these objections, not to show that we ought not to have examinations, but in order to point out that the use of examinations is exposed to dangers which must be guarded against, if we would not forfeit some of the best effects of University education. Mankind are always ready to transfer their solicitude from the end to the means. When examinations have become a prominent part of our system, when it is seen how much the effect of the system depends upon the mode in which they are conducted, it may

easily happen that men may turn all their attention to the arrangements and circumstances of examinations, as if this were the supreme object of the legislation of a University. This would be to discipline soldiers, not for the battle, but for the review. We cannot make the examinations every thing to our students, without making the love of knowledge nothing.

The University of Cambridge is proud, and with much justice, of the acknowledged purity of her examinations. They are free from all taint of sinister motives and practices;—above partiality, and above the suspicion of partiality. This is an inestimable advantage;—an elevation of character which she has reached by long years of vigilance and scrupulousness, and which must be vigilantly and scrupulously guarded. But this virtue must not be regarded as if it were a sufficient pledge for all others. The examinations may be perfectly fair, and yet useless for all the best purposes of education. I have no doubt, that when disputations were as important parts of the University proceedings as examinations now are, disputations were usually *moderated* with perfect fairness by the presiding officer. But that circumstance alone would not save them from being useless trifling, and perverse subtilty. Examinations, though perfectly impartial, may come to deserve as little respect as most persons now give to the logical exercises of the days of disputation.

The recommendations of the system according to which the University teaches by examinations, are obvious enough, and deserve to be attended to.

Besides that, as I have said, the application of some test of proficiency is a necessary part of the functions of a University, examinations such as now exist among us are more agreeable both to most teachers and to most pupils, than the system of direct teaching. Teachers often prefer the former system, because it relieves them from the constantly repeated effort and anxiety which accompanies direct instruction,—at least, when bestowed on unwilling or unintelligent pupils. If all solicitude about the student's daily attendance, his daily progress, his transient difficulties, his fluctuating diligence, can be rendered superfluous, by examining, at last, what has been the general result of his study, they are naturally glad to escape so easily a burden so oppressive. With such recommendations, the labour of examination, although not light, is readily undertaken. On the other side, the student often prefers the examination to other modes of instruction, because he is there impelled by the desire of distinction, by the stir of contest, by the play of hopes and fears, sympathy and novelty. In the examination-hall he is not passive, but active. He is there one of the principal actors in the piece, not a subordinate character, as he is in the lecture-room. It is not wonderful, therefore, that examinations, at least voluntary examinations, are crowded by hosts of our willing pupils.

What has been said hitherto refers to voluntary examinations, which students are induced to enter by the love of distinction. The effect of compulsory examinations, also, requires notice. These, or something equivalent, must exist in a University; but

when they are considered as the only means of University education, it is easily seen that the education must be bad. For their requisitions must be lowered to the level of the average power of mind and of application which young men possess, in order that University degrees may be the general mark of a liberal education: and, hence, the substance of such examinations cannot be sufficient to exercise and improve the quicker and more capacious intellects. Moreover, for reasons already stated, the knowledge which is acquired for examinations operates less as culture, than that which is obtained under other circumstances. And when the examination is a compulsory one, there is a servile and ignoble influence breathing about it, since it acts not on the hopes, but on the fears; and holds disgrace and degradation before the eyes of the candidate. Such examinations may be necessary, but they never can be more than a necessary evil; and that system would, indeed, be unworthy a great and highly-civilised nation, in which the machinery of education was all of this structure.

Besides the University examinations, there exist, in all the Colleges of Cambridge, College examinations, on which I will make a few remarks. These examinations approach much more nearly to the character of instruments of direct instruction, than the University examinations. They are different in each year of the student's progress; and, taken in connexion, they conduct the pupil through a course of instruction selected with care and judgment. The appointment of such a course of study for the employment of the successive periods of the pupil's

residence, is indeed part of the original structure of most College codes. The subjects which are thus enjoined in the ancient statutes are, in many cases, as will readily be imagined, now obsolete; in Trinity College, of which I can best speak, the system has been repeatedly accommodated to the changes occasioned by the progress of science, but always with a careful reference to the general spirit and purport of the statutes. The mathematical course, even now, deviates very little from that described in the original code*. The College lectures take up these subjects in order; at the end of the academic year, an examination in these subjects takes place in each College, and is conducted by some of the fellows of the College, selected according to certain general rules.

The College course exhibits that element of instruction which I have called direct teaching; since not only a certain proficiency is required, but the circumstances, means, and order of the student's progress, are prescribed. This is, I conceive, the proper place and office of the Colleges;—an office of the highest importance to the cause of education in our Universities; since without it, the bad consequences of mere examinations, which I have pointed out, would become most grievous evils, and the University system would lose the whole of its real value. The College examinations should therefore be conducted with reference to this office of the

* *Lector autem Mathematicus doceat primum Arithmetica, deinde Geometricam, tum cognitionem Sphæræ et Cosmographiam, deinde Astronomiam, postremo Musicam.—Stat. cap. ix.* Theoretical Harmonics, which is meant by *Musica*, is not yet abandoned as a subject of lectures.

Colleges; and are by no means to be carried on as if they were merely preparatory to the examinations required by the University.

A question here occurs, which, though it may appear a point of mere detail, when considered with reference to the English Colleges, involves a principle of considerable extent and importance, and may concern all institutions which have education for their object. The question is this:—Whether the same persons ought to teach and to examine in the same subjects?

This can occur as a practical question, only in those institutions in which there are other persons besides the teachers, among whom examiners may be found. But this is the case at most of our Colleges; in consequence of the existence, in each, of a body of Fellows, provided for, to a certain extent, by the foundation, and not necessarily engaged in the tuition. And there are obvious advantages in committing examinations into such hands. For such persons are free from the prepossessions which tutors may be supposed to have with respect to their own pupils, and which may bias their judgment in estimating the performances of the candidate at an examination. Such examiners form a kind of tribunal which may check caprice and carelessness in the tutors. They also strengthen the hands of the teaching body, since they appear as an independent class, sanctioning the studies and instructions of the teachers, and keeping up an acquaintance with such literary and scientific pursuits as they recommend, without the same professional obligation to do so. Again, it is advantageous to the cause of general

cultivation of mind, that there should be a motive supplied, such as is afforded by the duties of the examiner's office, to induce a number of persons, whose previous training has made such studies easy, to keep their hold on science and literature, and to acquaint themselves with the highest point that knowledge has reached.

But these advantages, however desirable, are not always attainable. It is not easy, except in Colleges which have a considerable number of resident fellows, to find a sufficient body of independent examiners. Even where there are persons on the spot, fitted for the duty, it may often happen that they may not have energy and public spirit enough to prevent their feeling such an office as intolerably irksome and laborious. They may, too, want skill in examining, especially if each holds the office a short time only. But one of the greatest inconveniences which attends the employment of such examiners is, the almost inevitable want of any close correspondence between the instructions given by the tutors, and the questions asked; and the consequent diminution of the efficacy of the teaching process. In almost all subjects of study, it is possible that a long string of questions, not in themselves objectionable, and a very good course of instruction, may lie wide of each other; so that the student who has followed the path of study pointed out to him by his tutor, may be unable to appear with advantage in the examination. And though this entire discrepancy of the lectures and the examination is an extreme case, which may not often occur, the want of a mutual bearing in the two, which will always exist, will destroy in the student

that vivid interest and attention, which he would bestow upon his tutor's communications, if he felt assured that the love of knowledge would lead to the same point as the love of distinction. Again:—not only may the independent examiner's questions be devoid of relation to the teacher's view of the subject, but they may be bad in themselves. A man cannot conduct an examination well, except he be quite master of his subject. If, instead of being an habitual study, in which he is familiar with all that has been done in its various forms, the subject be a portion of literature or science which he takes up merely as an examiner, his acquaintance with it will probably be meagre, unconnected, and partial. His knowledge will have no fulness, richness, depth, or variety; and he will not give to those who are really accomplished in the study in question, the opportunity of doing themselves justice, by showing the extent of their acquirements. Again:—an examination conducted by a person who does not habitually pursue the study, will not be brought up to the recent progress of knowledge. In classics, such a person will be disposed to confine himself to a mere interpretation of the language, without requiring any knowledge of modern critical researches; in mathematics, he will omit the recent forms and results of scientific investigations. He will deal only with that part of knowledge which, once acquired, has abided by him in spite of neglect. The person who is most likely to acquaint himself with the last advances in any study, is he who habitually teaches the subject; and who is thus impelled himself to learn, by his interest in the results, by his famili-

arity with the methods, and by the desire he must have to preserve the respect of his pupils, and his superiority over them. It is true, that the professors of letters and sciences may be bigoted to an established system, and may thus resist improvement and progress; but the operation of this feeling rarely continues longer than is requisite duly to balance the love of novelty and change in another class; and, in fact, almost all general improvements in literature and science have been introduced and diffused by professors. The progress of knowledge runs far less risk of being retarded by the bigotry of teachers, than by the ignorance, indolence, and carelessness of unprofessional examiners. And with regard to the objection derived from the possible partiality and caprice of the teachers, it must be observed that persons in so important and responsible a situation as theirs must necessarily be treated with a confidence proportioned to the fidelity which is expected of them. It is not by detached and external checks that they can be made to do their duty, if they have not a due feeling of it themselves: and if their partiality and caprice be excluded from examinations, it may still find abundant room to produce its effect, except the teacher is so far controlled as to have this usefulness materially damaged. The position of teachers who are themselves examiners, would generate, under any tolerable system of selection of teachers, a mutual observance and a self-watchfulness, which would be far better safeguards than any external and occasional interference.

The establishment of a board of examiners independent of the teachers, converts the system from one

of direct to one of indirect teaching; and must be avoided or modified, except we are prepared to give up direct instruction altogether. If we do this, and trust entirely to the force of examinations, using only the honour and disgrace which they bring, as the means of stimulating indolence and calling forth exertion, we come to an intelligible system, but one very different from any which has ever prevailed in the English Universities. We need then make no demand for attendance at lectures, nor even for residence. One final examination, or several examinations at certain intervals, must be all the evidence we require of the student's proficiency, and of his fitness to receive the stamp of University approbation. In this system, all the influences of our direct College teaching, both those which have been mentioned, and others which are still to be spoken of, are entirely abandoned. There may be persons who would think this an advantage;—who would prefer the uncollegiate system of foreign universities to ours; or who would think that we might sufficiently supply any deficiencies which may exist in them, by university examinations properly devised. Such a system is quite intelligible; but it behoves us to understand what it is, before we decide in its favour. It is right that we should see clearly that it never has been our system; and that when we talk of its establishment among us, we propose, not the improvement, but the destruction of our College practices;—not a modification, but a revolution in our English University education.

If, on the other hand, we wish to retain the advantage of direct instruction, we must preserve or

reform the habits of our colleges in the manner which is requisite to make them efficacious in their proper sphere. We must consider College lectures as important parts of our process, and College examinations as part of the same scheme of direct teaching; we must rather make our examinations auxiliary to the effect of our lectures, than the lectures merely subservient to the examinations. And if it appear, as there seems much reason to believe, that this can be done only by giving the lecturers a considerable practical influence upon the examinations, it would be very weak and inconsistent to hesitate to adopt that arrangement, in consequence of any such fears and suspicions as have been spoken of.

If we were thus to connect our lectures and our examinations, we should, I conceive, do much, not only to produce a body of cheerful and active teachers, and of willing and attentive hearers, but also to favour the rapid adoption and diffusion of all that the progress of knowledge brings to light. For a lecturer would prepare for his audience, with pleasure and with spirit, all that was likely to interest the most zealous and intelligent among them, when he was secure of having his instructions carefully attended to and treasured up. And the student would, in such a system, go on with all his impulses tending the same way;—urged forwards alike by his love of knowledge and his emulation, his sympathy with his teacher and his desire of honour.

SECT. 2.—OF PROFESSORIAL LECTURES.

I HAVE spoken hitherto of our College teaching; but it must be recollected that this, though the peculiar and characteristic, is not the only part of our University system. Besides this, there are in the English Universities not only university examinations, but, as in other universities, professors of various departments of science, literature, and speculation. These professors have been, and are, some of the most eminent men of their time in their respective provinces; and their lectures have been rich in instruction and interest; but a few remarks upon them will suffice for our present purpose.

Reproaches have often been cast upon the English Universities, in consequence of several of their professors discontinuing their lectures; but the cause has not been duly attended to. In almost all cases in which this has been done, the discontinuance of the lectures has arisen from the defection of the audience. It may be said, that this shows the lectures to have been bad;—that they would have been attended if they had been worth attending. I think this assertion may be shown to be unfounded.

In the first place, I would observe, that professorial lectures appear to have very small attraction for the greater part of Englishmen. The German student pursues the career of his professor with avidity through the most thorny and abstruse paths of speculation, without any motive except his taste for such an employment; and even writes down his

lectures, with a diligence which must be considered as somewhat superstitious, since it goes to the extent of fixing his attention principally upon the mechanical process of writing at the time, and his voluminous "heft" is often turned to small account afterwards. I do not think that, under any circumstances, English students would be brought to do this, or anything like this. Even when the matter is interesting, and the manner striking, how rarely does the lecturer collect and keep together a voluntary audience in England! And if his topic be a subject of exact science or critical research, we are certain that his hearers will soon be reduced to a very few students, and perhaps a few personal friends. In the metropolis, most persons have known of many admirable lectures, delivered in various institutions, on subjects even of great popular interest, as geology or political economy, where general neglect was bestowed, so undeservedly, as to be a matter of grief and indignation to those who attended. We may explain this as we can, but the fact is certain. It might appear as if our countrymen were too practical to love knowledge and speculation for its own sake, and to bestow time and systematic thought upon it, except it leads to something of profit or distinction. We have seen evidence of the same temper in various circumstances connected with the institutions for academic education recently established. It may be possible for a lecturer to draw together an audience by treating some popular subject in a striking manner; but he must have very crude or very visionary notions, who thinks that a solid, unambitious course of lectures, on a subject in which

little of novel views or striking exposition could be introduced, would be diligently and regularly followed by voluntary students.

But I observe further, that even if there were in this country at large a disposition to attend professorial lectures which are really instructive and valuable, such an attendance could not be expected to be generally given by the students of our Universities. For their time is engaged, and their efforts are drawn away from such occupations, by the demand which the University makes upon them, and especially by the examinations. As the examinations are now constituted, they require all the study and intellectual exertion which many of the students are able to give. The influence of such requirements on voluntary study is not a matter of opinion or conjecture. A few years ago a new University examination was established at Cambridge, to take place in the second year of the student's residence. Not only has its effect in interfering with the attention to the College courses been very decided, but the University professors at once felt its operation. The lectures of Professor Smyth upon modern history, eloquent and thoughtful disquisitions, which had long enjoyed great popularity, and drawn together, year after year, a crowded lecture-room, immediately lost half their audience. Something of the same kind happened to others of the University professors. With men of moderate talents and application, the demands of the examinations are a familiar, and I believe a just, excuse for not pursuing with earnestness any voluntary study. And even those of most active minds, and of the most lively interest in matters of taste and knowledge, can

only with difficulty snatch from the course of study into which the University prizes impel them, fragments of time to give to other pursuits. It is true, that in many cases the energy of youthful zeal and love of knowledge breaks through all difficulties; and that our lectures on geology, botany, chemistry, and other sciences, are pursued, as they well deserve to be, by a body of intelligent and persevering voluntary students, and even by persons who aim at high honours in our examinations. But these are young men happily constituted in intellect and disposition, whom systems cannot spoil, as systems cannot make them. It is very certain that the great body of young Englishmen during their residence at the Universities, will never, till their characters and dispositions have undergone a material change, derive any great portion of their education from their voluntary attendance on the public lectures of the University. They bring to the Universities no tastes, or ambition, or preparation, which lead them to follow the speculations which are thus placed before them; and though they do, I conceive, under a proper administration of our institutions, derive from them very great advantages, these advantages would be reduced to nothing, if they were made to depend upon the voluntary pursuit of literature and science, carried on with the assistance of the University professors.

Some of the University lectures at Cambridge, particularly those of the Regius Professor of Greek and the Plumian Professor of Experimental Philosophy, have been so directed as to be of great use to those who are candidates for the honours which the University bestows; and on that account, as well as

for their other merits, have been attended with avidity. But this attraction, and the consequent benefits, apply only to students of active minds and generous ambition; a class about whose education there is nowhere any difficulty. Professorial lectures of this kind can exercise no influence upon a class who are numerous among the students of all universities,—the comparatively dull and inert intellects. And yet these latter are a body which must not be neglected as of no consequence; since not only it contains a great number of estimable, right-minded, and useful men, but also such men are capable of a very large share of mental cultivation, which it is most important to them and to society they should receive. Many of these persons will pass none but compulsory examinations, and for such examinations professorial lectures can never be an effective preparation. For these, therefore, if College teaching be supposed absent, the system will become entirely one of indirect instruction. They will derive their knowledge from private study, or from private tutors, under the expectation of the examination which the University insists upon their passing. But before I proceed, I must say a few words on one of the subjects just mentioned.

SECT. 3.—OF PRIVATE TUTORS.

I BELIEVE that private tutors, under various forms, exist in all universities. Objections have often been made to them, some of which I will consider.

It has been objected, that they encumber the student with a large and unreasonable expense; but this allegation I shall not dwell upon. For if private

tuition be really an advantage, both parents and pupils will desire to have it; and it would be absurd to legislate against their sacrificing a pecuniary to an intellectual benefit. And if private tuition be prejudicial to the pupil, or to the university system, it ought to be opposed on better grounds than the mere consideration of expense.

The objections to private tuition, which principally require notice, are,—that it generates intellectual dependence and superficial knowledge; and that it interferes with public teaching.

It cannot be denied, that the reader who overcomes for himself the difficulties which occur in his studies, and who thinks over his subject by himself till he sees it clearly and fully, is likely to acquire both more distinct ideas, and more conscious power of thought, than he who carries his difficulties to a private tutor as soon as they arise, and passively accepts his explanation. At the same time, it must be observed, that many students would never overcome their difficulties at all, or free themselves from the little embarrassments of learners, without some special assistance. The best way of securing the advantage without the disadvantage, in this case, appears to be, that the student should have some persons capable of explaining what he finds obscure, whom he may consult occasionally when his perplexities occur, but upon whom he shall not be in habitual and close dependence for his progress. Such persons the public tutors in the universities ought always to be.

But this view supposes, that the student's object is merely to master the subject of his study. In general, however, the student's temptation to engage

a private tutor arises from the wish to prepare himself for an examination;—either a voluntary examination which he enters from a wish for distinction, or a compulsory one which he is required to pass. In these cases, it may be true, that the dependence on the private tutors much diminishes the value of the knowledge acquired; but still, so long as it is found or thought that such instructions give a person a superior chance of success in an examination, they will be sought for: legislation against such tuition will be felt to be a rigid measure, and will, probably, be evaded. Such a law did exist some years ago, in the University of Cambridge, but has since been repealed, for such reasons as have been mentioned. It does not appear advisable, therefore, to prohibit private tutors on such grounds, in a system of indirect instruction.

But let us consider the other objection;—that private tuition interferes with the direct instruction of College tutors. It is evident that this will be the case, if there be, besides the College lectures, a College examination, not founded upon the lectures. For the same temptation will exist in this case as in the case of University examinations, to obtain and depend upon the assistance of a private tutor, in preparing for the examination. And here, as before, although the College lectures, by assuming a professorial cast, may be useful and valued among the best intellects of the class, those who are more dull, or indolent, or ill-prepared, will not be able to profit much by such lectures, and will prefer to study, if they study at all, under the direction of a private tutor. Thus, the indirect teaching, in such a case, will stifle the direct teaching.

But it may be said, the instructions of private tutors, are direct teaching; therefore, it might be added, let those who please be left to such teaching, and not placed under a College tutor, by whose lectures in general they cannot profit.

To this I answer, that private tuition is *not* direct *University* teaching. If the pupil be allowed to prepare himself for the examination by the aid of a person who is in no ostensible and responsible situation, he is not in a state of pupilage to College or University at all. The examination is, then, the one point of contact between the educating body and the person educated; and if this be the case, there remains no longer any reason why the pupil's presence at the university should be required, in the intervals of the examinations. The private tutor may, with equal reason, be a clergyman in a distant country village, or a young man in London, if he is not responsible for his charge, any further than he is interested in the result of the examination. And the student, if he is left entirely to himself, his private tutor not professing to direct his efforts towards any thing except the pupil's fitness for examination, will, in most cases, be much better situated in any place removed from the University, than among a body of young men of the most various fortunes and character; where it must often happen that, if no superintendence be exercised, the extravagant and idle will set the fashion, and the worse will corrupt the better, in habits, manners, and morals.

But, it may be said, the private tutors must not be indifferent about the general character and conduct of their pupils. They must exercise a general

superintendence and control over their expenses and habits. To this I reply, that to make such a condition effective, the tutors must be placed in some direct official position, and their authority and responsibility clearly declared and enforced. This being granted, as it can hardly be denied, they become precisely the "Tutores" of our College statutes, and differ from the actual College Tutor only in the number of their pupils.

But our present business is with private tutors, who have not this official place and responsibility; and I think it has been shown, that they cannot be considered as teaching directly on the part of the College, or of the University. By their natural tendencies, they belong to a system of indirect teaching; and a system of direct teaching in Colleges can be maintained, only by prohibiting private tutors, or by making them subordinate to the College system.

The latter alternative appears to be much the preferable one, when we consider, that among those who come to Universities, there must be many, who from slowness of intellect, or previous defects of education, cannot, without such assistance, derive advantage from any course of lectures. And private tutors being thus allowed in some cases, the proper mode of securing their subordination to the College system of teaching appears to be, to place them under the control of the College teachers. We may, for instance, direct, that the public tutors shall determine or advise whether a private tutor be needed, shall select the person, and shall communicate with him from time to time on the progress of his pupil.

If this practice be adhered to, (as, in fact, something like it has hitherto generally prevailed,) and if the College examinations be made to support the College lectures, the system of direct College teaching may be preserved; but if not, the system of indirect teaching will absorb everything, and the public tutors will become an empty name. The most able of the students will desert the public lectures for the instructions of those who specially prepare them for the highest examinations; the slower minds will seek those private tutors who may enable them to pass the inevitable ordeal; the Class will be broken into pieces, and almost into individuals, by the diversity of men's powers and courses; with their influence on the studies of their pupils, the Tutors will lose their influence on their character and conduct in general; and the system will cease to be that of the English Universities.

If, on the other hand, we wish to preserve the English College system of direct teaching, since we have to combine it with the system of indirect teaching, which is almost essential to a University, we must consider how this combination can be effected.

SECT. 4.—OF THE COMBINATION OF THE UNIVERSITY WITH THE COLLEGE SYSTEM.

I SHALL dwell very briefly on this subject, for I do not here intend to propose changes in detail in any particular University. I will only offer a few general considerations.

The continued superintendence and control which direct College teaching implies, are most easy and

natural in the earlier part of the pupil's residence in the University. I should judge it desirable that the two first years of his career were employed in this kind of study; and I think it would be a great advantage, if no University examinations, compulsory or emulous, disturbed the even tenour of this course of instruction. In the University of Cambridge, this maxim has been of late departed from. Besides various prizes, which are open to the junior as well as the senior students, an examination, termed "the previous examination," was established in 1830, at which all the students are required to acquit themselves in a satisfactory manner, in the middle of their second year. The ground of this step was a persuasion that in some of the Colleges the progress of the students was not sufficiently insisted upon; and the belief that it was the duty of the University to secure an attention to study, in the first years of residence, by a compulsory examination, as she is supposed to effect the same object, at a later period, by the final examination which precedes the admission to an academic degree. It is impossible not to respect the motives which actuated the authors of this measure, and I believe it is conceived to have answered its purpose to a very great extent. It has, however, interfered very seriously with the College instruction, in Colleges where no such new compulsion was needed; and I should gladly see it removed out of the second year of the College course.

After two years spent under the influence of College rules, I conceive the student might, with advantage, be given over to the motives and em-

ployments which the University offers ; though still, as before, under the general superintendence and direction of his College tutor. By this time, the list of mathematical subjects would have been gone through, so far as it is important to follow them in a definite order, and with a discussion of principles ; and classical subjects might easily be framed into a progressive system, fitted to the same period. After this, the forward student would be prepared for the highest exertions and the widest speculations, for competitions and professorial lectures ; while the slow learner would have exhausted all that could easily be communicated to him directly ; and might be well employed in preparing for the final examination ; and, if possible, in also voluntarily attending the lectures of some professor on a subject of general interest ; and it would be quite consistent and reasonable, that this, the University period of the student's career, should be opened by a *previous examination*, fitted to ascertain that he was in the state of proficiency which the system supposed.

I give this sketch merely with a view of pointing out the mode in which the University and College systems may be combined, and the great inconveniences avoided, which may arise, and have arisen, from their conflicting tendencies ; by no means intending to offer it as a scheme of which the details are matured. But this, or something of this kind, is, I think, a plan well worthy the notice of all English Universities.

CHAPTER III.

OF DISCIPLINE.

SECT. I.—OF THE NECESSITY OF DISCIPLINE.

THAT the teaching of the intellect alone is insufficient to prepare man for his place in society, and for all the higher purposes of his destination, is allowed by all who have thought seriously on education. This declaration has, for instance, been repeated again and again by some of the wisest among those patriotic men who, in France, are trying to remodel in a beneficial manner the national education. We must, say they, *educate*, not *instruct* merely; we must infuse a sense of moral and religious responsibility, as well as mere knowledge; we must form the principles of conduct as well as the intellect.

But how is this to be done? or can it be done? What selection of the matter or of the mode of communication, can affect the moral nature? What kind of knowledge can give habits of self-government and a sense of duty? We may make the boy learn by memory, maxims and rules, prayers and creeds; but the memory does not sway the heart. And when we have placed the youth in the independent position of the student at a university, how shall we

teach his light mind and impetuous spirit to recollect that his condition is one of grave responsibility; that he must act with considerate reference to external regards and internal convictions of duty; and that the religion taught to his boyhood is intended to form an unbroken part of the business of his life?

The answer which the principles of English education direct us to give to such inquiries, is this;— that the meaning and the value of the moral and religious maxims which are taught to the boy, are to be impressed upon his heart by the personal exhortation of parents and other instructors; and that the student at the university is not to be uncontrolled, but is to be in such a condition that he is never allowed to forget, that the demands of society and the rules of duty must direct his habits of action and shape his manners.

This lesson, which cannot be taught through the memory alone, is conveyed by the position in which the student is placed at the English Universities. For he is subjected to many rules, and put under governors and monitors, who, by their institution, are invested with a combination of parental and official authority. And hence he acts in a little world, which is constituted of definite relations and duties, and requires a certain self-restraint and self-regulation at every step; and thus is a fit school to prepare him for the world of real action. Whereas, without such a constitution of the University, the student's academical career is a period of unbounded freedom from restraint and responsibility; which may be full of enjoyment, and, to many, of the occasions of great intellectual developement; but

which, to the greater number, must be a portion of life perfectly heterogeneous with all the rest;— a scene governed by its own principles, these being such as can by no means be admitted into the general business of society.

We shall now consider some of the rules and arrangements which thus constitute the Discipline of the English Universities. Each University, in its collective capacity, has its institutions and rules, constructed with reference to the preservation of good manners, morals, and religion; but I shall speak principally of the discipline of the English Colleges, since I shall thus sufficiently bring into view the principles of the subject.

SECT. 2.—OF COLLEGE MANNERS.

WHAT the manners of Colleges were intended and expected to be by the founders of Colleges, I cannot show better than by a few extracts from the Statutes of Trinity College, Cambridge; and especially from the chapter, “*De modestiâ et morum honestate colendâ.*”

“Whereas there is nothing which more adorns men of letters than modesty and purity of manners; we therefore decree and ordain, that all inferiors behave themselves towards their superiors in a submissive and reverent manner;—the Scholars towards the Bachelors, the Bachelors towards the Masters of Arts, these towards Bachelors and Doctors of Divinity, and all towards the Master as the supreme governor, and also towards the eight Seniors as fathers and leaders. And if any shall be shown to

have offended in this point, let them be punished according to the will of the Master, or, in his absence, of the Vice-Master and Senior Dean. Let none of the Bachelors or Scholars go into the town without taking some one with him to be, as it were, the witness of his proper conduct: let no one in the hall, in the court, or elsewhere within the College, neglect to take off his cap in the presence of a Master of Arts, or one of higher degree. And if any one be found to have gone into the town alone, for the first offence let him be deprived of one week's commons; for the second, of two weeks; for the third, of a month; for the fourth, by the consent of the Master and eight Seniors, or the greater part of them, let him be removed from College. But Bachelors who have finished the second year after their degree, we allow to go into the town without a companion. Let no one of the Fellows, or of the Scholars, or of the other residents, frequent houses suspected, or of ill name; and if after two admonitions from the Master, he abstains not, let him lose the College in the manner above described. Let the authors of domestic sedition, detraction, dissension, or wrangle, for the first offence lose a month's commons; for the second, three months; for the third, let them, as we have said, be expelled from the College. . . . We also decree, ordain, and exhort, that the Master, Fellows, Scholars, and other residents in the College, do use their utmost endeavour to nourish, cherish, and preserve concord, unity, peace, and mutual charity; and avoid, in word and deed, scurrility, ribaldry, scoffs, whisperings, reproaches, and scandals. (*Scurrilitatem, obscœna*

verba, scommata, susurros, probra, scandala, verbo et facto vitent.) . . . Let no one keep dogs, ferrets, hawks, or singing birds, in the College; nor be immoderately given to hunting or hawking; and if any one transgress, let him be punished as above." In the same manner, it is directed that no one shall spend the night elsewhere than in his chamber; or dine or sup in his chambers, except with the permission of the Master; or go without his cap and gown; or depart out of College without leave granted; with many similar rules. And again, (*De Cubiculorum Distributione*):—"We will and decree that each person conduct himself with propriety in his own chamber; and do not, by immoderate clamour, or loud laughter, or singing, or noise, or dancing, or musical instruments, keep his neighbour from sleep, quiet, or study; and also that he abstain from late revels, and from potations." And with like views, it is provided that no Bachelor, Scholar, Pensioner, or Sizer, be without a Tutor; and not only the relation of Tutor and Pupil is described in the way we have already noticed (p. 53), but it is directed that all the bills due to the College shall be paid by the Tutor.

It may be asked whether these rules have been observed, and what the effect has been. And to this we answer, that both in this, and in other Colleges of the English Universities, these and similar rules have been in force, in a great measure literally; while in other cases, where the change of circumstances and manners required a modification of the forms, the spirit and tendency has been preserved, and in all well-conducted Colleges has regulated the

temper and principles of their usual proceedings. We may add, also, that the effects of this discipline have been in the highest degree beneficial; and have shown that such a system, if earnestly and faithfully administered, may, in a great measure, lead to a general prevalence of that respectful temper, that moral character, those good manners and orderly habits, at which it aims.

The impression made on the disposition by such a system of discipline, is stronger than might be expected by most persons. Even tempers of great levity and stubbornness, if they are met at every turn of their extravagant and self-willed motions with the calm, but severe countenance of a system of rules like these,—imposing punishment for transgression, so long as it can be ascribed to thoughtlessness, but pointing constantly to the door, if transgression is persisted in;—are awed and tamed; and in a little while moulded to their position: while the great body of young Englishmen, of the condition of those who come to the Universities, conform, with a generous obedience of spirit, to rules which are the very essence of the institution in which they are placed, and of which all the better natures among them see and feel the value. I am quite persuaded that no one could become acquainted with the temper of the students of our Universities towards their College discipline, and towards those who administer it, without forming a strong affection and admiration for them, and a steady hope and trust in the beneficial influence of the College system upon their manners, temper, and practical character.

How, indeed, should it be otherwise, considering what is the extraction and the previous condition of our students? The youth of England, those whose childhood has been nurtured in the homes of England; who come to us from the arms of English mothers, and from the side of English sisters; whose memory is stored with the history, and with the poetry, and with the prayers of their native land;—these are not men to bring to us a churlish and captious spirit, looking for and finding nothing but evil in the body in which they are placed. These are not men to set themselves in array against the mild and equal restraints of beneficial rules;—these are not men to think resistance and insurrection glorious, against laws and authorities however necessary. Who can suppose that Englishmen are not ready to conform to a wise system of discipline, to enter into it with all their hearts, and by this means to bring forth the very utmost strength of their strenuous national character,—who can suppose this, that looks at what they have done and do, in this very manner, in our army, and in that unparalleled example of the combined force of strong character and rigorous rule, our navy? I have not the smallest doubt that the full and cheerful obedience of the pupils of the English Colleges to any portion of the requirements I have above quoted, which, on a considerate revision, it was thought proper to preserve, might be obtained, with moderate vigilance and care.

It is long since an opinion was expressed, that Discipline was declining in the English Universities. The reader of Cowper will recollect that this subject is pursued at some length in *The Task*,

In Colleges and Halls in ancient days,
 When learning, virtue, piety, and truth,
 Were precious and inculcated with care,
 There dwelt a sage called Discipline. * *

* * * * *

If e'er it chanced, as sometimes chance it must,
 That one among so many overleap'd
 The limits of control, his gentle eye
 Grew stern, and darted a severe rebuke:
 His frown was full of terror, and his voice
 Shook the delinquent with such fits of awe
 As left him not, till penitence had won
 Lost favour back again, and closed the breach.
 But Discipline, a faithful servant long,
 Declined, at length, into the vale of years,
 A palsy struck his arm.

I do not know how faithful, as a general representation, was this poet's censorious picture of the state of Colleges and Halls in his time; but I have little doubt that, in regard to morals, and, as to essentials, in regard to manners, the condition is better now than it was then. At least, I am very certain that the consummation which he describes has not yet taken place, and, I trust, never will, when "Discipline, at length, fell sick and died." In some cases, the alteration of the national manners, in others, the changed circumstances of the students, are such as to make a literal enforcement of the original rules absurd. For example, in the passage above quoted, the same reason which made it fit to allow Bachelors to go into the streets of the town at their own discretion, applies now to under-graduates, who are as advanced in age at the present day, as Bachelors were when the statutes were given. It may be, too, that with an improvement in many respects, there is

an increased laxity in the observance of rules on other points; for example, the constant use of the academic dress. But in most such cases, the fault is in those of superior position, who ought to enforce the observance of rules, and who are not sufficiently vigilant and earnest in this part of their duty. "Nos, nos consules desumus." If, for instance, all persons in the Universities, who have pupils under their care, were persuaded that the academic dress is a valuable remembrancer of the duties and obligations of the student's position, and were to enjoin its use on all occasions, and to rebuke its absence, there can be little doubt that omission in this respect might soon be rendered as rare as it ever was. But it is not my intention, at present, to propose special reforms.

The tendency of one of the directions above mentioned may not be obvious as a matter of discipline: I mean, that which directs that the College bills of the pupils shall be discharged by the tutor. This is now extended, in most or all of the Colleges in Cambridge, into a practice of passing, not only the College, but also the tradesmen's bills, and the payment of them, through the hands of the tutor. I have no doubt that this practice tends much, by the superintendence and opportunity of remonstrance and control which it introduces, to moderate, both the extravagance of thoughtless young men, and the demands of unscrupulous tradesmen; and that, even when it is not extended to the whole of the expenses, it keeps up among the students a general feeling of the necessity of probity and punctuality in pecuniary matters, which might soon be seriously impaired, if they were left to frame their own code of honour on

such subjects, with no check to their inexperience, levity, and caprice. The vulgar prejudice, that in such an arrangement the tutors improperly gain much by paying the tradesmen's bills long after they receive the money, though they may lose by paying the College bills before they can receive anything, as they are compelled to do, is not worthy notice in a survey of principles like this. Nor, perhaps, ought the great labour and solicitude thus occasioned to the tutors to stand in the way of the continuance of a rule so beneficial.

In our view of the influence of English University education upon the manners of the students, it would not be right to omit to consider the effect the students have in forming each other. This, indeed, is, and must be, one of the most important points in all systems of social education. And the operation of the English Universities in this way, is one of their most important and beneficial functions. Young men of all classes, from the highest to very lowly ones, are brought together, and made to feel that a common participation in a liberal education puts them, to a certain extent, on a footing of equality, and establishes an obligation of mutual respect. The peasant's son, who becomes the country clergyman, is thus elevated in feelings to the level of his office; for he is made to feel that, in the obligation to good manners and straightforward conduct, and in the right, too, to judge of such matters, he is no way behind the duke, who was his contemporary at College, and is his neighbour. At the University, also, the young Englishman receives the most decisive part of that feeling which he is acquiring during his whole education,

and which it is one of the most essential offices of his education to unfold;—namely, the feeling that he *is* an Englishman;—a knowledge of the principles by which the actions of his fellow-citizens are regulated, and by reference to which his own will be judged of, joined with a sympathy with their objects, and a habit of balancing himself among their impulses. Finally, at that crisis of life, when the vigour of manly thought blends with the warmth of youthful susceptibility, engaged in the enjoyments of literature, speculation, companionship, or competition, with his fellow-countrymen of his own age and position, he acquires a number of subjects of common interest, of agreeable retrospect, of endearing recollection; and these points of union bind together the Universitymen of the same standing, by a tie which rarely loses its hold, or its charm, during their lives.

We must, however, look at the dangers of this mutual influence, as well as its advantages. Many of these dangers are obvious enough; and against these, the College system, with its discipline and its tutors, appears to me, if well administered, to provide as far as human institution can provide. For we must recollect, that evil cannot be entirely removed;—that men can be taught to act, only by being in a great measure free agents; and that when all act freely, some will act ill. Some may become vicious or extravagant at the universities, but the contagion of such men is far less baneful under the system there pursued, than it would be in a similar body of young Englishmen, collected under almost any other circumstances.

Besides the operation of example and private intercourse, which students exercise on each other; there occur sometimes occasions in which their mutual influence appears in a more public manner. But such manifestations cannot proceed far, without coming in conflict with obvious maxims. If the actions of the students of English universities ever assume a character of studied independence, or concert, or tumult, implying a forgetfulness that they are under a system of superintendence, control, and discipline;—in such a case I conceive that the English university system is infringed; and that the governing body, or the pupils, or both, have lost sight of the rules which alone can make their relation permanently sound and beneficial.

SECT. 3.—OF COLLEGE PUNISHMENTS.

THE subject of punishments in education is one of extreme difficulty. Even in the earlier stages of youth, how hard it is to find any infliction which represses faults, without exciting a spirit of evasion and hostility. And when we have to do with youths who have acquired, in a great measure, the character and the privileges of manhood, how shall we invent a punishment, which they will feel sufficiently to make it effective, and to which they will submit? By what severities shall the teacher repress and constrain those who almost feel in themselves a right to independence, without introducing extreme punishments for those small offences which must often occur? Corporal chastisement, though habitually referred to in the statutes of English universities, constructed when the

age of students was different from what it is now, is of course out of the question. Personal restraint, though not so utterly disused, is not favourable to health of body or mind, and is not easily enforced with rigour, except by a force organized for the purpose. Tasks for the memory vary much in their efficacy, according to the habits of him who performs, and of him who imposes them; besides being a serious infliction on the latter, as well as the former: moreover, except supported by some possible ulterior punishment, they are evaded or neglected. The same may be said of tasks for the pen, which, besides, offer additional modes of evasion. Fines are felt little by the son of a rich parent, or by the thoughtless son of any parent. Taking away days or weeks, as it is technically called, that is, not allowing them to be reckoned to the student's requisite residence, besides sharing the inconveniences of other punishments, leads to procrastination, and to a habit of speculating on the chances of the future; since the evidence of residence is only examined at certain epochs of the student's career. Temporary banishment may be useful in some cases, but it is not applicable to small offences. And final extrusion is a sharp sword, which cuts, but does not untie, the knot; which must be considered as sacrificing one to many, and therefore must not be lightly brought into play.

Moreover, how shall we induce the teacher to inflict these punishments?—to incur ill-will and anger from those who are almost his equals; with whom, perhaps, he is living on terms of familiar intercourse; and with whom, at any rate, such a

hostile position must impair confidence and regard? And this too, perhaps, for some neglect of what appears a mere form; for if forms be not insisted on, rules crumble away. It is as difficult to find a hand to hold the rod, as it is to construct the rod itself.

How have our colleges attempted to deal with this difficulty, and how have they succeeded? It appears to me, that they have devised a plan, which, if faithfully and consistently acted on, would produce the true results of punishment, all so desirable, yet so difficult to reconcile;—which would repress small offences without extreme severity, and would be severe, when necessity was, without forfeiting respect and regard.

This plan has already appeared in the quotations which have been made from college laws. Its general character may be briefly stated: it is this:—*Every college punishment is an expression of the disapprobation of the college; this disapprobation is increased by every successive offence; and, carried to a certain point, makes removal from the college necessary.*

Thus, we have seen in the above extracts;—for the first offence, let him forfeit one month's commons; for the second, three months'; for the third, let him be expelled the College;—and the same kind of formula is used in almost every penal appointment. It will easily be seen, that in this manner, punishments, which are slight as inflictions, are serious as warnings. A small fine, or the forfeiture of a college allowance, or some restraint on the pupil's motions, or an exercise of the memory, or of the pen, which in themselves might be thought lightly of, receive efficiency from the consideration

of their possible consequences. They do not, when gone through, leave the delinquent where he was before: there is a shade on his prospect: he has to re-establish a character, without which he is in a situation of increased danger. He may dispel the shade; he may resume his original position of safety; but that must be by showing the will to avoid further offence. Without this, the frown of the body, under whose regard he is, becomes continually darker and darker, and at last the sentence of rejection is uttered.

Such appears to be the intended spirit of College punishments. Their efficacy in fact, will depend upon their being administered in this spirit. If any penal process is ever put forward as an intended infliction of so much inconvenience for so much transgression, the general meaning of the proceeding is changed, the language of College law is misconstrued, and its words lose their force and significance. The purpose of the college was, not retribution, but warning; the demand was, not pain, but amendment; the process was intended to operate, not on the passive, but on the active powers of the offender; not to task his patience, but to teach his will.

And hence, in estimating transgression, the will is mainly to be attended to. For instance, in reference to the neglect of any formal rule, the question is not so much, Did the pupil exactly conform to the rule? as, Did he endeavour to conform to it? Did he make regularity an object, among the things which are really his objects? Did he allow himself no intentional omissions? were there no deviations arising from obstacles which he would have overcome, or

thoughtlessness which would not have occurred, on a matter in which he was in earnest? If he was thus blameless in purpose, the violation of the rule in form need not be insisted on. In such a case, impunity will lead to no bad consequences.

It becomes necessary, on this view of the case, that the infliction of punishment should be usually accompanied with personal intercourse between the officer and the culprit, for otherwise the character of the offence cannot be rightly judged of. And this intercourse, to a considerable extent, is absolutely requisite to the efficacy of College punishments. It is important, not only in order to enable the officer to ascertain that temper of the offender on which the amount of the transgression depends, but still more, on another account; namely, to give him an opportunity of explaining its meaning and tendency according to the principle above laid down, and of enforcing its influence by such remonstrance, rebuke, and warning, (or encouragement, if necessary,) as the situation of the pupil and of the officer may give opportunity for. The occasion which the institutions of our Colleges afford for intercourse of this kind, is among the most valuable parts of the structure, and must be a main source of their beneficial influence, till their principles are utterly changed, and English University education entirely subverted.

Undoubtedly such intercourse as this is often very distasteful and irksome, both to officers and to students; and especially to those who have never been led to consider, that the whole usefulness and importance of the Colleges, as distinguished from the University, resides in the relations between the College

officers and the students; from which relations the duty of remonstrance and warning necessarily flows. Instead of this plan, which unavoidably produces solicitude, and often very unsatisfactory conversations and unpleasant feelings, many persons would doubtless much prefer a system in which certain fixed punishments should be applied according to certain fixed rules; and in which no perplexity or irritation on either side need exist, since all that happened must have been covenanted and foreseen. But the proper reply to the proposal of such a scheme would be, that there are no punishments, which, so administered, can answer the purpose of punishment. For suppose the lighter inflictions to be disregarded: nothing then remains, but to enforce them by heavier severities; and so on, till we come to some punishment which is a real misfortune to the student. And to suppose the teacher careless of this, would be to suppose in him such an indifference to the welfare of his pupils, as is a very unfit temper for an English University. The teacher, then, must warn his pupil of the ultimate consequences of transgression, and endeavour to induce him to avoid them; and thus we come back to the plan of personal remonstrance. College rules, and the existence of rule at all, necessarily lead us to this conclusion, whenever the teachers and the pupils are living in mutual good will and friendly intercourse.

But the business of remonstrance and personal intercourse, with regard to violations of rule, is not only irksome and repugnant to those who do not sympathize with the spirit of College institutions; it is also, in a large body, oppressive and difficult,

from the time, and energy, and vigilance which it requires of the officers, and from the solicitude and pain which it occasions to them. And this may be so serious an evil, that it may be well worth consideration whether it cannot be in some measure alleviated. And especially if the true principles of College government should have been partially lost sight of, or misunderstood, by officers or by pupils, the task of restoring them to their proper authority and efficacy by personal intercourse, would require exertions which it might not be easy to obtain. In such a case, perhaps something might be done by putting upon paper admonitions which are suited to the most common offences, and which might, without trouble, be used when any occasion occurred. For example, a paper to the following effect might be conveyed to the pupil, preceded by a statement of the rules laid down by the College for his conduct.

“These are the rules which you are required to observe by the College of which you have been admitted a member. You are to understand that the intention of obeying such rules as exist in the College, was taken for granted by the College in consenting to your admission. You are to understand, also, that the constant intention of obeying such rules is taken for granted so long as you continue a member of the College; and that as soon as it becomes clear to us that you have not such an intention, we cannot permit you to remain among us.

“In case of your deviating from the rules by thoughtlessness or accident, you are liable to such punishment as the officers of the College may impose.

And you are to understand such punishment, not as a satisfaction to the College, but as an expression of the disapprobation of the College towards you. If such punishments are repeatedly incurred, you are to understand that each of them expresses an increasing conviction on the part of the College, that the purpose of obedience and conformity, which is the condition of your being allowed to remain among us, does not exist. If this conviction is not removed or diminished by your own conduct, any additional confirmation of it by future offences will be considered as making your removal necessary.

“ You are to recollect that the *intention* of obeying the rules constitutes your duty, and that the College officers are to judge of this intention. It is therefore no palliation of any omissions to say that equal or greater transgressions are committed by others ; or that you are not *very* irregular ; or that you observe some rules though you transgress others ; or that you did not expect to have absolute regularity required. The *intention* of absolute regularity is required.

“ Such are the conditions of your position here : without attention to these on your part, we do not hope to be of any use to you ; nor can we allow your connexion with us to continue, when that hope is gone. And every occasion which we may have to remind you of these conditions, you must consider as an admonition and a warning, which, if not duly attended to, will be followed by more serious consequences.”

Such a paper as this might be conveyed to the student on each transgression ; and perhaps it might

be useful to mark, in the list of rules, that rule, the neglect of which had occasioned the admonition's being sent. Such a communication would remove all reasonable ground of complaint and misunderstanding; and in all the better disposed, would probably produce the effect of bringing them to a due sense of their position and duty.

There is one mode of influencing the students, which I have not mentioned yet, but which ought not to be overlooked;—I mean the step of the tutor's communicating with the student's parents or friends in serious cases of offence, representing to them his pupil's errors and danger, inviting their aid, or suggesting a voluntary temporary removal. As connected with punishment, this step may be considered as a more forcible remonstrance and warning, and may be very beneficial.

I believe that, in some institutions for education, the difficulty of providing punishments and enforcing rules has been got rid of, by calling in the parent's interposition at the very first. For example, the list of the student's attendance at his teacher's lectures may be sent at once to the parent, and thus the lecturer may escape the troublesome and disagreeable task of compelling attendance from the unwilling student.

This plan appears to me to be one which, from misunderstanding or despairing of the powers of a College, misapplies and throws away the parent's influence. For the remonstrance, displeasure, and pain of a parent might be strong motives with a young man, if they were reserved for very serious cases;—if the mere fact of applying to the parent

were evidence how gravely the tutor or the College looked upon the matter; and if such a step were never taken in consequence of the neglect of rules, till the failure of the lighter forms of remonstrance, and the neglect of the common punishments of the College, had aggravated the case. Such an appeal might affect even a stubborn spirit, if it were made the catastrophe of a tragedy of which the previous acts took place in College; but if it appear in the first scene, it is lightly thought of. The student may easily satisfy an indulgent parent by excuses which would not satisfy a College officer; or may disregard his dissatisfaction: and in either case, not only the rule, which we must suppose a salutary one, is evaded, but also a general habit of disregard, both of regularity and of authority, is nourished.

We must now say a few words of the application of this kind of discipline to particular cases.

SECT. 4.—OF ATTENDANCE AT COLLEGE LECTURES.

IT will easily be supposed that constant attendance at the College lectures is one of the rules of such institutions, and is, therefore, enforced by such a discipline as we have described. Express directions on this point are found in the statutes which I have already quoted:—"If any one is absent from the lectures, let him be fined; but if he is absent often, let him be brought before the Master of the College."

Since the lectures constitute the teaching in the College, the necessity of their being regularly carried on, both by teachers and pupils, is obvious. But an objection to this is sometimes made, to this effect:—

“What is the use of compelling attendance in the lecture-room, when you cannot compel the pupil to give his thoughts to the lecture? If he is interested in the subject, he will come without compulsion; if he is not, you can do him no good.”

To this objection we might obviously reply, on the principles of the last section, that a willingness, not only to repair to the lecture-room regularly, but to give attention to the lecture, is supposed in the student; and that where there is no disposition on his part to avail himself of the means of teaching which the College employs, there is no longer any reason for his connexion with the College; that is, no reason which the College can recognise.

But we may say further, that the assertion, that though you can compel the student's attendance, you cannot compel his attention, is altogether frivolous. You do not compel, indeed, but by the habits which you establish, and the occasions and inducements which you offer, you are almost certain of engaging his attention in no small degree. Placed for an hour under the eye of his tutor, who presents to his notice a subject urged upon him by its known place in the College course, and perhaps by its occurrence in an examination which he must undergo;—surrounded by his fellow-students, who are actively employed on the same subject;—perhaps personally addressed by his tutor;—his path directed, his mistakes pointed out;—the student ought not to refuse, and in most cases will not refuse, to give his mind to that which is thus recommended by duty, sympathy, and circumstance. The use, or at least one use, of the habit of College lectures is, like the use of all habits, that by

bringing an employment before us in a regular and familiar manner, it takes away the disposition to deliberate whether or not we shall engage in it. We enter into it, according to the common expression, as a *matter of course*. And thus, under a system of compulsory lectures well administered, the pupils will devote many an hour to real study, which otherwise might have been spent in other employments.

It may be said that lectures can be of little use, since the student has access to books; and since it is probable that the College tutor will not know so much as the best modern authors have known. But it is easy to see, that though he may not know so much, he may communicate more: he may collect from many books all that best suits the immediate object; and books have none of the power of obtaining attention from the thoughtless which, as we have seen, the lecture-room supplies. The mere existence of books is of little use to those who have no wish to read. Of writers assuredly we may say, if not of College lecturers, that they may offer to teach, but cannot compel others to learn.

Again, the meeting in the lecture-room is of use, not only in enabling the tutor to explain the subject, and direct the learner's studies, but also in making him acquainted with the student's powers and habits of thought. He sees what his pupil does, in the way of study, and how. The frequent and oral intercourse which a College lecture-room allows, enables the teacher to obtain an acquaintance with the progress of his hearers, quite different from that which the professor in his chair can acquire. And this increased acquaintance with the students' ability and

character may enable the teacher not only to make his instructions more efficacious, but to give them that turn which best suits their object as a part of a liberal education.

It is not easy to point out in detail how this is to be done; but some points are tolerably obvious. Mathematics, for example, which is to operate as a discipline of the reasoning faculties, must be treated in a manner suitable to this purpose. No false reasoning must be introduced or tolerated, however true or important the result; and it must be constantly ascertained, by question or trial, that the student apprehends the force of the proof;—that he sees the demonstration *as* demonstration.

There is another point, not so obvious, but not unimportant. The tutor may usefully dwell on the *grounds* of the reasoning; and here his employment will require some thoughtfulness on his part: for the common mathematical works, very properly, omit any detailed discussion of the grounds of the elementary truths on which their reasonings are built. Such discussions belong rather to metaphysicians, and have been with them a favourite employment. It is among them that we find attempts to resolve the questions respecting the foundation of the axioms of geometry, the proofs of the laws of motion, the generality and interpretation of algebraical language. The mathematician goes forwards from these elementary principles, and travels in the light; the metaphysician tries to trace backwards the origin of these principles in a region of comparative obscurity. But still it becomes him who possesses mathematical knowledge as an element of mental cultivation, not to take his principles

upon trust from others. And though he need not go deeply into metaphysical disquisitions on the nature and origin of our knowledge, he ought, at least, to turn his thoughts to this subject, so far as to apprehend the difference of necessary truths and mere observed facts. To do this, he must be led to perceive the full force of the axioms of those sciences which he cultivates; and this the tutor may enable him to do, by turning his attention to the origin of these elementary convictions, at the same time that he traces their consequences. And such speculations may serve to educe, in due distinctness and clearness, the fundamental ideas which the sciences involve, and the possession of which, by the student, constitutes, as we have said, the cultivation of mind which scientific studies give.

It may be thought difficult to give such lectures as shall be suitable to the whole of a large class, since there must be such wide differences of ability, quickness, and previous instruction among them. And if the lecture be considered merely as a preparation for an *independent* examination, this difficulty is formidable: nor can we carry on a successful struggle against it by any subdivision of our classes. But if the teaching of lectures be considered as valuable for its own sake; if the examination which succeeds the lectures be one in which the lecturers are the examiners, or shape the course of the examination; and if the subjects be properly chosen; I conceive the difficulty may be very nearly conquered. For this purpose, the subjects should be such as require little previous knowledge, and demand only patient thought and clear notions. Such a course of mathematics

might, for instance, be framed, by taking Geometry as the business of the first year; elementary Mechanics, treated with the plainness and rigour of geometry, for the subject of the second year; and Hydrostatics, Optics, and Astronomy, treated in the same manner, for the employment of the succeeding time. If these subjects are considered to be the basis of the College lectures, even slow learners may be carried on in the College course: and if the tutor provide himself with a good selection of problems and methods, not contained in the common treatises, which he may propose to the more advanced students, as matter for the employment of their own ingenuity and skill, he may, I think, furnish them with abundance of profitable occupation; while at the same time even the quickest and most accomplished students will gain a benefit by being brought back occasionally to the proof of their elementary propositions. And in this system, the community of occupation of the whole class will give the students opportunity to form judgments of one another, which produce a beneficial influence. The slowest and most thoughtless will learn duly to respect, and in some measure to understand, the character of the better intellects.

These latter remarks must be understood rather as suggestions of what the spirit of College lectures ought to be, than as any distinct proposition. For such a system might easily be carried so far as to sacrifice the higher students to the lower;—a proceeding by all means to be avoided; since it would impair the dignity of our education, and cloud the prospects of the progressive sciences in England.

SECT. 5.—OF ATTENDANCE AT COLLEGE CHAPEL.

THE subject of the enforcement by rule of the student's attendance at the religious services of his College, is one in which the discussion of opposite opinions can hardly be carried on without offence and pain. The sacred character and deep interest of all which belongs to our religious concerns, lead men almost inevitably to look at such questions with excited minds: while the very wide and profound nature of all the principles on which religious questions must be discussed, renders it difficult to argue closely on this subject. What! it is said, on the part of those who object to the enforcement of rules in such cases, do you undertake to make men pious by compulsion? Do you not know that the consciousness of a perfect freedom is requisite in order that a man may turn his thoughts in any fitting manner to his Heavenly Master? Would you degrade the ordinances, which ought to be so sacred, into mere lifeless formalities? Would you constrain men, with averse minds, and unregulated thoughts, to go through the external ceremonies of prayer? Would you make that which pretends to be the worship of God, be in reality a muster for the sake of order? Would you force men to come together in the name of God, when you have no higher object than to interrupt their idle or foolish employments? Constraint, which in matters of study is merely absurd, is here profane.

It will readily be supposed that the ancient College system, in this, as in other points, has taken the side of discipline, in opposition to that of perfect freedom.

A daily public worship in the College Chapel is established, or supposed, in the English Colleges; and the attendance of the students at this service is in most, I believe in all, enforced by means similar to those already mentioned. At the period to which these institutions owe their origin, it does not appear to have been conceived possible, that thoughtful and pious persons should wish to be liberated from this obligation of daily public prayer. The thoughtlessness of youth might require to be admonished of its duty; the infirmity of age might require indulgence; but the general rule, that the Christian members of a great institution, collected for the most serious purposes, and living together after the manner of a large family, should have a practice of daily prayer in common, appears to have presented itself to the minds of the legislators of that time as a self-evident maxim. Nor can we wonder at this; when we consider that, after the Reformation, pious men of our own Church, most averse in their minds to mere hollow show and lifeless ceremony, were most earnest in recommending a rigorous and formal regularity of time, place, and circumstance, in the conduct of men's devotions. And when we consider further, that in most large families, of which the heads have strong religious feelings, daily regular family worship is in our own time kept up, and is considered as a practice highly important, both as it testifies their sense of their relation to God, as it tends to sober and direct each person's own thoughts, and still more, as it proceeds upon the hope of obtaining for the whole family, the blessings promised to common supplications;—when we consider this, we cannot be

surprised that College worship, which may be looked upon as only another kind of family worship, has always been insisted on.

But, it may be said, by all means preserve the daily celebration of divine service in the College, but let it be attended only by those who repair to it voluntarily. You will thus have a genuine worship; and those who go will really derive from it religious benefits.

To this I should reply, by asking whether those who practise daily common prayer in their own families, leave it to their children and their servants to attend the service or not, as if it were a matter of indifference? whether, if any member of the family were to absent himself constantly,—I do not say out of religious scruples, but out of mere want of seriousness and impatience of constraint,—whether, in such a case, remonstrance and urgency would not be the proceeding and the duty of a pious head of a family?

But it may be said, remonstrance and advice are very different from College punishment for absence from the College chapel. And to this I reply, by referring to what I have already said, respecting College punishments. They ought always to be so administered and understood, as to have the character of remonstrance and warning. College punishments, however slight, however formal, are an expression of the disapproval of the College. Every person in authority, and every governing body, have their respective modes of expressing their approbation and disapprobation. The parent, or the master of a family, does it in one way; the College does it in another; but the meaning and object are the same

in all such cases. If, then, we allow the propriety of interference in the case of the family, on what grounds do we deny it in the case of the College?

Or, take the matter another way. Suppose that we leave attendance at the College chapel voluntary; and suppose, as would probably be the result, that a great number of the students appear there very rarely, or absent themselves altogether. Suppose, too, we know (as may easily be known,) that this practice is not accompanied by any voluntary religious exercises of any other kind, but arises from mere want of serious thought, and aversion to regular habits. Are we to allow this state of things to continue, without interposing in any way? It appears to me that we cannot do so. The whole system of our Colleges is framed upon the principle of not allowing those habits to continue unchecked and unopposed, of which we disapprove. We could not see our pupils going on, week after week, and year after year, with no recognition of their Christian duties and hopes, without some expression of our sorrow and dissatisfaction. Let it be supposed, then, that we must remonstrate. But what will verbal remonstrance effect, or who can employ it adequately, in a body, it may be, of several hundred young men? Remonstrance, then, must be represented, or at least supported, by College punishment.

But it may be said, that if we thus obtain the form, we lose the substance;—that the persons thus brought together by compulsion, have no devotion in their thoughts, and are not bettered by the practice. I acknowledge, with regret, that a College chapel is not, in the sincerity and earnestness of its devotions,

all that the friend of religion would wish it to be; but is the Parish Church? In both places there are the cold and careless; in both, the serious and pious. I trust that many a heartfelt prayer arises to heaven in the daily services of our Colleges; and that many, even of the thoughtless and callous, have their thoughts calmed and solemnized by its stillness and order.

Institutions can be bound to do only what is possible. They keep up the laudable practice; they give the daily occasion; they prevent manifest neglect and transgression. They can hardly do more; they cannot control men's wandering minds, or drive the spirit of prayer to their hearts, or breathe warmth and life into their supplications. It is most inconsistent to blame institutions for confining themselves to the enforcement of forms. What else can be enforced but forms? And is this a reason for enforcing nothing?

But when we say that institutions can enforce nothing but forms, do we, therefore, allow that they can do no real good? Far from it. Though they can *compel* forms only, this very existence of forms, according to the common laws of human habit, preserves and supports the substance. As we have already said, in speaking of attendance at College lectures, the occasion, the knowledge of sympathy and mutual approval, the recognised duty, the satisfactions which arise from acting under its influence;—these and similar inducements make the institution of habitual public worship far from inoperative, in exciting and maintaining real piety of heart. And there certainly is not, in the demands of College services, anything which need destroy this operation.

It has been asked, and so far as I am aware, no answer has ever been given to the question, how the consciousness of perfect freedom, which is supposed to be inconsistent with the religious customs of our Colleges, is reconciled with the various restraints and requisitions and formalities which occur in all our national religious observances;—with a rigorously defined formula of prayer, scarcely allowing of any deviations;—with the obligation of precise religious ceremonies on all the great occasions of life;—as birth; marriage; death; admission into the Christian Church; into its ministry; into many of the situations of our social scheme, especially in our Colleges and Universities. When any one has published an attempt to draw the line which shall include these appointments as laudable, and exclude the rules of College chapel as inadmissible, we shall better know how to estimate the opinions which are delivered on this subject.

When it is said that the rules of attendance at chapel are enforced for the sake of objects extraneous to religion, as regularity and sobriety of conduct; I conceive there is no force in the argument, except it could be shown that the rules are enforced on this account *alone*, which is not the ground on which I have been maintaining their value. For I presume the most sincerely and devoutly pious man, who thinks and feels daily worship to be of inestimable value as a really religious exercise, will still think it an additional advantage in such a course, that regular habits of daily worship are inconsistent with extreme listlessness, or frequent revelry, or wild extravagance of demeanour. In these respects it is surely no

reproach to godliness that she has the promise of the world which now is, as well as of that which is to come.

Indeed, I know not why we should hesitate to urge as one reason for insisting upon the College observances of which I have spoken, the circumstance so constantly remarkable, that the students of the best regulated minds, and the most admirable for temper, character, and morals, are those who give to College rules, in all respects, the most cheerful and scrupulous obedience. A person who is irregular and refractory in respect of the rules respecting the College lectures, and prayers, and the like, is the most likely not to be blameless in matters about which there can be no difference of opinion. In almost every instance, such a person carries away from College a part only of the advantages which its institutions are fitted to communicate to the willing pupil. Nor is it unimportant to remark, that the constant meetings with the pupil, to which this regularity gives rise, enable the officers of the College to form an opinion of his character and manners, which, though resting on apparently trifling indications, can hardly be erroneous when these are daily repeated.

It may, perhaps, be said, that after all, the system of College daily worship has not succeeded in fact; and that many of those who attend it have little reverence or devotion in their thoughts. I think that this aspect of the facts may, at present, very easily be overstated; but I should be sorry to enter upon a ground of defence, which might appear as if we were satisfied with ourselves in such points; in which Christian men ought always, forgetting the things

which are behind, and striving after the things which are before, to press forward toward the goal of their high calling. I will only say, that, of persons having authority in our Colleges, if it would be unbecoming in those who have laboured to make the ordinances efficacious, to speak of what they have done, it would be still more unreasonable in those who, though involved in like obligations, have not taken any part in such endeavours, to object upon the ground of what remains undone.

There appear to be one or two maxims with regard to College ordinances of this kind, which may serve still further to illustrate their operation. All external decency and decorum should be as much as possible insisted on. In all cases, and especially in an assemblage of young persons, among whom will occur ready sympathies, light thoughts and unstable characters, any absence of gravity of manner in those who are present, is contagious, extending from one to another, and from the countenance to the mind. The habit by which we adopt the attitude of inward supplication, or follow the well-known service along the printed page with our eyes, is no unmeaning formality: it excludes the wandering gaze and mutual glance which unsettle the serious thought. In a College of which I have already spoken, the appearance, and it may be hoped the efficacy, of the worship was much improved, by prohibiting a common practice of entering the chapel when the service was some way advanced. Again; the regulations should as much as possible be such as admit of a devotional meaning. To require attendance a certain number of days in the week, is, on this account, not a desirable rule:

but to enjoin a participation in morning prayer *every* day, is a fit ordinance among Christians; and to admit of attendance at the evening worship, as a mark of willing obedience, when that of the morning has been neglected, is conformable to the usual course of College administration.

It may be said, that, after all, this is a cold and lifeless aspect of religion;—that we have hardly gone further than to show, that our forms cannot consistently be abolished;—that we have shown little in our ordinances likely to excite vital religion;—that we may defend our system, but that we cannot induce really pious men to look upon it with admiration. And this we are ready to grant, not entirely, but partly, in the sense in which really pious men would urge it. We know that forms of themselves can do nothing; we know, that, when we defend forms, we are urging points which zealous men may assent to, but do not deeply care for. We know that we ought to go beyond these beggarly elements. But what is that to the purpose? To go beyond, we must go through them. If our forms cannot be abolished without intolerable evil, and do all that forms can do, what more is needed for their justification?

But we have spoken of going beyond these forms; how, it may be asked, is that to be done? This is a question to which no definite general answer can be given. Who shall say, what other ways, besides formal rules, best promote and maintain a true sense of religion in a community? Here, at least, a freedom of thought and action are requisite. What observances, besides those of College worship, what solitary or social readings, lectures, or exercises, on

religious subjects, shall be selected, as fit instruments for such a work, must be left to teachers and students, according to their stations, to decide. Those who endeavour to frame a scheme of self-regulation or mutual edification, with an earnest and serious mind, will hardly hit upon a plan that will not be profitable.

Yet one maxim may here be offered. A regular recurrence of observances is, in such things also, a wholesome and beneficial practice. In those persons, who have had the inestimable blessing of an early religious education, the feelings of piety are often best sustained by the continuance of early religious habits. The prayers that they have first been taught, the religious writers whom they have admired from childhood, are the oil which may best feed their lamp. The established devotional habits which can be retained, should not be lost. But here the student's case brings some difficulties, arising from his change of circumstances in coming to the University. For example, his Sunday, with its stated habits and religious employments at his home, may have been one of the main events of his Christian life. While he is at College, these habits can no longer be nourished by the arrangements and intercourse of his family. Nor can his College, from the very nature of the case, supply this want, except by forms, of which we acknowledge the insufficiency. Here, therefore, the student must provide for himself; and, as he values his Christian welfare, must give such a character of sobriety, and thoughtfulness, and religion, to the employment of his Sunday, as becomes a Christian man. And though the habits of home

may be changed, the gentle and kindly pressure of habit may be retained. Supposing, for example, that the student attend the morning and evening worship of his College chapel, and one of the sermons which are every Sunday preached before the English Universities, there still remains a large portion of the day, which may be moulded into a shape by suitable habits. If some of the vacant time which the cessation of his ordinary studies leaves, be usually occupied in intercourse with friends, these may best be one or two only, and, as much as possible, always the same. And to attend habitually some one of the parish Churches within his reach, may keep up the recollection of the Church of his home, and preserve the social sympathy of English worship. The day, too, may have its own books and studies. But I do not here dwell upon such points, wishing only to point out in a general manner how the student may best feed and foster, during his University career, that religious faith, and hope, and love, which we may trust he will bring from his mother's knee and his father's hearth; and which, if he hold it fast, will be his best guide and support in those wider and busier scenes, of which the University is the portal. It is such a character of mind, too, which will give him a cultivation of a higher kind than that of which I have spoken; which will not merely transmit a refined and elevated tone of thought to another generation, but will prepare the soul, by a progress in holiness and love, for its own future place in a higher region of purity and blessedness.

SECT. 6.—OF FELLOWS OF COLLEGES.

IN the Colleges of the English Universities, the administration of the education, as well as of the property, and other interests and duties of those institutions, is, by their statutes and constitution, committed to the Fellows of the College, along with the Master. These persons, thus invested with important possessions, privileges, and offices, are those upon whom the working of the College system depends; and it is important, in order to judge of the tendency of the system, to consider, both what their functions are, according to the plan of these institutions, and what their actual character is. I think I shall assist the reader in forming a judgment upon these subjects, by quoting the statements of an intelligent and accomplished American traveller, deservedly much admired and esteemed in his own country, who visited England a short time ago, and whose account is in the main correct and impartial.

“As there are no fellowships in our American colleges, you may perhaps be gratified by some account of them as they exist here. In this University (Cambridge) there are about one hundred and fifty fellowships attached to the different colleges, most of which are given on examination, and to merit only. They vary in value, from 150*l.* to 300*l.* a-year, besides free commons and apartments. They are held during life, or until marriage. Many of the occupants become tutors of colleges, private tutors, &c.; but nothing is absolutely required of them. Much has been said of the indolence of Fellows; of their dis-

position to quarrel and petty intrigue; and of their fondness for guzzling ale, tipping port, and playing whist. Such things *were*. Nay, since such are the natural consequences of a want of ambition to be useful or distinguished, a want of occupation, and a want of that most practical stimulant, dire necessity, such things *are*. The cases, however, are unfrequent. The Fellows to whom I had the honour to be introduced were men of a different stamp. They were gentlemen, in the highest sense of that high term, and bore about them no traces of their somewhat monastic system. Their conversation smelt a little of the shop;—was sometimes a little too mathematical, at least for me;—but was throughout the most thoroughly intellectual that I ever enjoyed. Their *reunions*, after a plain but well-cooked dinner on the dais of their College-hall, either in the common sitting-room, or in the apartments of some individual member, left on my mind a delightful impression. It was such as literary society should be, composed only of men of real learning; of friends confiding in the mutual esteem entertained by all, undisturbed by ambitious quacks or impudent pretenders*.”

From the class to which belong the persons thus described, are selected, not only the tutors, but all the College officers engaged, both in education and administration. The Master and Fellows are, in fact, the College. And these institutions expect from their Fellows, not only care and fidelity in the discharge of office, but active zeal and lively affection. According to the statutes which I have already quoted, a

* Remains of the Rev. Edward Griffin (of New York), Vol. II. p. 259.

Fellow of the College, on his admission, swears "that he will be faithful and friendly to the College; that to it, and to all the fellows and scholars, and to the master, he will bear good-will and give help, not only while he lives therein, but afterwards, to the best of his power, when occasion may arise; that he will never cause loss or trouble to the College, and that the designs, combinations, conspiracies, plots, deeds, and words of others, which may bring damage and evil fame to the College, he will repel as far as he can, and will denounce them to the officers of the College who are to take cognizance and give judgment concerning such things; that even if he is formally expelled, he will not bring any action against the College or its members; that he will obey the master, vice-master, seniors, and officers, in all lawful and honest matters, and pay them due reverence and honour; and finally, that he will take upon himself all offices imposed by the master and seniors, and will administer them with the utmost fidelity and diligence."

Nor have these provisions been without their effect. The Fellows of Colleges not only undertake the offices which the College imposes upon them, (of course, with no unnecessary disregard of their private convenience,) but they do also, almost universally, bear a domestic affection to the body, or, as it is often familiarly called, "the house." This is not difficult to understand; for there is among the Fellows of the same College something approaching to a family bond. They have common possessions, a common home, a common table, a common interest to deliberate upon; they have among them numerous close

ties of intimacy and regard, formed in the period of life and under the circumstances which render friendships most durable and dear. And thus it is very natural that there should prevail among them a general sympathy and unity of feeling, with regard to the fundamental principles of the institution of which they are all children.

It will be understood, therefore, that the administration of the College system of discipline, such as we have described it, may generally be committed to such hands with every prospect of its being faithfully carried into effect. The Fellows cannot but feel that the enforcement of such a system, by their joint and separate influence, is one of the main objects of their institution. In this view, there is an immense advantage in the existence of a body of men, who, though only some of them are teachers or officers, all sympathise with the teachers and officers, discountenance irregularity and indocility, and assist in carrying rules into effect. The use of such a body in supplying examiners in addition to the teachers, is also great; for though, as I have already urged, there appear to be strong reasons against making the College examinations *independent* of the tutors, there are also strong reasons against committing them to the tutors *entirely*; and against destroying that acquaintance and sympathy with the College course of instruction, which the Fellows in general acquire by taking a share in the examinations. And for the discharge of those most important offices by which, in addition to the superintendence of the tutors, College discipline is preserved, (the offices of *Deans*, &c.,) Colleges are dependent entirely on

the willing and persevering exertions of their resident Fellows. If this support should fail them, the system must fall into ruin.

Besides these advantages, the institution of Fellowships has other uses which must not be overlooked. They are prizes of considerable value; and these and other minor prizes of the same kind (scholarships, &c.) being given to merit according to the test of examinations, supply a constant encouragement to those academic studies, which although, as we have seen, they are essential to the preservation and progress of intellectual civilisation, would not be adequately supported by the demands of practical life and popular opinion. The institution of Fellowships, as they now exist, extends this influence in a peculiar manner to the learned professions; for since most of the Fellowships may be held for a certain period without residence, they are objects of great competition to those who intend to be lawyers, or physicians, or clergymen; and they always give something of a literary and speculative tone to the mind; both by the preparation which they require, and by the opportunity which they afford of lingering a little while in the region of letters and science, before the business of professional life absorbs the powers of thought and action.

Such appears to be the proper intention, and such has hitherto been in a great measure the actual operation, of the Fellowships of our English Universities. But since I have, throughout this essay, examined the actual principles of our Universities, by weighing them against their alternatives, let us consider what would be the effect of the decay

or absence of the College spirit which I have endeavoured to describe. If the Fellows should lose their interest and sympathy in the general business of the instruction and discipline of the College;—if they should discontinue the traditional practices of being often present in the Chapel and the Examination-hall;—if they should endeavour to evade offices which bring any labour and trouble, or should discharge them with a cold and scanty service, barely fulfilling the forms, and taking no pains to make them effective;—if this should ever happen, we cannot doubt but that the effect of the College system must be grievously crippled and weakened.

But we may go further in supposition. It is not very easily reconcilable with our view of the intention of Colleges, that those persons who compose them should openly declare themselves against the College system; for it would seem that he who is member of a legitimately-constituted body, if he disapprove of its practices, should endeavour to reform them by efforts within the body, and not by calling in the stranger. But suppose that any of the governing members of a College (and all the Fellows are governing members, since all in turn may take offices of administration,) should disapprove of the College system of instruction or discipline, as we have described it above, and should express his opinions openly. It cannot be concealed that this would be a great evil; and if such opinions came to be held, or were supposed to be held, by several, beyond doubt such a difference of sentiment among the governors must needs throw a chill and gloom over the general administration of the College. For those of the Fel-

lows who, thinking their own College system the most beneficial and excellent of all systems of education, would labour with unstinted efforts and with cheerful hope to make it efficacious, if they conceived themselves to be supported by the general good-will, sympathy, and confidence of their brethren and daily companions, would, if they were compelled to see that this sympathy did not exist on very important points, be driven to take refuge in a joyless sense of duty; and though they might not labour the less, would lose the hopeful and buoyant spirit which makes labour easy and efficient. If we might use a comparison somewhat too large for the subject, we might say that they would have to nourish the steadfast but melancholy resolve of a patriot, struggling for what he knows to be a sinking state. But our Colleges, we trust, will never come to this condition.

No additional supposition which we can make would bring us to any increased difficulty. For if we conceive some one of the members of our Colleges, in recommending changes, to show none of that affection and reverence to the institution, which is the bond of union among its members, or if we suppose him to urge accusations against it in that scoffing and scurril tone of which the statutes above quoted express their detestation, the consequence may easily be foreseen. He would excite among all around him, even those who themselves wished for change, no feeling but dislike and repugnance; and the finger of public scorn, and the shudder of silent disgust, would make him feel at the bottom of his soul, coarse though it might be, how much he had mistaken the character of the society which he blemished.

To return, therefore, to the case before supposed, of a difference of opinion among the governing body of a College, moderately and considerately expressed, but carried so far as to damage that co-operation and community of purpose in which the strength of the body consists:—it may be asked whether there be any means of preventing or of remedying such a grievous distemper. But upon this inquiry I shall not here enter. It is easy to see that the remedy, if it exist, must be difficult to discern and to apply, since the disorder is one affecting the spirit, and not the forms of the institution. Perhaps something might be suggested: but as my object in the present work is rather to consider the operation of the principles which have hitherto prevailed in Colleges than to propose changes, I shall not at present pursue the subject.

SECT. 7.—OF THE FREE SYSTEM.

By the *Free System* of Universities, I mean that system in which there is no discipline such as I have described, the students being left to act without control, both as to attendance upon the lectures and other appointments of the College, and as to manners and conduct in general. It is to be observed that this free system is perfectly consistent with examinations and public trials at certain periods; for these processes are so far from implying discipline, that they do not even imply the student's residence in the intervals between the public occasions.

The free system is understood to be the one which prevails in a large portion of the universities

out of England. The Germans consider "Academic Freedom" as one of the main principles of their universities; but this has never been the system of English Universities. It is, however, the system towards which we tend by every relaxation in the enforcement of our discipline, and by every resistance to discipline on the part of our students. It may therefore be useful to point out some of its features.

The free University system is founded on the doctrine that there is no University control over the private and social conduct of the student. He is left, like any other citizen, to be guided by his own sense of propriety, and controlled by the law of the land. But it will readily be supposed that a large body of young men, just emerging from boyhood, most of them belonging to families of some property, and given over for the first time in their lives to the unrestrained exercise of their own propensities and judgments, will conduct themselves in a manner very different from the same number of citizens of any other class. Their newly-felt freedom will need to be exhibited in a conspicuous manner; and an opinion of their own superiority, which will naturally arise from sympathy and companionship, will make them despise all who are not of their body. And thus, if by ancient usage the students wear a peculiar dress, their position will generate the turbulence and the pride of *the Gown*. If they are not so distinguished from their fellow-townsmen, they will soon find means themselves of marking the difference between the *Bursch* and the *Philister*.

That a body of young men, who conceive that no right to control them exists, will receive with the

utmost indignation all attempts to subject them to any kind of rule, may readily be imagined. They will consider the cause of resistance as the sacred cause of liberty, and will, with the greatest self-complacency, speak of, and behave to those who would impose any restraints upon them, as narrow-minded oppressors. We have examples of such a spirit, in the conduct of the medical students of our own metropolis. Among these persons, we are told*, any attempt made to ascertain the regularity of the student's attendance at the lectures, is held up to scorn as the "lecture-room spy system." But this spirit does not confine itself to resistance to rule; it soon assumes a right to interfere in the appointment of professors and similar matters; or at least to resent, by active proceedings, any such measures, when they do not suit the taste of the students. Thus, there has recently been a tumult on a subject of this kind, in one of the schools of Paris; and it is well known that in Germany, the students have often manifested the offence they have taken on such occasions, by organized migrations, or by putting some particular University under the interdict of the clubs of the young men.

These may appear to be extreme cases, but they serve to show, what that free University system is, which is opposed to the discipline system; and it is useful to recollect, that we cannot recede from the one, without approaching the other. It is easy to conceive many other proceedings, which, without assuming the principles of the free system in their full vigour, are still inconsistent with the condition

* British Magazine, April, 1837.

of persons under discipline. Such are, for example, all acts of a political kind, as meetings or organizations for political purposes, public petitions, or public discussions on the agitated questions of the day, and the like. Under the discipline system, the student cannot act at the University, except in the capacity of a pupil. In like manner, public and tumultuous exhibitions of opinion by the cries of a crowd, (although, in the excitement to which crowds are subject, even members of the governing body may be drawn on to join in the shout,) cannot, in any calm view of propriety, be reconciled with the pupil's position. Indeed, the exaggerated and insatiable manner in which public applause is given by bodies of students, is of itself an evidence that in such cases, they feel that they are not merely expressing an opinion, but are also gaining a victory over some expected restraint by the mode of expression. It often happens, that meetings under such circumstances inflame themselves by their own tumult, till all order, decorum, and common sense are lost sight of; and the cries that are uttered, and the manner in which they are received, show how decided the tendency of such proceedings is, to make the actors in them lose all regard for good manners, as well as for subordination.

It can hardly be doubted, I think, that the tendency of the free system, if introduced into the English Universities, would be to corrupt the character, and deprave the manners of the students. If they felt themselves out of the reach of control and authoritative monition on points of general conduct and habits, they would feel that the regulation of the fashions, manners, and principles of the academic body was

committed to their hands; and they would not fail to devise a system of their own. They would make their own rules of morals, their own codes of honour and honesty; and though I do not doubt that these would bear traces of the general morality, probity, and good sense of the English character, I fear they would be below the discipline standard. The teachers too, among a crowd of imperious, self-willed and self-satisfied young men, who would be, by the constitution of the academic body, their equals in all but knowledge, would be held, in the opinion of the young men themselves, to be an inferior class to the students. I do not suppose, that the generous spirit of young Englishmen of the better orders would ever take the tone which is said to prevail among the medical students of London*; of representing the teachers as interested in increasing the burdens of the students, and entertaining no other views towards them, than to rob them of as much money as they can;—but I do not think that we could have that cordial respect and sincere deference of pupils to tutors, which at present generally prevails in our Colleges, except under a system in which the privilege of remonstrance and admonition which age, experience, and reflection give, was sanctioned and dignified, by being made at the same time a right and a duty.

I conceive, therefore, that any one who seriously wishes the education of our Universities to continue and extend its beneficial influences, cannot hesitate, on every occasion which may occur, to lend his best exertions to the preservation of that system of College and University discipline, of which the only

* British Magazine, as above.

ultimate alternative is a system of entire misrule, and the unbounded sway of youthful caprice, extravagance, and turbulence.

SECT. 8.—OF CHANGES IN THE COLLEGE SYSTEM.

THE system of education in our Colleges, like all other systems, may require some modification from time to time, for the very purpose of causing it the better to answer its genuine beneficial purposes. For example, an alteration in the aspect of some branches of science and learning, produced by the progress of knowledge, may render changes in the course of reading and examination desirable. A few brief general remarks on the principles which apply to such changes, must close our present task.

In the first place, I observe, that the common topics which are sometimes used in favour of changes in general, are to be listened to with great suspicion, when applied to the provisions of the College system:—such as, that the world is constantly advancing, and that we must accommodate ourselves to its progress;—that the present generation is more wise, more enlightened, more free from prejudice than its predecessors, and that, therefore, we must not bind it in fetters which they constructed. Without here dwelling on the doubts which might be urged against these assumptions, we must consider that the office which Colleges have to discharge, is inconsistent with any hasty or frequent application of the maxims founded upon them. Universities, so far as they are schools of *general* cultivation, represent the permanent, not the fluctuating elements of human knowledge.

They should be progressive, for otherwise, they cannot be permanent; but the progress in which they ought to share, is not one which can be estimated from year to year, but rather is reckoned by centuries. They have to transmit the civilisation of past generations to future ones, not to share and show forth all the changing fashions of intellectual caprice and subtlety. They ought not, therefore, rapidly or easily to introduce changes into the subjects of their study. They ought to wait till novelties have been well discussed, and firmly established, before they adopt them into their *elementary* course. I am here, of course, not speaking of *professional* education; for an accomplished and thoroughly educated man, of any profession, will possess the most advanced knowledge, and be acquainted with the best literature, which belongs to his department. But in that fundamental education, of which I have principally treated, the old ways are not lightly to be abandoned. As I have already said, I should be sorry to see Euclid lose his ancient place, or even his ancient form, in our system.

In the statutes of several of our Colleges, not only the subjects, but the books, are prescribed, which are to be the subject of study. This may appear an inconvenient and importunate interference with the progress of literature, by which one book constantly supplants another. Probably such a rule would not be introduced by persons legislating at the present day, when we are more familiar with changes in literary currency. Nor would I recommend such laws. But we may observe, that provisions of this kind appear to have been suggested by a regard for that permanence of the course of culture which is

necessary to the utility of our Colleges. And the subject is not without its difficulty; for if we prescribe no fixed course, and leave the determination of the subjects of study to the teachers of the moment, we incur the danger of capricious changes and sudden revolutions of doctrine, which would throw the system into confusion and annihilate its effect as culture. And if our laws point out subjects only and not authors, they do not escape the evil of instability, except where the subjects have long assumed a permanent form, in which case, the authors also have generally become classical. If, for instance, we adopt Political Economy as one of our subjects, who can tell us what kind of science political economy will be fifty years hence? whether it will be most connected with metaphysics, mathematics, or history?

The course adopted by the legislators of our Colleges has, in practice, worked well. The prescribed list of authors has not been adhered to; but in the deviations from it, care has been taken, that the new books introduced should, as much as possible, represent those which they supplanted; and that the new plan should, in its general bearing and spirit, conform to the original scheme: and in this way we have courses of mathematical and classical reading, in which the books, and many of the modes of treating the subject, are modern, but the subjects themselves are little changed from the foundation of the Colleges. In other cases, new subjects have been introduced. The power of making such alterations has been supposed to reside in the governing body of each College, and has been exercised under an habitual sense of the importance of the duty: nor does it appear that

any better authority can be set up for this purpose. The authority of the University may prescribe subjects of examination for its degrees; but to confine the education of the Colleges within this limit, would be to deprive it of its best advantages. Nor need any one fear that, under such government as we describe, the reluctance to admit change will be too great. I believe most of those who have had much to do with the administration of education at Cambridge, will agree with me, that we have, of late years, admitted changes in our system rather with too much than with too little facility.

An objection will, perhaps, be started to changes in College courses, introduced in the manner I have described, on the ground that the governing body have sworn to obey the original statutes, and, therefore, have no right to alter them. I confess I cannot assent to the soundness of such a decision. It appears to me, and I think will appear to many persons, that the substitution of a better book of elements for a worse on the same subject, might well be included in a conscientious interpretation of conformity to the statutes. But if the removal of such discrepancies will satisfy the minds, either of those persons who have taken such oaths, or of any others who are fit judges, by all means let the attempt at a closer reconciliation between precept and practice be made. Only let this be done with due attention to the considerations we have pointed out;—the necessity of great permanence in our College courses, in order that they may form a national education;—and the difficulty of establishing such permanence by a mere enumeration of the subjects to be studied.

Above all, let no one who wishes to have our Universities really useful and respectable, and who, therefore, would remove such defects as they may labour under, bring to his work of reformation a hostile and excited temper. If any one shall apply himself to this subject, believing that great chasms have been formed in our system, and are to be repaired ;—that our practice is far removed from our statutes ;—that our system is much behind the condition of the age ;—that we have gone on in our beaten track, careless and inobservant of what has been passing in the world about us ;—that we feel no strong sense of duty and responsibility ;—if any one shall come, believing this, and having, therefore, in his breast, a magazine of suppressed indignation and contempt, which a single spark may explode ;—such a person is, by his own state of mind, not only utterly unfit to be our judge, but probably incompetent to investigate the subject of University education at all. He probably does not know that Universities and Colleges have for their office, not to run a race with the spirit of the age, but to connect ages, as they roll on, by giving permanence to that which is often lost sight of in the turmoil of more bustling scenes. He can hardly be aware in what temper all reform of Universities ought to be undertaken. In order to introduce real improvements, we must bring to the task a spirit, not of hatred, but of reverence for the past ; not of contempt, but of gratitude towards our predecessors. If we are able to go beyond them, it must be by advancing in their track, not by starting in a different direction. We must continue their line of instruction, and study their academic constitutions.

What the vocation of the present age for such legislation may be, I know not. The men of our day will deserve no small admiration if they succeed in framing laws which shall operate as beneficially, and endure as long, as those of our English Colleges have done. And if they are to do this, it must be, not by rejecting and despising, but by adapting and improving the older codes. If, instead of such a Reform of the English Universities, we attempt to remodel those institutions on some foreign or imaginary plan, we shall justly incur the condemnation of all wise men, and shall deserve a sorrowful and indignant remembrance from our successors.

“*Let not England forget her privilege of teaching the nations how to live.*” This was proudly said ; perhaps too proudly, for nations do not always profit by adopting even the better institutions of another nation. But it was said with a patriot pride ; and those who administer our institutions in the spirit which this sentence expresses, will hardly fail to refine and elevate the character of their countrymen. Nor is the exhortation without a solid ground ; for has England not taught the nations how to live ? By an admirable combination of active and original intellect, with unequalled practical sagacity and force of character, England has constantly impelled the progress of thought and of institutions in Europe, while, at the same time, she has held back from the extravagances and atrocities to which the progressive impulse has urged more unbalanced nations. The bold and vigorous metaphysicians of England first put in action the speculative movement of modern Germany ; but England refuses to follow the wild onward

whirl of system after system, to which this movement has led. English teachers of political freedom, and the free institutions of England, called up the spirit which has broken the bonds of more than one despotism; but England, (thank God!) was never hurried into the democratic madness of her nearest neighbour. England had a Reformation of religion without the abolition of her Church; she had a Revolution of dynasty without the destruction of her Loyalty; she has had a Reform of her Parliament, we trust, without any fatal wrench to her Constitution. We have, therefore, no small reason to confide in the practical sense and fixed sobriety of the English character, and to believe that England may still continue to teach the nations how to live;—how to preserve and how to reform ancient and beneficent institutions. And this she may do, not by new modelling her ancient Universities, the sources of so much benefit, and the objects of so much love; not by an abrogation of the functions, or a revolution of the constitution, of her Colleges; but, when need shall be, by a calm and serious revisal of their laws; above all, by a revival of their genuine spirit, and a fit estimate of their exceeding importance and value.

This I urge, not in a spirit of inflexible adherence to the past, but of care for and hope in the future. I trust it has appeared in the preceding reflections, as I trust it has appeared also by other indications, that I hold opinions respecting the improvement of our modes of education, which are not dependent upon any recent or external suggestions of the need of reform. And it is because I consider that the right administration of the Universities of the land

involves the welfare of countless generations of Englishmen yet unborn, and of centuries of English civilisation yet only in the germ, that I warn all whom it may concern, against attempting this task in a hasty or angry spirit ; and remind them that they cannot exercise any wise deliberation concerning the future, without a sober and reverent regard to the past.

So may our mother flourish while the name
Of England holds its proud pre-eminence
Among the nations: in her ancient halls
And venerable cloisters be our youth
Invigorated by salubrious draughts
Of free and fervent thought, and let the mind
Of our great country, like a mighty sea,
Be fed and freshened with perpetual streams
Of pure and virtuous wisdom, from those springs
Gushing unceasingly.

THOUGHTS
ON
THE STUDY OF MATHEMATICS,
AS A PART OF
A LIBERAL EDUCATION.
TO WHICH IS ADDED,
A LETTER TO THE EDITOR OF THE EDINBURGH REVIEW,
OCCASIONED BY THE REVIEW OF THE FIRST
EDITION OF THE THOUGHTS.

THOUGHTS
ON THE
STUDY OF MATHEMATICS,
&c.

THE various opinions which we hear and read, on the use and effects of the Study of Mathematics, show us that the subject is far from generally understood. There must be in the world a good deal of misapprehension and confusion of thought respecting this matter, or we should hardly meet with such different and opposite judgments as perpetually come in our way. On the one hand we are told that mathematics is a most admirable mental discipline; that it generates habits of strict reasoning, of continuous and severe attention, of constant reference to fundamental principles: on the other side it is asserted, that mathematical habits of thought unfit a man for the business of life;—make his mind captious, disputatious, over subtle, over rigid;—that a person inured to mathematical reasoning alone, reasons ill on other subjects, seeks in them a kind and degree of proof which does not belong to them, becomes insensible to moral evidence, and loses those finer perceptions of fitness and beauty, in which propriety of action and delicacy of taste must have their origin.

Any view of this subject which would show us how far and under what circumstances each of these opinions is true, would probably help us to see how we must regulate our studies so as to make them most beneficial;

and might therefore be of interest to some persons, even though the argument should be of a nature somewhat metaphysical; as, indeed, having to treat of the effect which certain processes of thought produce upon the mind, it can hardly avoid being. It is in this belief that the few reflections which follow have been written.

The most obvious point of view under which the study of mathematics, as a mental discipline, offers itself to us, is as an example and exercise of exact reasoning. It will probably be allowed by all, that the *power*, at least, of tracing securely and readily the necessary consequences of assumed principles is a desirable acquisition. Yet it can hardly be denied, that in a great part of mankind such a power requires to be confirmed and strengthened by education, since by nature it exists in a low degree and confused form only. Men's minds are full of convictions which they cannot justify by connected reasoning, however reasonable they may be. Nothing is more common than to hear persons urge very foolish arguments in support of very just opinions; and what has been said of women is often no less true of the sex which pretends to have the more logical kind of head:—namely, that if they give their judgment only, they are not unlikely to be right, but if they add their reasons for it, those will most probably be wong. There prevails very widely an obscurity or perplexity of thought, which prevents men from seeing clearly the necessary connexion of their principles with their conclusions.

Now, though there is this chance of being practically right and speculatively wrong, it will probably be allowed that this is not a state of mind in which those can acquiesce contentedly whose object is the mental culture of man. It may be very possible to act well and to judge justly, while we think confusedly and argue ill; but we cannot on that account see no harm in confused thought.

and bad reasoning. The object of a *liberal education* is to develop the whole mental system of man, and thus to bring it into consistency with itself;—to make his speculative inferences coincide with his practical convictions;—to enable him to render a reason for the belief that is in him, and not to leave him in the condition of Solomon's sluggard, who is wiser in his own conceit than seven men that *can* render a reason.

This complete mental culture must, no doubt, consist of many elements; but it is certain that an indispensable portion of it is such a discipline of the reasoning power as will enable persons to proceed with certainty and facility from fundamental principles to their consequences. And this part of the cultivation of the mind is what I shall at present especially consider. Let us suppose it established, therefore, that it is a proper object of education to develop and cultivate the reasoning faculty. The question then arises, by what means this can be done;—what is the best instrument for educating men in reasoning?

There are two principal means which have been used for this purpose in our Universities; the study of *Mathematics* and the study of *Logic*. These may be considered respectively as the teaching of reasoning by practice and by rule. In the former study, the student is rendered familiar with the most perfect examples of strict inference;—compelled habitually to fix his attention on those conditions on which the cogency of the demonstration depends;—and in the mistaken and imperfect attempts at demonstration made by himself or others, he is presented with examples of the most natural fallacies, which he sees exposed and corrected. In studying logic, on the other hand, a person finds the conditions formally stated under which an inference is legitimate; he is enjoined to see that in any given case these conditions are satisfied;

and if a fallacy exists, he is provided with rules by which it may be condemned and made more glaringly wrong.

Now I venture to say that the former kind of teaching is, in my opinion, likely to be the more efficacious of the two. For reasoning—a practical process—must, I think, be taught by practice better than by precept, in the same manner as fencing or riding, or any other practical art, would be. Our object, or at least our first object, in this case, is that the student should conduct his train of deduction securely, yet without effort, just as in the riding-school the object is that the learner should proceed firmly and easily upon his steed. It is desirable, not so much to define good arguments, as to feel their force; not so much to classify fallacies, as to shun them; just as the horseman tries to obtain a good seat rather than to describe one, and rather avoids falling than considers in how many ways he may fall. To cultivate logic as an art (for I do not now speak of the theory) appears to resemble learning horsemanship by book; and though such learning is not without its use, it cannot supersede the necessity of habitual exercise, which the pursuit of mathematics supplies. In reasoning, as in other arts, we are not masters of what we have to do, till we do it both well and unconsciously. Now, this advantage a judicious cultivation of mathematics supplies. It familiarizes the student with the usual forms of inference, till they find a ready passage through his mind, while anything which is fallacious and logically wrong at once shocks his intellectual habits, and is rejected. He is accustomed to a chain of deduction, where each link hangs from the preceding; and thus he learns continuity of attention and coherency of thought. His notice is steadily fixed upon those circumstances only in the subject on which the demonstrativeness depends; and thus that mixture of various grounds of conviction, which is

so common in other men's minds, is rigorously excluded from his. He knows that all depends upon his first principles, and flows inevitably from them;—that, however far he may have travelled, he can at will go over any portion of his path, and satisfy himself that it is legitimate; and thus he acquires a just persuasion of the importance of principles, on the one hand, and, on the other, of the necessary and constant identity of the conclusions legitimately deduced from them. Logic, on the contrary, forcing upon our notice the rules which we follow when we reason well, hardly allows them to become so habitual as to escape our consciousness; nor does she familiarize us with long trains of strict reasoning, since she generally gives special deductions only as examples of forms of argument. And thus the continuity and concentration of thought, and the quick sense of demonstration, which it is our aim to educe, are not taught so well by this study as by that of mathematics.

Supposing, then, that we wish to consider mathematics as an element of education, and as a means of forming logical habits better than logic itself; it becomes an important question, how far the study thus recommended is justly chargeable with evil consequences such as have been already mentioned. Does it necessarily make men too little sensible to other than mathematical reasonings? Does it teach them to require a kind of fundamental principles and a mode of deduction which are not in reality attainable in questions of morals or politics, or even of natural philosophy? If it does this, it may well unfit men for the most important employments of the human mind; for the power of reasoning, however cultivated, can be of no use on any particular subject, if we cease to be able to appreciate the just principles of the subject. To educate the logical power in such a way, would be to strengthen the cable, but to

lose the anchor: it would be to learn to read all languages on condition of understanding one only.

But is this, in fact, usually the case? And if it happen sometimes, and sometimes only, under what circumstances does it occur? This latter question has, I think, important practical bearings, and I shall try to give some answer to it.

I would reply, then,—that if mathematics be taught in such a manner that its foundations appear to be laid in arbitrary definitions, without any corresponding act of the mind:—or if its first principles be represented as borrowed from experience, in such a manner that the whole science is empirical only;—or if it be held forth as the highest perfection of the science to reduce our knowledge to extremely general propositions and processes, in which all particular cases are included;—so studied, it may, I conceive, unfit the mind for dealing with other kinds of truth. For if there be any portions of human speculation which depend upon mental faculties and operations of a peculiar kind; if they require special and appropriate conceptions, which definitions may fix, if they are present, but cannot convey if they are absent; the student, whose mind has been entirely formed by such mathematics as we have just described, will have no aptitude for seizing the principles of such subjects; he will be discontented with the supposition that any science should require a mental process which, in the most perfect of sciences, does not occur; and will be constantly attempting to reduce his new study to a dependence on definitions alone, and thus to give it the simplicity and independence which formed the charm of his mathematical speculations. Again:—if he be left to suppose that mathematical truths depend ultimately upon the evidence of the senses, he will look in other subjects for evidence equally palpable; and will not bring away

from mathematics that lesson which another mode of pursuing the study might impart to him,—that there exist vast and solid edifices of truth, the foundations of which are not laid in the information which our external senses give us. And again:—the habit of ever aiming at extreme generality would further aggravate such tendencies as I have mentioned, since it would draw his thoughts away from all peculiarities of principle and reasoning in particular parts of his science; and would thus remove the last chance of the applicability of the analogy of mathematical reasoning to other subjects. Moreover, all these injurious effects of the study of such a school of mathematics would evidently be much inflamed, if these peculiar doctrines of the school should be false in their mathematical reasoning, as well as inapplicable to other matters; for then the sensibility of the intellect to sound principles must be blunted by the perverse habit of not seeing them under the most favourable conditions. Add to this, that all which concerns the nature of first principles operates, far more than any other portion of the mathematical discipline of the mind, when we apply ourselves to other subjects: for in most other provinces of speculation the question is mainly what principle can be admitted and maintained; and it is only in few cases that we find long trains of continuous inference, in which considerable powers of mathematical deduction are brought into play. If, therefore, by the cultivation of mathematics, we impart false or inapplicable notions of the nature of first principles, at the same time that we teach men to reason well when the principles are given, our discipline is of imperfect character and of doubtful advantage. And if it appear, as I think it will, that such a kind of mathematics as I have mentioned be most likely thus to mingle evil with the good, it will probably be allowed that we have strong reasons for adhering

rather to a different school; and the more especially, as I have already said, if a different set of doctrines from those to which I allude be right in mathematics as well as useful in philosophy.

In order to be understood more distinctly, I will notice some of the points in which we may trace, in mathematical teaching, such tendencies as I have noticed.

In doing this I shall not fear giving offence by my criticisms of the mode in which mathematical principles may be or have been presented by those who have written on the subject. The authors in whom such views occur as those which I have to point out, will, I am persuaded, rather rejoice than grieve at the discussion of their principles. But, in fact, it is not to particular authors that I have to refer. The characters of a peculiar school of mathematical speculation are to be found scattered through various branches of the science in various forms, often implied rather than expressed, but still so far characteristic and connected as to make them fit instances of that which it is my object to describe.

It will be recollected that the first character which I noticed, in the school of which I speak, was "the studying mathematics in such a manner that its foundations appear to be laid in arbitrary definitions, without any corresponding act of the mind." I will give several examples where this has been done, and, as I conceive, erroneously.

I. I will first speak of the grounds of Elementary Geometry; not because I have anything to blame in the way in which these are commonly taught; but because I can thus, perhaps, best explain my meaning.

It has been a question much discussed among metaphysicians and mathematicians, whether the truths of geometry depend on axioms or on definitions. It has

been asserted by some that they result from definitions alone; and that on this circumstance depends their necessary and demonstrable truth. On the other hand, they who maintain that axioms also are requisite, challenge their opponents to produce a system of geometry without axioms; and though much ingenuity has been expended in the attempt, this has never yet been satisfactorily performed, or the challenge fairly answered.

But supposing this could be done—supposing we could get rid of geometrical axioms altogether, and deduce our reasoning from definitions alone—it must be allowed, I think, that still our geometrical propositions would properly depend, not on the definitions, but on the act of mind by which we fix upon such definitions; in short, on our conception of *space*. The axiom that two straight lines cannot enclose space, is a self-evident truth, founded upon our faculty of apprehending the properties of space, and of conceiving a straight line. We cannot find a form of words which will express at the same time the nature of the line and the resulting truth. We have, consequently, in our books of geometry, a definition apparently useless, and a principle apparently unproved. But who does not see that the axiom does really depend on the definition? or rather, that we see the axiom to be true, precisely because we conceive perfectly the nature of a straight line, which the definition imperfectly expresses?

Although, therefore, I do not here deny that it may be possible to approximate to a system of “Geometry without Axioms*,” and although I am willing to allow that the more simple and the more obviously coherent our first principles (whether definitions or axioms) are made, the more perfect our system becomes;—I still hold

* Colonel Peyronnet Thompson has published an ingenious work with this title.

that it is no philosophical blemish in our geometry that it rests upon axioms as well as definitions, since the one may serve, as well as the other, to express those properties of the fundamental conception of space, to which our demonstrations must refer. And we should present a false view of the nature of geometrical truth if we were to represent it as resting upon definitions, and were to overlook or deny the faculty of the mind and the intellectual process which is implied in our fixing upon such definitions. The foundation of all the properties of straight lines is certainly not the definition, but the conception of a straight line; and in the same manner the foundation of all geometrical truth resides in our general conception of space.

This doctrine may appear to some too plain and obvious to require to be insisted on. Whether or no that be the case, it will be found, I think, not to be barren of consequences in its application to other parts of mathematics.

II. If it be thus clear that mathematical truths depend for their evidence and certainty upon some fundamental general conceptions, such as that of space; it will follow, that, in order to comprehend aright any portion of mathematical science, we must apprehend steadily and clearly the fundamental conceptions belonging to that portion. And any attempt to supersede this necessity by definitions borrowed from another subject, will inevitably leave us with imperfect and insecure principles, and with false notions of the nature of truth.

I would notice, as an example of this error, the modes in which the doctrine of *Proportion* is usually presented. It is clear that we are capable of readily forming a distinct conception of proportion, and that a very slight suggestion is sufficient to call up this conception in our minds. We may begin by defining proportional quantities to be those in which the *first* magnitude is the same

multiple, part, or parts of the *second*, which the *third* is of the *fourth*; but we find that when we have done this, we cannot abstain from applying the same conception of proportionality to cases in which one quantity is neither multiple, part, nor parts of another; for we readily allow that the diagonals of two squares are proportional to their sides. Thus the conception of proportion is immediately extended beyond the limits of the definition; an undeniable proof that the conception is not the creature of the definition. This conception being thus formed, certain self-evident properties are seen to belong to it. The simplest of these properties appear to be such as those which have recently been noticed as the fundamental principles of the subject* ;—“That when magnitudes are expressed by the number of equal units they contain, their ratio is not altered by altering the magnitude of the unit;” and the like. But the principle which was used by the ancient geometers, and which still holds its place in our treatises on geometry, is that stated in Euclid’s fifth Definition of the fifth Book;—That equimultiples, any whatever, being taken under certain conditions, a certain relation of greater and less obtains. This definition, and the demonstrations founded upon it, are usually considered by learners as obscure and confused. I conceive that this impression arises, in part at least, from the attempt which, in this case, was made by Euclid himself, to reduce the subject to definition alone. For if proportion had been separately defined, so as to bring the conception of it distinctly before the mind, I conceive that the assertion of this fifth definition would be assented to without difficulty as an *axiom*. But then, what definition of proportion shall we take? It is clear that, in this case, we must have one which is liable to the same objections as Euclid’s definition of a straight line; namely, first, that the defining

* Peacock’s Algebra, Art. 355.

term itself requires definition (for *evenly* is not more intelligible than *straight*); and secondly, that the definition is useless (for the demonstrations rest on the axiom.) Now the observations which have been made help us out of this difficulty; for they teach us that the objections just stated are not fatal to the utility of our definition; since its use is, not to afford a verbal proposition which may enter into our demonstrations, but to direct us to that conception by which we may seize the fundamental necessary truths. If the definition of proportion does this, it answers its purpose. If it give us such a notion of proportion as enables us to see the axiomatic truth of the characteristic property contained in the "fifth definition" of Euclid, it makes our system complete: and this it is not difficult to obtain. A few examples of proportions will, at any rate, produce the impression; and perhaps the definitions which are usually rejected may be considered as sufficiently clear; namely, "ratio is the mutual relation of two magnitudes in respect of quantity," and "proportion is the similarity of ratios;" or, as it has been expressed by others, "ratio is the relation of two magnitudes in respect of *quotity*," (*how-many-times-ness*), and "proportion is the equality of ratios." These definitions, I say, though apparently indefinite and insulated, would hardly fail to answer their purpose; for they would give such a conception of proportion as would entitle us to make the "fifth definition" an axiom.

If we take any other course, we either run into the apparent confusion and complexity which, as has been stated, arises from mixing in the "fifth definition" the character of definition and of axiom; or, on the other hand, by taking as our definition the one first mentioned, which describes one quantity as a multiple, part, or parts of the other, and reasoning from it in cases to which it does not apply, we transform our mathematics from a praxis of

logic to an example of the most loose and inconsequent reasoning possible. We give pretended demonstrations where the only material difficulty in the proof is slurred over in silence; and thus present geometry as a system in which our sole object is to get, by some probable mode of conjecture, right results; and where we have not, nor can have, any fixed and certain method by which we prove them to be right.

That such a mode of treating the most perfect of speculative sciences must both degrade the reasoning habits of the student, and enfeeble and pervert his taste and relish for speculative truth in general, cannot, I think, be doubted.

III. I will notice, as the next example of the erroneous system to which I refer, the mode in which the first principles of the Differential Calculus are sometimes presented. There are, no doubt, various methods, all satisfactory, in which this may be done; but there are other methods which, according to the view I am now taking, cannot be allowed to be sound and philosophical, because they endeavour, by definitions and other artifices, to evade all reference to the real fundamental principle of the subject. That fundamental principle is the conception of a *Limit*. And this conception, like those already mentioned, may be expressed either by means of definitions, or axioms, or both; but whatever course is taken, the foundation on which our conclusions rest is the idea itself. Newton appears to have been the person who first clearly developed the properties of this idea, although we can trace its influence upon the reasonings of geometers at an earlier period, and even among the ancients. The first Section of the *Principia* contains the results of the conception of a limit or an ultimate ratio, stated in various forms, as definitions, axioms, and proportions; and precisely because they all contribute to

express a fundamental idea, these different forms are by no means kept clearly distinct; but, on the contrary, are all grouped together under the title of *Lemmas*. In attempting to exhibit in a clearer light the properties thus asserted, we find that we may make various arrangements of them, and refer them, in various ways, to the fundamental idea, and to collateral definitions and axioms. But we can in no way evade the necessity of recurring to the peculiar conception of a limit, which, though as difficult to define as a straight line, or proportion, is, like them, soon distinctly formed by the student, and easily made subservient to mathematical reasoning. Having once arrived at this conception, we may state in various ways the axiomatic results that flow from it; for instance, we may employ one general and familiar axiom, that "what is true up to the limit is true at the limit;" an axiom of most extensive and important application in entering upon the higher mathematics.

Of this conception of a limit and its consequences, the Differential Calculus is the symbolical exhibition: and I do not hesitate to say, that it is impossible to present the doctrines of that calculus in a logical manner, without referring to this fundamental idea in some part of the process. In speaking of the calculus I include, of course, its applications to curves, mechanical forces, and other problems, since it is, in fact, principally valuable as an instrument for proving propositions on such subjects: and I maintain, that though it may be possible to establish, by means of algebraical operations, without any new principle, a branch of analytical calculation which we may call the Differential Calculus, we cannot justifiably use it as the calculus is used by mathematicians, till we have introduced into it the notion of a limit. The necessity of this step may be shifted from one part of our reasoning to another, but never be altogether evaded. I

shall proceed to show that we are, in such applications of the Differential Calculus, driven to the doctrine of ultimate ratios, or to some equivalent method.

1. In order to apply the Calculus to the Rectification of Curves, we may assume the axiom of Archimedes, that a curve is less than any broken line which has the same extremities and includes the curve. This assumption is made by Lagrange in his *Théorie des Fonctions*, (partie 2^e, chap. vi. no. 29); in the title-page of which work he professes to give "the Principles of the Differential Calculus, disengaged from all consideration of infinitely small quantities, of vanishing quantities, of limits, and of fluxions." Now I say, that without the consideration of limits, this assumed axiom is not only not evident, but is not true; for a sinuous curve may be greater than a broken line, with the same extremities, which includes it. And if it be replied that the axiom is asserted only of curves which have their concavity turned throughout to the same side, I demand how the property can be evidently true with the condition, and not evident or not true without it, if we do not see some evident bearing of the condition upon the property? and I ask what bearing this is? It may be answered, that a broken line composed of *straight lines*, which has its concavity turned throughout the same way, is less than another such broken line which includes it; and that both the truth and the evidence of this property are secured by the condition respecting the concavity; and it may be added, that we cannot conceive a *curve* to differ in this respect from such a broken line. To this I assent; but I require further, that we should put in the simplest and most exact form, the expression of the necessary conviction that the properties of a curve must be the same as the universal properties of a broken line composed of straight lines. Now this, I maintain, can be done in no other way than by a reference, explicit

or implicit, to the conception of a curve as the *limit* of a broken line; and to the general principle of limits, that "what is true up to the limit is true at the limit." If it is imagined that the necessity of the condition with respect to the concavity can be shown in any other way, let the requisite axioms be stated; but if this is not done, the principle of Archimedes, as far as it is true, is by no means of an axiomatic character. As a foundation of the applications of the Differential Calculus to curves, it would be much simpler to assume at once Newton's seventh Lemma, that the arc, the chord, and the tangent are ultimately equal.

2. Similar remarks, as to the want of axiomatic evidence in the geometrical principles usually assumed, apply still more clearly to the mode in which the Calculus is applied to find the areas of surfaces. For in this case, when we have two curved surfaces bounded by common borders, it is far from easy, even to conjecture, which is the greater of the two. For instance, if a curve, and the broken line made up of the two tangents at its two extremities, revolve about any axis, which of the two generates the greater surface, the curve or the broken line? Probably the young geometer will not at once guess the conditions which determine the answer. Here, therefore, we shall not only reason loosely, but perhaps make false assertions, if we endeavour to establish the application of the Differential Calculus to surfaces, by means of assumed axioms which do not refer to limits. How difficult it is for a scrupulous mathematician to satisfy himself in the attempt may be seen in Maclaurin's Fluxions.

But it may be said, the axioms assumed by writers on these subjects have always led to right results. I grant that they not only have done so, but probably always will do the same. And why is this? Precisely because they are applied only *at the limit*. It is there only that they

are wanted, it is there only that they are used, and there they are always true. Whatever may be the relations of the broken lines and curve lines, of the broken surfaces and curve surfaces, as to greater or less, while they are finite, when we come to the limit, the relation of greater and less ceases, and they are equal. Newton's seventh Lemma for curves, and a similar proposition for curve surfaces, are then indisputably true; and this is sufficient for all the purposes of analytical and geometrical reasoning.

I presume it will not be maintained that correctness of logic is of no importance in our mathematical teaching; and that, if the conclusion be right, it need not disturb us that our fundamental principles are false, and our course of deduction inconclusive. I conceive rather that all are agreed that soundness of reasoning is the first and indispensable merit of such instruction. If therefore the conclusions, in treatises of the Differential Calculus which do not employ the principles of limits, are true only in virtue of the principle which they reject, and can have no adequate support in the reasonings on which they profess to rest, it is not unimportant to point out the existence of this paralogism.

Whatever course of sound demonstration we follow, the properties of the limit will be the foundation of it. If we employ the assumption of Archimedes, the essential part of the assumption is, that it should be true at the limit. In this case the assumption coincides nearly with Newton's seventh Lemma, which obviously and professedly depends on the ultimate condition of the figure. We may treat the subject either in these or in other ways. We may, for instance, *define* a *curve* to be the *limit of a polygon* of many sides, and may transfer to curves the properties of polygons, in virtue of the axiom that "what is true up to the limit is true at the limit." And in the same manner we may get rid of the difficulties respecting

tangents, by *defining a tangent*, to be the *limit of a line cutting the curve in two points*, which limit is obtained as the points coalesce. In defining the radius of curvature, the conception of limits is introduced by most writers. But in all cases, if we fairly trace back to elementary principles the properties of curves, we shall find that we must include in our reasonings the conception of a limit, and an axiom or axioms founded upon this conception.

3. The application of the Differential Calculus to Mechanics gives room for the same observations which have been made respecting its use with regard to curves. It is impossible to justify this application, without reasoning upon the principle of limits. And we may introduce this principle, by means of certain axioms respecting the spaces and velocities, in various ways. We may, for instance, assert, as axioms, that when a body moves with an increasing *velocity*, the *space* described in any time is greater than the space which would be described in the same time with the *initial*, and less than that which would be described with the *final* velocity. Such an axiom would be analogous to that of Archimedes respecting curves. It would express nothing but what is very obviously seen to follow from our general notion of velocity, and would not require any precise definition of velocity. It would however appear, on a more scrupulous consideration, as in the case of curves already discussed, that the evidence of this property of velocity resides in our being able to follow the axiom up to the limit; and that the security from error in its application arises from our applying it only at the limit; for how, without recurring to the conception of a limit, shall we find a criterion to distinguish cases in which the velocity constantly increases, from those in which it alternately increases and diminishes? Similar remarks might be made concerning *force*.

Another method, and perhaps a better, of treating this subject is, to introduce the conception of a limit into the *definition* of velocity and of force; which being done, we can reason from our definitions without the need of any special axiom. We thus purify our fundamental principles at the same time from the superfluous notions of greater and less, from insulated and useless definitions of velocity and force, and from apparently unsupported assumptions in our axioms. This we effect by *defining* velocity as the limit of the ratio of the increments of space, and time, and force, as the limit of the ratio of the increments of velocity and time. This method corresponds to that which I have suggested in the other case, of defining a tangent as the limit of a straight line cutting the curve in two points, or a curve as the limit of a polygon.

The principal objection which offers itself to this mode of presenting these subjects is, that the definitions thus appear to become too remote from the common conceptions of the things defined. Tangents, curves, velocity, force, it may be said, are notions which we can form, without considering anything so abstract as a limit. To this I would reply, that I do not think we *can* form these notions with sufficient distinctness for the purposes of our reasonings, without introducing the conception of limits; and that the proof that we cannot do so is, that all attempts to reason correctly on these subjects without the aid of the doctrine of limits have failed. It will be found to be the general or universal process in forming definitions for the purposes of science, that we substitute for the common and current notions, which are always in some degree vague, other more exact notions which include them, and are so much more distinct as is requisite for the purposes of strict reasoning. Our reasoning in the cases now before us is conducted by the principle of limits; and our definitions are accordingly shaped on the

conception of limits, so as to allow the principle to come into play. In this method the conception of a limit is employed in constructing our notions as well as in regulating our inferences.

But whether we take this course or any other, in treating of velocity and force by symbolical reasoning, we shall find ourselves compelled (if we are at all scrupulous in our reasoning) to introduce the conception of a limit, either into our definitions or into our axioms; nor can any refinement of geometry or algebra in any degree diminish this necessity, however they may serve to disguise it by complicating and confusing the subject.

The doctrine of limiting ratios may be considered as the key to all the abstruser parts of mathematical science; and if a boundary were to be drawn between the *Elementary* and the *Higher Mathematics*, the employment of this doctrine might most properly be made the frontier line. And if, when the student arrives at this critical point of his career, we neglect to educe, or even endeavour to discard, the fundamental conception on which all his ulterior knowledge must in fact depend, we not only sow the seeds of endless obscurity and perplexity during all his future advance in this science, but we also weaken his reasoning habits and disturb his perception of speculative truths; and thus make our mathematical discipline produce, not a wholesome and invigorating, but a deleterious and perverting effect upon the mind.

IV. The next example which I shall notice of the dependence of the branches of mathematics on some fundamental conception, is an important one. The conception of *force* or *pressure* is the groundwork of the whole doctrine of Mechanics. However we may *define* force, it is necessary, in order to understand the elementary reasonings of this portion of science, that we should *conceive* it distinctly. Do we wish for a test of the distinct-

ness of our conceptions? The test is, our being able to see clearly the necessary truth of the axioms on which our reasonings rest. These axioms may be different according to different ways of treating the subject. If we begin from the properties of the lever, we have such axioms as this,—that when two parallel forces act on a lever, the pressure on the fulcrum is equal to their sum. If on the other hand we begin with the composition of forces at a point, and hence prove the lever, it will be found that we inevitably assume such principles as these,—that forces, any how resolved into their components, may have their components substituted for them *in all cases*;—again, that a force may be supposed to act at any point of its direction, which introduces the conception of a perfectly rigid body; and again,—that a pressure necessarily supposes an equal and opposite pressure. These principles are all perfectly evident as soon as we have formed the general conception of pressure; but without that act of thought, they can have no evidence whatever given them by any form of words, or by reference to other truths;—by definitions, or by illustrations from other kinds of quantity.

In the present state of our mathematical studies, I cannot so properly say that this necessity of the conception of force as a foundation of mechanical reasoning is denied, as that it is too vaguely and slightly acted upon. Force is usually and rightly described as the cause which produces or tends to produce motion; and is thus referred to the more general conception of *cause*. But this particular kind of cause, which is thus described as producing a *tendency* to motion, (a definition which it will easily be seen is liable to the same remarks as the definition of a straight line,) is so conceived as to give rise to certain axioms, some of which we have seen above; and the conception, thus rendered

available for the purposes of deduction, is the inevitable foundation of mechanical reasoning. The student cannot advance in this field steadily or clearly, except he feel distinctly that he is on new ground;—that he is dealing with a set of notions different from those of pure mathematics, and resting on peculiar principles. Of this, perhaps, he is not always apprized. He is led, or left to imagine, that his new study is merely a developement of his notions acquired in the previous parts of mathematics;—that the quantities which he has to do with now are of the same kind as the quantities he had to do with then;—that the addition and mutual destruction of forces can be understood, by understanding addition and mutual destruction of algebraical quantities, without considering specially what force is, and what peculiarities belong to this new kind of quantities. Should he approach the subject with such an impression, it will be no wonder if his notions always remain mere algebraical abstractions, without mechanical value or meaning; and if he himself continue, to the end of his career, incapable of applying them to any really mechanical question.

Some persons, indeed, appear to go so far as not only practically to neglect, but speculatively to deny, any essential peculiarity of character in the notion of force. Thus Professor Playfair, in his “*Outlines of Natural Philosophy*,” Art. 86, says that “*force* has, in reality, no other signification than $\frac{dv}{dt}$; and that thus an entire treatise of dynamics might be written, in which the *word* force would not once occur.” If he had attempted to write such a work, he should have found the necessity of referring, at any rate, to the *conception* of force. How, without such a reference, would he have shown that action and reaction are

equal? When two equal bodies act on each other, why must $+\frac{dv}{dt}$ in the one be equal to $-\frac{dv}{dt}$ in the other? The student who recurs to this conception of pressure, can readily deduce such a result; but without that, he would not be able to advance a step in the train of deduction.

It was nothing but the want of this distinct idea of pressure, or the loss of it, after Archimedes, which made all the attempts of the ancients in mechanical reasoning entirely futile up to the time of Stevin. It was, for instance, impossible that men could reason on these subjects to any purpose, so long as their minds were in such a state that they could accept the fable of the Remora or Echineis, a fish half a foot long, which, merely by sticking to the bottom of a ship, without any other hold, could prevent its going on, though impelled by the strength of four hundred rowers; and though the fish, when caught and laid on the deck, possessed no such power*. Any one, whose notion of force had acquired any degree of distinctness, would at once see the absurdity of this; since the ship and its rowers must pull the fish, as much as the fish the ship; a result which it would however be difficult to deduce from the definition of force $\frac{dv}{dt}$, without some accompanying idea.

That this distinctness of mechanical conception is not always sufficiently inculcated, we have often very clear evidences in our Examinations. Students whose talents and proficiency in pure mathematics are very considerable, are frequently found quite incapable of solving a very simple mechanical problem so as to bring out any significant result. It is not difficult to see whence this

* Plin. Nat. Hist. ix. 41. xxxii. 1.

arises. Their minds have never been taught to grapple with the real mechanical elements of pressure and reaction; they have been accustomed to trust the process of deduction to certain representative symbols and the rules of their combination. These, rightly used and well understood, may, no doubt, be useful aids: but such representations can never be employed to any purpose by those who have no distinct conceptions of what they represent. And even in the most favourable cases, it is to be recollected, that by this mode of treating a problem we make two operations necessary;—the obtaining our symbolical result, and the interpreting it. The student who can rightly combine his symbols, may read them wrongly, or not at all. His familiar oracle may deliver a response indeed, but it may be in a language which he cannot understand; his devotion must be very blind if he is satisfied with such a reply; yet this may happen if we, his instructors, acquiesce in these empty rites.

If we neglect to inculcate and require distinctness in the student's apprehension of the idea of force and the resulting principles, the evil in reference to the discipline of the mind is so much the more grievous, in that we thus let slip one of the most favourable opportunities for showing the wide range of mathematical reasoning;—for teaching that the strictest logical necessity, and the most remarkable continuity of deduction, are not confined to the domain of space and number only, but belong to all subjects on which our notions are sufficiently distinct and precise;—and that the mode in which this rigorous and scientific character may be extended to new subjects is, by making our fundamental ideas so steady and clear, that they may generate in the mind principles, whether definitions or axioms, which may serve as the starting-point of our reasonings.

V. My object is to illustrate, not to exhaust the subject; and I will therefore only mention one other instance of the importance of possessing aright the fundamental conception of each branch of mathematics: I now speak of the conception of fluidity as the basis of the doctrines of Hydrostatics. It has often been proposed as a definition of a fluid, that it is a body having parts moveable among each other with perfect ease; and many attempts have been made to deduce from this definition the general property of fluids, that they transmit pressure unaltered in all directions. But in all such attempts there is and must be a latent reference to something not expressed, which is really the foundation of the science. It is manifest *à priori* that the definition just given cannot be a sufficient basis for the doctrines of the pressure of fluids; for how can we evolve, out of the mere notion of mobility, which includes no conception of force, the independent conception of pressure? All such attempts, as far as they lead to true results, do so in virtue of a tacit assumption of that part of our conception of fluids which is, hydrostatically, the essential part, namely, that they transmit pressure *in all directions*; if we *press* a full bladder downwards at the top, it *presses* outwards at the side. This is clearly supposed in our conception of fluidity: and from this we may prove that the pressure is *equal* in all directions, which is the most material proposition of the science*. But without thus including pressure as well as mobility in our conception of fluids, we can have no sufficient grounds for our hydrostatical demonstrations.

The way in which a neglect of clearness and completeness in framing the fundamental conceptions of our sciences leads to bad reasoning, and consequently to bad mental habits, may be seen in the subject now under

* See Mechanical Euclid, B. 11. Props. 2, 3.

consideration. We shall probably find among our mathematicians (for I do not pretend to criticise particular books,) such reasoning as the following: "A fluid is a body, the parts of which are perfectly moveable in all directions: if therefore a force act in any direction upon any particle of it, there must be, acting on the same particle, equal forces in all other directions." Now this is palpably a fallacy. If a *particle* be kept at rest by forces acting on it, the only consequence which follows from the laws of mechanics is, that it must be acted on by *pairs* of equal and opposite forces: we cannot hence infer the smallest necessity that the lateral forces should be equal to the vertical ones. But, it may be said, the particle is a *fluid* particle, and thus a vertical pressure will be resisted by a lateral pressure. This, no doubt, is a reason for the inference above drawn, or may be developed so as to become one. But then, it is exactly that reason which we assert to be the only proper one; namely, the conception of fluidity as implying the transmission of pressure in all directions.

To apprehend the idea of a fluid in such a manner as to deduce from it all the remarkable conclusions which form the science of Hydrostatics, has always been justly considered, from the time of Stevin and Galileo to our own, as an important and critical step in our philosophical knowledge of nature; and hence, the science which teaches us to do this, may be a valuable portion of our intellectual discipline. But this effect it can never produce, if those properties of fluids, on which all the reasoning depends, are, at the very outset, so expeditiously and completely wrapped up in symbols that the student never has a distinct view of them, or perhaps is not aware of their existence as a separate object for the employment of his thoughts. The hydrostatic paradox may cease to be considered as a

paradox in two ways; in one, by our seeing the difficulty and its solution; in the other, by our seeing neither. It is not difficult to judge which is the more instructive view of the subject.

Thus I have, I think, shown, by a sufficient number of instances, that there is, with some mathematicians, a tendency to exclude or overlook the peculiar fundamental principles of several portions of mathematical science, substituting for them mere verbal definitions, or forcing a way, in defiance of all maxims of sound reasoning, to the point where symbolical calculation begins. I will not now dwell further on the injurious effects which such practices must produce when these portions of mathematics are used as instruments of education, but will proceed to explain another of the objections which I have stated in general terms.

I mentioned it as likely to make the study of mathematics less beneficial as a mental discipline than it might otherwise be, if the first principles of our knowledge be represented as borrowed from experience, in such a manner that the whole science becomes empirical only.

I will not suppose that any person who has paid any attention to mathematics does not see clearly the difference between necessary truths and empirical facts; between the evidence of the properties of a triangle, and that of the general laws of the structure of plants. The peculiar character of mathematical truth is, that it is necessarily and inevitably true; and one of the most important lessons which we learn from our mathematical studies is a knowledge that there are such truths, and a familiarity with their form and character.

This lesson is not only lost, but read backwards, if the student is taught that there is no such difference, and that mathematical truths themselves are learnt by

experience. I can hardly suppose that any mathematician would hold such an opinion with regard to geometrical truths, although it has been entertained by metaphysicians of no inconsiderable acuteness, as Hume. We might ask such persons how Experience can show, not only that a thing *is*, but that it *must be*; by what authority she, the mere recorder of the actual occurrences of the past, pronounces upon all possible cases, though as yet to be tried hereafter only, or probably never. Or, descending to particulars, when it is maintained that it is from experience alone that we know that two straight lines cannot enclose space, we ask, who ever made the trial, and how? and we request to be informed in what way he ascertained that the lines with which he made his experiment were accurately straight. The fallacy is, in this case, I conceive, too palpable to require to be dwelt upon.

When we pass from the properties of space and number to those of force and matter, we shall perhaps find a larger class of persons who will hold our fundamental principles to be derived from experiment. That experiment has had a share in the establishment of such principles, the history of science very clearly shows; but if this share be loosely and obscurely conceived, such an opinion may still lead to very unphilosophical views, and very illogical habits. By what experiments is it found that the pressure on the fulcrum is equal to the sum of the weights? Who supposes that Archimedes thought it necessary to verify this result by actual trial? or if he had done so, what practical mode could he have employed, of showing forces to be equal, which did not take for granted some principle, requiring proof as much as the axiom does? I shall not here dwell upon the share which experience really has in the formation of our mechanical principles, having already attempted to

explain elsewhere* the manner in which external phenomena call up and interpret the intellectual conceptions on which science depends.

An imperfect exhibition of the fundamental conception of Hydrostatics may render the elementary reasoning of that science illogical, as we have seen; some mathematicians have been driven, by the apparent insufficiency of such reasoning, to throw themselves entirely upon experiment for the foundations of hydrostatical science. "Fluids," say they, "are found *by experiment* to press equally in all directions." There would be no difficulty in pointing out experiments which are sufficient to *illustrate* the proposition; and to remove any difficulty which the first announcement of it might occasion: but I do not think that all the experiments of this kind which ever were made, could be held sufficient to establish a proposition so general and so rigorous, if we saw no antecedent reason for it. And in fact, it cannot be doubted that good mathematicians, in tracing the consequences of this general property of fluids, do reason from their perception of its connexion with the nature of fluidity, and do not find themselves obliged to refer to the contingent and limited conditions of an experimental proof.

This disposition to ascribe such an empirical origin to truths which have in fact a deeper root in our minds, is injurious in its influence upon our speculations on other subjects; for it tends to make us suppose that the foundations of other sciences and bodies of demonstration are to be sought in plausible maxims, collected from experience by the same kind of loose and casual observation, and assented to with the same slight attention to the facts on which they profess to rest. It tends moreover to lead us to imagine, that when our common experience sug-

* Trans. Camb. Phil. Soc. Vol. iv.

gests to us no maxims possessing this kind of apparent evidence and generality, we may despair of ever arriving at a connected system of truth and certainty; and it teaches us to believe that any appeal to experience, however vaguely made, is to be held inevitable and final, and is to put an end to all speculation on the subject; instead of suggesting to us how difficult the interpretation of our experience is, and how much caution and thought are required in order to infer anything from it. It is easy to see how fatal to our success and welfare in other provinces of speculation impressions of this kind must be.

I must now again briefly notice a third character of the school of mathematics which I am venturing to describe;—that it is there held forth as the highest perfection of our knowledge, to reduce it to extremely general propositions and processes, in which all particular cases are included.

This love of generality is in fact a natural consequence of the obliteration of all the peculiar fundamental conceptions which belong to different parts of mathematics. If there be no essential difference in the ideas with which we have to deal, there is no reason why we should not embrace as many of them as possible in one form of expression. And thus we may neglect the peculiarities which belong to our conception of space, and identify our geometrical propositions with the corresponding properties of numbers, and of symbols which originally represent numbers. We may then consider the difference between plane and solid figures (so peculiar a difference in itself) as merely the difference between the combinations of two and of three quantities. We may express the properties of forces in like manner by algebraical symbols; for forces may be measured by lines and by numbers; and he who sees nothing peculiar in the prin-

ciples of this measurement, runs forwards with no philosophical scruples to the point where it is supposed to be already established. The reasons for all peculiar consideration of any special classes of figures or quantities being thus pushed aside, the most general views are the most simple:—straight lines are merely a kind of curve;—plane curves must not be considered as confined to their plane, but as existing under the most general form of reference;—positions, paths, forces, motions, are all best described by means of algebraical elements;—and these, though called three *rectangular co-ordinates*, are considered as depending on the conception of *space*, only at a few points of the calculation, all the intermediate steps being determined by the rules of the combination of symbols alone.

To the beauty of mathematical generalisations no one can be insensible who is capable of deriving any pleasure from the study of mathematics; and this process, and the habit of thus generalising, are of very instructive effect on the mind, even for the purposes of philosophy of all kinds. But this act of generalisation, to be of any value, must be founded on particulars rightly and distinctly conceived; and must be capable of being verified by inversion, that is, by carrying back the general proposition at will into any number of particular cases. The great geniuses of the mathematical world have always delighted in the widest generalisations, because they have by nature possessed this distinctness of particular knowledge, and have thus been able to perform the ascent to generalities and the descent to particulars with a secure rapidity; but these are feats of strength and agility which it is not given to all to imitate. The talent of generalisation is the last which is developed in the mathematical student; and if he attempt the process while his possession of particulars is still obscure and wavering, he can-

not fail to reduce his knowledge to a state of confusion and worthlessness. The attempt is much like undertaking to read the lyrical poetry of a language in which we have not yet mastered the simplest phrases of prose. When a mathematician has apprehended the properties of curves as distinctly as Monge, or the conceptions of mechanics as clearly as Lagrange, he may pursue, and imitate if he can, the beautiful speculations of the *Géométrie Descriptive*, and the *Mécanique Analytique*. And even in a far smaller degree, so far as the student has the materials and the power, let him seize the most general point of view within his reach, as one of his stations. But let him be certain that he knows the path up to this summit and down from it; and let him shun the common fault of taking indistinctness as evidence of generalisation, for this is to suppose ourselves on a mountain because we are in a mist.

As I have said, the love of generalisation, so far as it is a fault, arises from a neglect of the peculiarities which belong to the reasonings of particular subjects, and is prejudicial to the student, because it prevents his rightly apprehending these reasonings, and their foundations. And thus the evil consequences of the disposition of which I now speak, in its effects upon the intellectual habits, are nearly the same as those which have before been described.

I trust that I have now shown that there exist certain modes of treating the study of mathematics, and certain views concerning its foundations, which must diminish its benefits as a mental discipline and a preparation for all other branches of philosophical speculation. It is a matter of great difficulty to catch with precision, to fix in words and to make the subject of reasoning, anything so indefinite and evanescent as the general effect of abstract pursuits and studies upon the mind; but still it appears

to me, on the grounds already stated, difficult to deny that a school of mathematics, which should seek to reduce the foundations of the subject to verbal definitions, or to the evidence of the senses, and the processes of the science to undistinguishing generalities, must tend to produce such impressions as have been pointed out. It must tend to make men believe that all certain knowledge is reducible to identical propositions, or to facts obvious to all the world; and that logical clearness, acuteness, and invention, are all that any branch of speculation requires; thus concealing the necessity of that research and meditation which are requisite to acquire a possession of the first principles of all philosophical subjects, and which are far more important than mere logical endowments. And on subjects on which no hope of certainty offers itself in definitions or in familiar maxims, minds so formed may naturally cease to hope or care for truth, however weighty be the interests which our opinions affect. If, besides this, the reasoning of this school of mathematics be in itself, as I have endeavoured to show that it is, indefensible and false, the logical habits as well as the philosophical capacities of the student will be perverted; and mathematical study will lose, as a discipline, that solitary advantage which has been allowed to it even by those who have held it to be injurious in other respects.

However slight may be the degree in which the tendencies of which I have spoken exist in the mathematical studies of this University, it would be desirable to remedy them, and to secure to our course of education those advantages which a sounder and better system would produce. It is with the desire of inculcating this object, that the present reflections are published.

Some persons may, perhaps, think that it is only an idle imagination to expect from the mathematical teach-

ing which students receive in the University, effects on the mind, such as have been here spoken of. They may suppose that, in by far the greater number of cases, the knowledge of mathematics which is acquired is too superficial, and too soon forgotten when the academic course is finished, to leave any deep or permanent impression. And it would not be difficult, by speaking of the problems which are brought under the student's notice here, as useless abstractions and fantastical subtleties, or by putting in print the familiar or slighting terms in which these matters are often spoken of in conversation, to throw an air of ridicule upon the doctrine of the formation of the mind by such means. No one, however, who is capable of serious thought on such subjects, would be moved by trifling of this kind. However obscure the process, however trivial the details, however uncertain the result of individual cases, we know that, in fact, the employments of the youth have a great share in forming the character of the man; and that pursuits leave traces of their indirect effect on the habits, long after they themselves have ceased to exist. But in this case we are not left to reasoning and conjecture. No one who knows the recent history of this University can doubt that the mathematical studies of its members have produced a very powerful effect on the general character of their mental habits. Any one who is acquainted with the lawyers, or men of business, or statesmen, whom the University has produced in our own and the preceding generation, knows, from observation of them and from their own declarations, that their mathematical pursuits here have in no small degree regulated their mode of dealing with other subjects. With respect to lawyers, indeed, we have the evidence of their practical success to the reality of this connexion; and, among them, the extraordinary coincidence of pro-

fessional eminence in after-life with mathematical distinction in their University career, shows that our studies may be an admirable discipline and preparation for pursuits extremely different from our own. That mathematical habits do, or have done, so much to make men good lawyers, is not an unimportant consideration with respect to that profession; but it is far more important as showing what such a training may effect in reference to other and wider studies.

I will not undertake the invidious task of pointing out cases in which the tendencies of that peculiar school of mathematics on which I have animadverted, may be supposed to have shown themselves in the mode of treating other subjects. But I may venture to observe, that the recent mathematical literature of the University appears to me to illustrate the views expressed in these pages. The number of new treatises on various portions of the mathematics which have been published by authors who had recently passed through their undergraduate career, shows that the mathematical studies in which men here are engaged do not leave their minds inert and passive, but rouse them to speculate for themselves. The subjects of speculation in these treatises have generally been such as bear directly upon some of the fundamental conceptions above spoken of: for instance, one of the most usual subjects of such treatises is the first principles and processes of the Differential Calculus. The frequency of such publications may, I think, be explained, by the consideration above stated;—that there prevails among us a mode of teaching the subject, in which the fundamental conception is slightly referred to or entirely eluded. For, this being done, the impression left on the student's mind will necessarily be unsatisfactory; and when, in a season of leisure, and with some skill in calculation, he begins to settle his

own views, it is probable that some new aspect of the subject will appear to him more clear than that of his masters. The vessel not being ballasted by any definite principle, rolls into a new position of transient equilibrium with every new wave. I am far from wishing to speak with disrespect of such treatises, and have great obligations to several of them; but it must have appeared, from what I have already said, that I conceive they must fail in their object, where it is to make algebraical definitions alone the foundation of the Calculus; and that they can do no service to the cause of education, if their merit be their generality.

I come now to the practical inferences which I would draw from the above reflections. The first of these obviously is, that we should, in the mathematical knowledge which we teach or require, avoid the evil and choose the good;—that we should not encourage by our lessons, or books, or questions, those tendencies of which the disadvantageous character has, I hope, been made apparent. It is highly for the interest of the University that the overdisposition to analytical generalisations should not be fostered;—that a clear acquaintance with first principles in all subjects should be demanded, and that to each subject its own proper principles should be assigned;—that particular as well as general propositions, special problems as well as comprehensive formulæ, should be made a part of the trial; so as to ascertain that generalisations are not introduced without a thorough acquaintance with their lower steps, and a power of applying them to the cases which they include. Works in which simple considerations are, by the aid of steady thought, made to lead to important and apparently remote conclusions, (such as Professor Airy's "Gravitation,") are

much to be preferred to works of mere calculation. And, without pretending to decide between the rival claims of geometrical and algebraical modes of reasoning in cases where either may be used, we should require that the mode which is selected be so presented as to show that the meaning of the expressions employed is distinctly understood by the student.

It will, perhaps, be objected to the opinions here maintained, that the kind of study which I recommend is much more laborious than the practice of symbolical calculations, while it leads only to the same results. That such a kind of study will require and occasion more thinking than the mere application of technical rules, I by no means deny; it is precisely because it does this, that it is a useful instrument of education. I can hardly believe that any one would expect to produce any beneficial effect upon the mind, without urging it to activity and effort. It would be a very strange and futile imagination, if we were to suppose that there is any branch of science, of which the results, when adopted as a matter of tradition, without being appropriated by any act of thought of our own, can be of any value, either as discipline or as knowledge. A scheme of study which escapes or tries to escape the labour of thinking, will answer none of the purposes at which we ought to aim.

But whether such a system of mathematical study shall or shall not prevail in this University, must depend entirely upon our Examiners. It is neither surprising nor blameable that our candidates for mathematical honours should be content with general formulæ as the solutions of all problems, and general equations as the representatives of all principles, if they find that their Examiners appear to desire nothing more. It is only by demanding a knowledge of real principles, and by rewarding the power of

applying them, that our mathematics can discharge its proper office in our system of teaching.

If those who conduct the examinations for university and for college honours were to regulate their conduct by maxims like these; and if the public opinion of the University, which is the guardian of our system of education, were to adopt these maxims, and to make them clearly heard on all occasions, I do not hesitate to say that the effect of our mathematical teaching, as a logical and philosophical discipline of the mind, would be greatly elevated, and that the beneficial results would be felt in the improved intellectual character of our most active-minded students.

But it appears to me, further, that it would be neither desirable nor necessary to confine the benefits of such an improvement to those students who are candidates for the mathematical honours of the University. We owe it to the intellectual interests of the country which are committed to us, that we should bestow as complete a mental culture as circumstances allow, on all on whom we confer an academical degree. I believe that the mathematical study to which men are led by our present requisitions has an effect, and a very beneficial effect, on their minds: but I conceive that the benefit of this effect would be greatly increased, if the mathematics thus communicated were such as to dissipate the impression, that mathematical reasoning is applicable only to such abstractions as space and number. For this purpose, let a knowledge of some portion of Mechanics and Hydrostatics be introduced among the requisites for a degree; and, if necessary, let the knowledge of Algebra be required no longer, for I can hardly believe that this part of our mathematical teaching is of much value in any point of view. Very plain and easy systems of Mechanics and Hydrostatics would answer the purpose which I recommend, but they

must be of an appropriate character. They must not, for instance, be of what is called a *popular* nature, consisting of assertions without reasoning, and propositions of the most different kind and evidence jumbled together. Such systems as would here be wanted, must contain none but the most rigorous demonstrations, although none but the most simple calculations. Unquestionably such systems are possible. Perhaps at present no treatises exist which would exactly answer the purpose, but I have no doubt that if the recommendation just given were once adopted by the University, the requisite books could easily be produced.

My object has been to speak of the study of mathematics as a logical and philosophical discipline of the mind, in which office I consider that study to hold a highly important place among us. It is on this ground that I now urge the introduction of Mechanics and Hydrostatics into all our examinations for the Bachelor of Arts' degree, looking upon these as the most instructive and philosophical, and also the most simple branches of mathematics, after Plane Geometry. I do not wish now to enter upon all the other reasons which might, as I conceive, be urged in favour of such a measure. The great practical utility of these sciences would weigh with many persons, and their application to a vast variety of questions which come under the notice of every one, and often demand our thoughts even in the course of common life. And a consideration far more worthy to be attended to, in my opinion, is, that these sciences are examples, and excellent examples, of that great system of physical knowledge which has been steadily advancing ever since the revival of learning in Europe, and with the character and nature of which no liberally educated man ought to be unacquainted. It is no small part of the value of the mathematical studies which we place before the candi-

dates for the highest honours, that by the cultivation of those, they are brought into an acquaintance with the most recent and profound researches, and thus feel themselves called upon to sympathize with the struggles and successes, the hopes and anticipations of the great men of their time, whose names and discoveries are to be an inheritance to the latest generations. There is no reason why this advantage should be confined to a few only. The mechanical principles on which the doctrine of universal gravitation depends may be presented in a very simple form; and even some of their most abstruse and remarkable conclusions may be obtained, as has recently been shown*, with very little of the apparatus of technical calculation. Whether or not it were thought advisable to conduct the great portion of students so far as this, they could not be led, even to enter on the path which leads through Mechanics to the Theory of the Universe, without feeling that they had acquired some view of the nature of that remarkable portion of human knowledge; and thus, as their classical reading brings them in contact with that which is best in the mental productions of the ancient world, their mathematical studies would place them within sight of the noblest effort of modern intellect.

That the study of mathematics, conducted according to the maxims which I have thus urged, is a most valuable and essential part of a liberal education; I hope I have convinced the reader. And I have no doubt that the alteration in our examination which I have above recommended, is, so far as it is desirable for the purposes here considered, practicable without material inconvenience to any parties.

TRINITY COLLEGE,
October 1, 1835.

* In Prof. Airy's "Gravitation."

ADDITIONAL THOUGHTS
ON
THE STUDY OF MATHEMATICS
AS A PART OF A LIBERAL EDUCATION.

THE following remarks occur in the Preface of a work which I have recently published: and as they contain a further developement of the views delivered in the preceding pages, I insert them here. The work in which they were originally published is entitled "The Doctrine of Limits, with its Applications; namely, Conic Sections, The First Three Sections of Newton's Principia, The Differential Calculus."

The Treatise on the Doctrine of Limits is intended to contain all those portions of a mathematical course of reading which it appears desirable to recommend to students, as their employment during the *second year* of their residence in the University; with the exception of the Elements of Mechanics, on which I have published separate works. It will, I think, be found convenient to have this group of subjects thus brought together; because it may not only save the trouble of reference to many books, but may prevent the omissions and repetitions which occur when the system is made up of detached fragments; and may secure that connexion and coherence in the reasoning, which are often wanting when a number of different persons undertake to construct each his section of the logical chain.

But though these considerations appear to render such a work as the present desirable, they would probably not have been sufficient to induce me to encounter the labour and difficulty of writing it, if I had not thought that it would illustrate and promote the genuine objects of the study of Mathematics as part of a University education. I have already endeavoured to define those objects, and to extend our means of attaining them, and I will now make a few further remarks on the subject, with a special reference to the Treatise just mentioned.

All exact knowledge supposes the mind to be able to apply, steadily and clearly, not only the processes of reasoning, but also certain fundamental ideas; and it is one main office of a liberal education to fix and develop these ideas. The ideas of Space and of Number are the subject matter of Geometry, of Arithmetic, and of Algebra in its character of Universal Arithmetic: and since all our knowledge, relative to the external world, must be subject to the conditions of space and number, the elementary portions of mathematics just mentioned are, rightly and necessarily, made the basis of all intellectual education. If we advance further in mathematical study, with the view of its thus serving as an intellectual discipline, what other ideas do we thus bring into activity and use? I reply, that the main general ideas which we have next to introduce, and which consequently should be the governing principles of the studies of the second stage of a liberal education, are the following:—the mechanical ideas of *Force* and *Body*, with their various modifications; the idea of the *Symmetry* of symbolical expressions;—the idea of the *Universal Interpretation* of symbols, including as an important branch of this, the *Application of Algebra to Geometry*;—and the idea of a *Limit*. In the present volume, I trust there will be found

exemplifications and applications of all these ideas, sufficient to form the basis of a system of study, such as our object requires; although the consequences of the last of them, the Doctrine of Limits, form the leading subject of the book.

It will be easily seen that, according to the course of study hitherto usually prevalent in this University, after the first year's studies are completed, all the ideas just noticed have been brought into use, although they may not always have been contemplated distinctly and separately. Mechanics has usually been a prominent portion of the studies of the second year. Of the ideas which form the groundwork of this science, and of the mode in which they may be evolved into a scientific system, I have elsewhere given my views*. The idea of Symmetry is introduced when we consider the Symmetrical Functions of the Roots of Equations, and is thus the basis of the whole Theory of Equations: it is moreover of extensive use and influence in the application of Algebra to Geometry. The Rules of Interpretation of Symbols are well exemplified by the investigations in which coordinates are used; and the principles of such rules, in their most general form, have of late years been exhibited in an able and striking manner†. The Doctrine of Limits has usually been studied in its principles in the First Section of Newton's Principia; and in its applications in the Second and Third Sections, and in the sequel to the student's progress, in the remainder of that immortal work. The idea of a Limit is also, as I have elsewhere shewn‡, necessarily involved in every application of the Differential Calculus, whether to curves or to mechanical problems. And thus our course of study in

* See The Mechanical Euclid.

† See Professor Peacock's Algebra.

‡ See above, p. 155.

the second year, in this University, has really been an intellectual discipline of a high order; exercising the student's mind to a definite apprehension and ready use of the abstruse and comprehensive ideas of which we have spoken; and opening to him the large and rich storehouses of knowledge, of which these ideas supply the key.

In the Treatise on the subject I have somewhat extended the usual domain of the Doctrine of Limits, by including in it all those portions of Conic Sections which depend upon Tangents, and consequently all which concerns Conjugate Diameters. It appears to me that no other satisfactory basis can be found for any part of our knowledge of curves (except so far as our propositions only refer to straight lines intercepted by the curves). The Axiom of Archimedes, as it is called, respecting the length of arcs of curves, cannot be rendered entirely satisfactory in any other manner, as I have elsewhere urged*. And although the usual negative Definition of a Tangent may be made the foundation of the properties of some figures by reasoning *ex absurdo*; the direct proof which offers itself when we define the tangent as the Limit of a line cutting in two points, resulting when the two become one, appears to be a more genuine demonstration.

With this view I found it necessary to separate the properties of Conic Sections into two parts; the first part (Book I.) being independent of the idea of a limit, (which forms the subject of Book II.) and, besides its being necessary to the proof of the following portions of my subject, serving to illustrate the ideas of Symbolical Symmetry, and Interpretation, and the use of Co-ordinates. The other part of the properties of Conic Sections (Book III.) comes after the Doctrine of Limits, on

* See above p. 157.

which it depends; and besides its value in itself, supplies those propositions which are used in treating of Central Forces. (Book IV.)

It thus happens, that my aim in writing a Treatise on Conic Sections has been different from that of most of those mathematicians who have preceded me in such an attempt. Their object has in general been to render their work as homogeneous and symmetrical as possible. They have endeavoured to produce a system which should be rigorously geometrical, with no taint of symbolical reasoning; or else one which should be purely analytical: and they have sought to make the demonstrations for the ellipse and hyperbola correspond as exactly as possible. My aim has been to employ such demonstrations as should illustrate some principle or some process of extensive use; and hence I have sought variety rather than uniformity in the kind of proof. I have demonstrated algebraically the properties of Conic Sections, which do not depend upon tangents; while I have given geometrical proofs of several other properties. I have deduced the property of the rectangles of oblique co-ordinates in the ellipse from the consideration of the *circular projection* of the ellipse;—a mode of considering the ellipse, which it is very useful for the student to be acquainted with; while in the hyperbola I have deduced the same proposition from the general proportionality of the segments of parallel lines; a property which is true of all the Conic Sections. Thus the equality of all the tangential parallelograms, in the ellipse and in the hyperbola, is connected with two quite different sets of properties in the two curves; although this identity of property results from a clear analogy of definition, which connection, by adopting another line of reasoning, might be brought into view. By the method which I have adopted, it appears to me that

the subject of Conic Sections is rendered more compendious than it can otherwise be made.

In Book iv, which contains the application of the Doctrine of Limits to the direct Problem of Central Forces, I have followed almost exactly the steps of Newton in the second and third Sections of the Principia. It appeared to me that little could be gained by any deviation, in the way of evidence or convenience: and the interest which belongs to these problems as features in the history of the greatest scientific discovery ever made, renders it desirable that the student should see the solutions in the form in which they came from the hand of the great master. I have only modified them so far as to obtain an equation instead of a proportion for the value of the force. I have, however, added to Newton's propositions a few others, which it is inconvenient to the student not to know.

The Differential Calculus has, from the time of D'Alembert, most commonly been treated as an application of the Idea of a Limit, as I have treated it in Book v. The attempt made by Lagrange to evade the use of this idea, however ingenious, is quite incapable of being realized, if this Calculus is to be employed in the solution of the problems which give it its meaning and value. The temporary favour which the project found in the eyes of some mathematicians, arose, as I conceive, from the persuasion that mathematical truths are exhibited in their most genuine shape when they are made to depend upon definitions alone; an opinion of which I hope I made the falsity apparent*. I have endeavoured to avoid the incoherencies and defects which are often introduced in the attempts to develop the fundamental idea into a systematic Calculus.

* See Remarks, &c. in the Mechanical Euclid.

I have added a book (Book VI.) on the Integral Calculus, which may conveniently be studied to a certain extent in the student's second year of residence. I have given certain processes of integration, but principally as examples of the methods which may be used. I have avoided following out this subject in a complete and systematic manner; a task which would have led me into too wide a field; and also, beyond the stage to which I wish to conduct my readers.

I have not attempted to avoid coincidences with other books in the processes and proofs which I have given. We who at this time of day write on subjects so often treated of before, are all too dependent on our predecessors, whether we know it or not, to have much right to complain of those who borrow from us. In further explanation of such coincidences, I may observe, that a few peculiar points which may have appeared in print before, as the proof of the properties of the ellipse by means of the circular projection, and the Rules for the Reduction of Integrals (Book VI. Art. 31.) were originally, or at least independently, devised by me, and communicated to friends many years ago.

If I have succeeded in producing a manual which brings together the mathematical studies of the second year in a convenient and satisfactory form, and in such a manner as to facilitate their operation in the way of intellectual discipline, I shall think my labour well bestowed. It is not likely that I shall hereafter endeavour to carry on to an ulterior point the scheme of mathematical education of which the Doctrine of Limits and the Mechanical Euclid may be considered as portions. But I may take the liberty of stating here, in what direction I should prosecute my labours, if I should ever be led to make the attempt. My aim would still be to furnish the student's mind with some additional wealth, from among

those comprehensive and fundamental Ideas on which science depends. I should wish, for example, to enable our young men to master two ideas of great importance and interest:—that of a *Wave*, and that of *Polarity*. The former of these offers itself in the course of the sciences of Hydronamics and Optics:—the latter occurs in various forms as the basis of a large portion of Optics, Magnetism, Electricity of all kinds, and Chemistry. My object would be, not to use any complex mathematical processes in tracing the consequences of these ideas; but to apply them in such cases, as without much mathematical reasoning might tend to make them fixed and clear in the reader's mind. It would be easy to shew how far this has been from a common case. The general notion of a wave, as a transfer of *form* distinct from a transfer of *matter*, has been a stumbling block to most unmathematical reasoners; and the confusion and perplexity which have arisen from the attempts to grapple with this notion, have appeared on various occasions. Now this notion is the basis of the Undulatory Theory of Light, as well as of all reasonings concerning the waves of water; and it is capable of being illustrated in a very elementary manner, to those who will give the subject a steady attention. Again, the notion of Polarity has been so far obscure among men in general, that many, and even mathematicians of note, have asserted that the phrase "Polarization of Light," was an arbitrary and unmeaning term. Yet it will be seen by a little consideration, that this is the only just phrase for the case; since Polarity, or Polarization, is the universal mode of describing *an opposition of properties depending upon an opposition of positions*. The same idea, variously modified, might be illustrated by the fundamental doctrines of Magnetism, Galvanism, and the like; and when the student has

gone through such elementary studies, he would be far better prepared, than without them he can be, to derive intellectual profit from the beautiful analysis which is applicable to such cases*.

By extending our mathematical studies in this manner, always insisting upon the most rigorous synthetical exposition of the elementary principles of each added portion, our mathematical education might become an intellectual discipline, such as the world has never yet seen, and such as it has not even learnt to hope for. Yet such an education alone can provide for the future progress and diffusion of real knowledge, and for the prosperity and advance of that civilization which depends upon the diffusion of knowledge. It has been, and is, my ambition to contribute my efforts to the object of securing to this University a large share in the merit and glory of preserving, improving, and rendering effectual, an education thus truly liberal.

* See Mr Airy's Tracts, for the Undulatory Theory; and Mr Murphy on The Principles of Heat and Electricity, for the other subjects.

TO THE
EDITOR OF THE EDINBURGH REVIEW.

UNITED UNIVERSITY CLUB,
January 23, 1836.

MY DEAR SIR,

I WAS gratified to find that a little pamphlet which I recently published as "Thoughts on the Study of Mathematics," had excited so much notice as to give it a place at the head of an article in the *Edinburgh Review*; and in regard to the manner in which the Reviewer has spoken of me, I have certainly no reason to be dissatisfied; nor am I at all disposed to complain of the way in which he has urged his own opinions. But I think the article is likely to give rise to a misapprehension which ought to be corrected, and for that purpose I trouble you with this letter.

I wrote my pamphlet in order to enforce certain views respecting the conduct of our mathematical examinations at Cambridge. The question on which I threw out a few "Thoughts" was, *what kind* of mathematics is most beneficial as a part of a liberal education. That this was the question to which I was trying to give some answer I stated in a passage (quoted by the Reviewer) at page 8 of the pamphlet. The previous *seven*

pages, in which, among other matter, I had said a few words on the question, whether mathematics *in general* or logic is the better mental discipline, were obviously only an introduction to the discussion of certain propositions which, as the Reviewer observes, "occupy the remainder of the pamphlet."

It was therefore with no slight surprise that I looked at the magnificent manner in which the Reviewer has spoken of the small portion of these seven small pages which refers to the more general question. He calls it "a treatise, (a *Treatise!*) apparently on the very point" (p. 410), "a vindication of mathematical study" (p. 411); and having thus made me work at a task of his own devising, he repeatedly expresses great disappointment that I have executed it so ill;—that, "so little is said on the general argument." I should have thought that this circumstance might have helped him to perceive that it was not *my* general argument.

I see nothing but the convenient and blameless practice of reviews in making the title of my book the occasion of publishing an Essay on a subject only slightly connected with mine; but it appears to me that to attempt to gain a victory by representing a page or two of my "Thoughts" as containing all that can be said by an able, earnest, official, advocate on the other side, is not a reasonable treatment of the question. The writer proclaims that he means to give "no quarter to my reasonings," but this proceeding looks rather like making an unexpected attack on a point when he thinks himself well prepared, on the arbitrary pretext that the truce has been broken by the adversary.

I should have no disinclination, on a convenient occasion, to discuss the very important and interesting question which is the subject of the Review. I cannot, however, look forward with confidence to the prospect of

my being able to take it up for a considerable period, and shall probably leave the Reviewer in possession of his self-chosen field of battle for several months, it may be years. But if I should return to the subject, I should wish to know as definitely as is possible what are the questions at issue between us; and I would therefore beg from the Reviewer information on the following points.

The Works which form our examples of Mathematical reasoning are well known: I wish to know also what works of "Practical Logic" on other subjects (p. 413) the Reviewer is willing to propose as rival instruments of education.

I wish to have some distinct account of the nature of that "Philosophy" which is by the Reviewer put in contrast to Mathematical study; (p. 422,) and if possible to have some work or works pointed out, in which this philosophy is supposed to be presented in such a way as to make it fit to be a cardinal point of education.

I may remark also, that all the Reviewer's arguments, and, I believe, the judgments of all his "cloud of witnesses," are founded upon the nature and processes of pure mathematics only;—on a consideration of the study of the mere properties of space and number. My suggestion of the means of increasing the utility of mathematical studies was directed mainly to this point;—that we should avoid confining ourselves to pure mathematics;—that we should resort to departments in which we have to deal with other grounds of necessary truth, as well as the intuitions of space and time: so far, therefore, the Reviewer and I have a common aim, and I notice this with the more pleasure, since we have so far a better prospect of understanding each other in any future discussion.

I will not now trespass further on your patience. In order to remind my Cambridge readers of the state of the question, I shall probably place before them something to the same effect as what I have now written.

Believe me, my dear Sir,

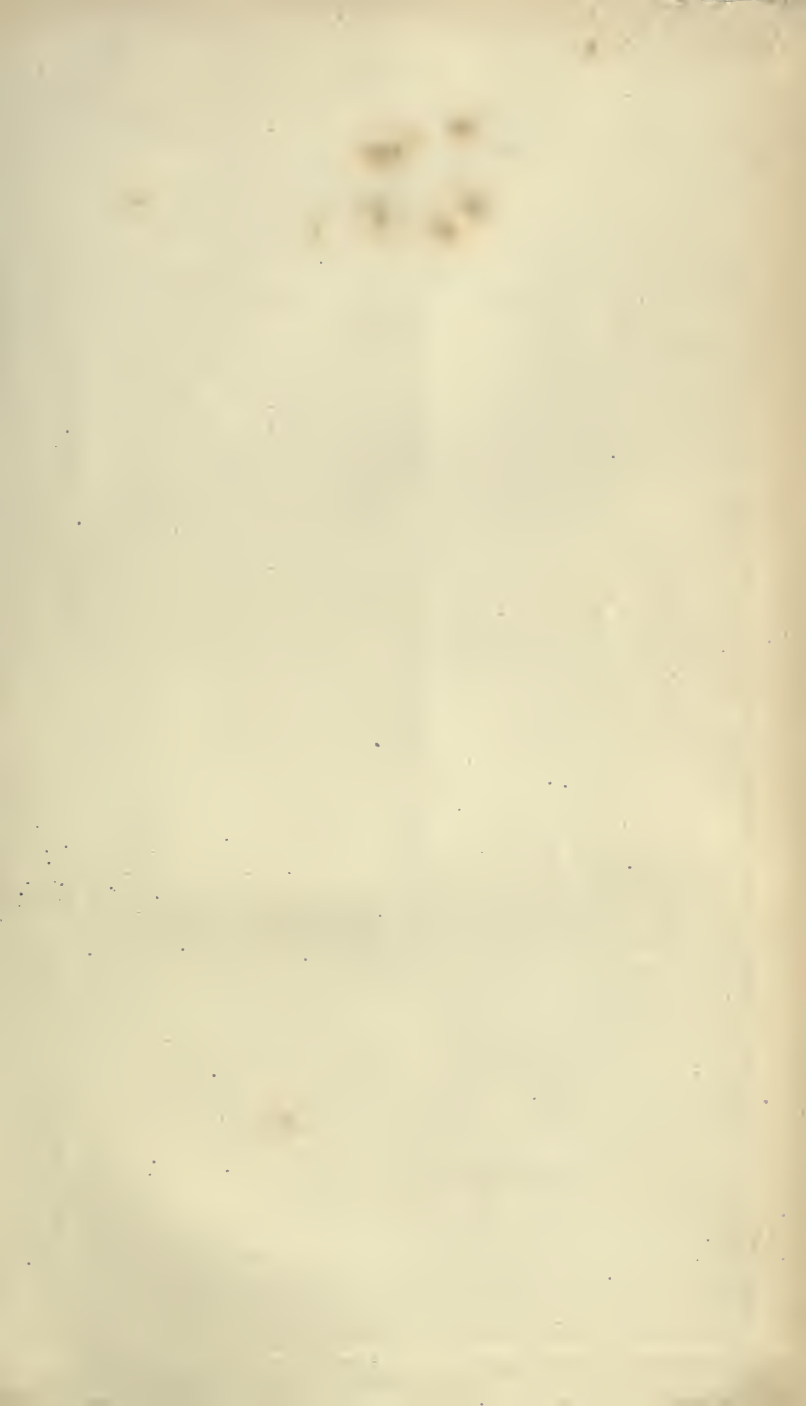
Yours very faithfully,

W. WHEWELL.



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