

covery has been inseparably connected with all sorts of useful and wonderful improvements in the arts and manufactures; with the production of an enormous mass of wealth, the improvement of all our conveniences of travel and correspondence, and the manifold comforts of our daily life. But such work, highly paid and profitable to others, must be chiefly performed by the adepts of the laboratory or the engine factory, and by the scientific minds employed in making calculations or designs for their particular service. There can henceforth be no fear, we suppose, of a deficiency in the number of skilful persons able and willing to do what is needful in the business of applying science to augment the riches and commodities of mankind. That is a thing which *pays*, and wants no other recommendation. But what has scarcely been so well understood hitherto is the advantage of learning science as a means of mental discipline, with a view to cultivating some of the most essential faculties and habits of thought. This question touches the highest interests of humanity; it is far more important than the uses of the electric telegraph, the steam-engine, or the spinning-jenny, or the entire contents of a Paris or London Great Exhibition. It has a most serious bearing on the moral and social as well as intellectual welfare of the community, in so far as "the education of the judgment" must affect the whole creed and conduct of the individual, influencing his sentiments and behaviour in all the relations of life.

Now, it is contended by the leading advocates of the study of the natural sciences, on the new ground they have lately taken up, that this kind of knowledge, or, more properly speaking, its peculiar method of investigation, supplies an indispensable element of sound culture of the mind. They insist on having it reckoned a part of "the humanities," meaning those branches of learning—formerly meaning only Latin, with the books of logic and metaphysics written in Latin, and nothing besides—by which an accomplished man is trained and equipped to live in the modern world. They say nothing against what is pedantically called "classical" literature, and the ancient history therewith bound up. Sir John Herschel is the latest translator of Homer, though his testimony is the foremost in favour of scientific education. But they do affirm that these studies of theirs are requisite in education for the sake of an intellectual discipline, which can be imparted in no other way, and without which a young man is sent forth, at the end of his University course, blind of one eye, halting upon one leg, maimed of one hand, imperfectly prepared for manly life. They trace the evil effects of this neglect in a multitude of delusive theories and blunders of practice detrimental to our social and political state. They submit, therefore, with considerable show of reason, that natural science is quite as necessary a portion of scholarship as the grammar and prosody of the Greek and Latin languages, and that it is the due complement of mathematical studies. For it calls into exercise the powers of observing facts, of weighing probabilities, and of reasoning by induction from particular instances to general laws, which are not sufficiently developed by geometry and algebra on the one hand, or by grammar, philology, rhetoric, and formal logic on the other, in the existing scheme of University education.

It appears to us even more urgent to grant this argument a fair hearing since the two English Universities have taken such wise and liberal measures to gain a broader basis of popular support. The success of the Oxford and Cambridge local voluntary examinations all over the country, and the esteem in which the degrees and certificates are everywhere held by middle-class people, show a confiding desire on the part of these to avail themselves of the same elements of education, bearing the credentials of the same authority, which are conventionally supposed to guarantee the social superiority of the privileged, wealthy and fashionable classes. In this matter, as in other affairs of domestic life and personal habit or taste, we are happily so free from the spirit of an envious democracy, that there is rather a disposition, without prejudice to the distinctions of rank, to enable all to rise to a common ground of respectability and of mutual appreciation. But, if the highest education received by the sons of the nobility and gentry at the Universities lacks an essential portion of that which should go to the complete education of the youthful mind, we hope the Universities will hasten to repair such defect before they extend their guiding and controlling influence to the education of the whole people. They have done so much in the way of reform during the last twenty or thirty years that we may expect they will see to

this. We have the example of the late Dr. Whewell, whose lecture, at the Royal Institution, "On the Influence of Scientific Discovery on Intellectual Education," is among the essays collected in this volume.

Dr. Whewell remarks, accordingly, that every great attempt ever made for the improvement of intellectual education, every advance of the standard of mental culture, recognized in any age and nation, has been the effect of some considerable scientific discovery or group of discoveries in the preceding years. In support of this proposition, he observes that the dialectic method of Socrates and Plato, or which Plato employed and ascribed to Socrates, in his ethical inquiries and his disputes with the rhetorical Sophists, came into use immediately upon the discovery of a connected body of geometrical truths, from which the Greeks of that age had learned what is the genuine aspect of truth in general, and that the discovery of truth is within the reach of the human mind. The Romans, for their part, cultivated the science of jurisprudence in the most comprehensive form, the doctrines of civil rights and obligations; and their discoveries in that science, with the method of its procedure, came to have the strongest influence upon the educational systems and the habits of thought in Western Europe, from the time of the Roman Empire, through the Middle Ages, and to the present day, especially in France and Italy, Germany and Spain. But Dr. Whewell further remarks, that neither the study of geometry and mathematics, nor that of the Roman law and general jurisprudence, nor both studies together, can give the intellect all its needful discipline, because they are both deductive sciences, in which every conclusion is to be demonstrated from axioms or first principles. He even suggests that an exclusive attention to processes of deductive logic may have an injurious effect on the mind, and unfit it for the investigation of truth in subjects requiring a different mode of treatment. The remedy or preventive of this evil is to cultivate the inductive faculty by the study of one or more of the natural sciences. "The knowledge of which I speak," says Dr. Whewell, "must be a knowledge of things, and not merely of names of things; an acquaintance with the operations and productions of nature, as they appear to the eye, not merely with what has been said about them; a knowledge of the laws of nature seen in special experiments and observations, before they are conceived in general terms; a knowledge of the types of natural forms, gathered from individual cases already made familiar. By such study of one or more departments of inductive knowledge, the mind may escape from the thralldom and illusion which reigns in the world of mere words."

Has this been done? asks the late Master of Trinity; has the plan of a liberal education been thus extended? The answer is to be found in the evidence laid before the Public School Commissioners, some extracts from which are reprinted in the Appendix. We have the testimony of such witnesses as Sir John Herschel, Sir Charles Lyell, Professor Owen, Professor Faraday, Professor DeMorgan, Dr. Joseph Hooker, and Dr. W. B. Carpenter, who agree in saying that, as the physical sciences and natural history have been almost entirely ignored in the teaching of the higher classes in this country, they find daily occasion to lament their deficiency of those faculties of observation and judgment which studies are proper to exercise. In this respect it appears to Professor Owen and Sir Charles Lyell that the middle classes, who have not had the advantage of going to Eton or Harrow, to Oxford or Cambridge, are not quite so ignorant as their superiors in social rank. "If I were to select any," says Professor Owen, "it would be the governing and legislative class, which, from the opportunities I have had of hearing remarks in conversation and debate, appears to be the least aware of the extent of the many departments of natural history, of the import of its generalization, and especially of its use in disciplining the mind." Mr. Herbert Spencer's remarks on the elements of a political education, and Dr. Hodgson's admirable sketch of the subjects of economic science, forbid us to allow that presumption.

"The Education of the Judgment," however, which is the title of Professor Faraday's discourse, includes yet more important considerations. We earnestly commend its perusal, in connection with the other lectures and addresses, which show precisely how the judgment is to be trained by means of the several branches of natural science; as, for example, by the study of physics, chemistry, vegetable and animal physiology, botany and zoology, of which respective branches