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The following paper was then read by the Rev. T. M. Gorman, the Author being unavoidably absent.

THE PLACE OF SCIENCE IN EDUCATION. By H. ALLEYNE NICHOLSON, M.D., D.Sc., F.R.S.E., Professor of Natural History in the University of St. Andrews.

THE subject of the place which Science ought to occupy in an ideal scheme of education is one which can only receive its full exposition at the hand of one who is at the same time practically acquainted, both with the methods and aims of Modern Science and with the merits and defects of our present Educational System. Having no claim to the rare combination of knowledge thus implied, I shall treat the question in a simply partial manner, taking, of course, the aspect in which it presents itself to a scientific worker. Nor is there any apparent reason why this aspect should lead to conclusions materially different from those which would be arrived at from the standpoint of the educational reformer. In any case the subject is one of vast extent, involving a number of theoretical questions of the utmost complexity, environed by formidable practical difficulties, and more or less overshadowed by the great divergencies of opinion which exist as to what is its true solution. I shall, therefore, simply touch upon some of the more salient and more purely theoretical features of this question; and I would wish, whilst expressing my own personal views, to approach the matter at issue in a spirit entirely free from dogmatism, fully recognizing that it is not only inevitable, but also right, that there should be many differences of opinion on such a subject.

Amongst the many problems, however, in our complex civilization which press with an ever-increasing urgency for solution, none, perhaps, is more pressing than the question of Education. Many burning questions may have grown cold, but this is one which will ever remain warm, until men shall have arrived at some general consent as to what constitutes its true basis of settlement. Many elements must go to form such a basis, but we have at present to deal only with one of these—

namely, the scientific element. Until recently this ingredient was comparatively unimportant, for Science, in its modern acceptation, hardly had come into existence, and its whole energies were employed in winning for itself a foothold in the world of accredited knowledge. This long and arduous struggle for existence is now nearly at an end, and there is at the present day, perhaps, a tendency, born of its successful and marvellous career, to exaggerate the claims of science, and to overestimate the benefits which it can confer. Without, however, going to either extreme, there seems to be a general *consensus* of opinion that some change is necessary in educational systems which were established in pre-scientific eras. A new mental nutriment has come into existence, and some alteration in our intellectual dietary is thereby imperatively demanded.

What this alteration shall be, and to what extent it shall be carried, must depend on many things, and on nothing more than on the precise signification which we may attach to the words "Science" and "Education." The former term, in particular, is often employed loosely, and some confusion has thereby been caused in more directions than the one now under consideration. The so-called Sciences, also, are many-sided, and short definitions always leave much unsaid; but we may consider "Science," as a generic term, to be, in its fundamentals, the analysis of the truths of the senses. In one signification of the term we may apply the name of "Science" to any kind of knowledge whatever, when this knowledge is methodized and reduced to its principles. In its more restricted, and at the same time more general acceptation, we understand by the "Sciences," what are known as the Natural and Physical Sciences. *These* deal with the phenomena of the natural world primarily, and their ultimate data are obtainable only through the medium of the *senses*. The foundations of the sciences rest, therefore, deep down in the sensuous life of humanity. By this definition it will be seen that we exclude Psychology, the *ultimate* data of which are derived from the internal consciousness of the individual, and not by means of observations carried on through the medium of the senses, though such contribute accessory and secondary data. Those, of course, who believe in the purely physiological basis of all mental phenomena, will naturally demur to this exclusion, and, from their point of view, rightly so; nor is it at all necessary that I should in this place endeavour to answer any objections on this score. I think it may be maintained, however, that though a "methodized knowledge" of Psychology has of recent years sprung into existence, there is no "Science" of this name,

nor will such ever exist unless mental actions and cerebral actions are proved to be one and indivisible.

It has been said that "*vere scire est per causas scire*"; but "Science," strictly speaking, deals with nothing more than phenomena and secondary causes, and in all cases leaves us in total ignorance of the primary causes of things. It is "Philosophy" in the true sense of the term, which finds its proper home in the world of causes. *Phenomena*, by the very derivation of the word, are *per se* only appearances, and they are, therefore, at bottom nothing more than our own *sensations*. They are the results of impressions made upon the senses; and though this does not prove them to be unreal, it leads us to see that they are to a certain extent infected with that fallaciousness and uncertainty which necessarily attends the operation of the sense-organs. What "Nature," then, really *is*, "Science" will never teach us; nor can we ever hope to attain to a knowledge of the essence of the universe by means of our scientific and natural faculties alone. Still less will these faculties assist us in the attempt to fathom that world of the unseen spiritual forces of which our material world is but an outward manifestation, and the very existence of which can only be learned by the moral and emotional faculties. Hence, Science, as pursued only in its lower plane, and as divorced from Reason, leads of necessity to the conclusion that there exists nothing outside of, or beyond, the purely phenomenal; or, that if such a further region should have any existence, it is for ever closed to our investigation by the irreversible limitations of our faculties. To this conclusion pure Science leads us inevitably; but its decision in a matter of this kind cannot be accepted, unless it be endorsed by the higher tribunal of Reason. Nor has this endorsement so far been forthcoming. The belief in the merely phenomenal is, by its very nature, at variance with the primeval and inherent instincts of the human race: its life is the life of the Schools and not of the People. The senses can show us nothing but phenomena—they would cease to be the senses, if they could; but the unquenchable assertions of our souls compel us to believe that these *Phenomena* rest upon a corresponding substratum of *Facts*. It may be, as some philosophers prefer to believe, that these facts belong to the domain of the "unknowable"—that vast and shadowy realm, in which the warm and living human spirit incontinently expires for want of air and heat. It may be so; but it is worth our while, even in this case, at least to convince ourselves that the world of realities is no myth or phantom. Whether or not we may ever be able to investigate it, there exists a world of which our material cosmos is but the faint

reflex and adumbration. This of itself is worth taking some pains to be sure of, unless man is to be regarded as simply an exceptionally cunningly-constructed machine. For my own part, I prefer to believe—and at present the known facts of the case render this preference entirely legitimate—that the region of the “knowable” is wider by far than some are inclined to admit; provided only that we obey the necessary laws of our mental being, are content to apprehend where we cannot comprehend, and learn to recognize that certain faculties are keys to certain locks in this marvellous universe of ours, but are of no avail if employed against other locks of a totally different construction.

In the second place, what are we to understand by the term “Education”? In its widest sense, I conceive we may take education as being the sum of the means necessary for the full development of the mental and physical faculties. In the comparatively rare cases in which its object is entirely attained, we have the “*mens sana in corpore sano*”; and we have the human being in the ideal condition of being at harmony at once with the material universe in which he lives and with the higher world of the moral and spiritual forces. Taking this view of the matter, it is clear that an ideal scheme of education presupposes the existence, for its basis, of a perfect science of physiology, and a complete knowledge of psychology. Obviously, we cannot determine how best we may train and develop the mental and physical faculties, unless we have previously determined the true constitution of both mind and body, and have made ourselves acquainted with the laws under which these act in combination and react on one another. At present, it need hardly be said, we are far from being in the position to claim any such complete knowledge of the human body or the human mind. Physiology, gigantic as its strides have lately been, is still far from its maturity; whilst psychology has not so much as fairly established, in the eyes of differing schools, its primitive and absolutely fundamental data. In the meanwhile, therefore, all schemes of education are necessarily more or less of a tentative and provisional nature.

Speaking thus tentatively, a study of the internal constitution of the marvellous composite resulting from the temporary wedding of a complex spiritual organism with a correspondingly complex corporeal mechanism, would seem to show that the order of knowledge is as follows:—*Firstly*, the senses should be brought into exercise, and trained to investigate and duly appraise the various phenomena of the material world. *Secondly*, the truths acquired by the senses should be analyzed, methodi-

cally arranged and reduced to sciences, and these sciences must be applied in practice. *Thirdly*, the mind should be conducted into the region of philosophy, which, as regards its fundamental nature, is properly an analysis of the truths of the sciences, just as the sciences are a more elementary analysis of the truths which we learn through the senses.

The order thus indicated by physiology and psychology is the one which has apparently been followed in the progressive development of the collective human mind, and sound reason shows that it is equally the order of development for each individual. *In the first instance*, we employ the senses, which make us acquainted with phenomena, or, in other words, with the world which is relative to Man. This portion of our education is commenced in early infancy, and is at first wholly unconscious and independent of lessons and penalties; nor is it wholly pre-termitted or abandoned sooner than the last hour of conscious life. And it may be here observed, *en passant*, that the objects of the senses are, in themselves, below reason and outside it—being simply objects capable of being perceived and apprehended by the special organs of sense. Sense alone is the faculty properly applicable to them, and when the higher faculties take in hand the task of investigating what they *are* in their essence, and whether they are within the mind or without it, or, in other words, whether they have or have not any real existence—then we get into the true Serbonian bog of Transcendental Metaphysics, in which some of the finest intellects the world has yet known have become hopelessly entangled and bewildered. *In the second place*, having acquired a knowledge of sensible things, the mind next proceeds (or ought to proceed) to consider the world of causes—of *noumena*. This is effected by reason, being the faculty by which the mind establishes a balance, proportion, or ratio between the outward and the inward, between the world of external effects and appearances and the world of internal causes and realities; reducing variety to unity, and establishing general laws in the chaos of apparently disconnected phenomena. *In the third place*, finally, the mind passes from the world of causes to what has appropriately been termed the world of *principles* or *ends*, in which it seeks for the link of purpose and design by which each effect may be duly united with its antecedent cause. The bridge for this passage is built by the combined exertions of philosophy and religion.

I am aware that there is a tendency at the present day, in certain scientific circles, to ignore all but the world of phenomena, to deny the existence of the world of causes, and still

more of the world of ends; or, if not to ignore their existence, at any rate to deny that they form, or ever can form, subjects which can be properly or efficiently studied by the human mind. From this view I must be understood as entirely dissenting; and it is the adhesion of certain powerful schools of thought to this opinion to which may be ascribed the singular intellectual one-sidedness which is often seen as a result of an exclusively scientific training. I think, also, that it can be shown that those who hold these views are, as votaries of true science, false to their own fundamental principles. By the senses (on strict and admitted Berkleian principles), we can only discover the mere surfaces and integuments of things, and can never explore the *penetralia* of matter, or unravel the mysteries of creation. Reason, however, is not bound by the same limitations, but is endowed with the sublime and heaven-sent power of penetrating on the one hand to the apparently inscrutable secrets of mechanism underlying the superficies of sensible things, and, on the other hand, of soaring beyond the "*flam-mantia mœnia mundi*," unfolding the infinite analogies of the universe, and establishing in all things that unity which is due to their origin from one Great Cause.

This will be the more obvious if we consider for a moment the positions occupied in this respect by the Ptolemaic and Copernican systems of astronomy. The former, firmly believed in more than a millennium, is a scientific system strictly founded upon the evidence of the senses. It takes the appearances presented by the heavenly orbs as being realities—it regards the sun, moon, planets, and stars as so many bright and luminous points placed in a firmament which immediately surrounds the earth—and it looks upon our terrestrial globe as the centre of the universe, round which the celestial bodies wheel subservient in their orbits. On the other hand, the Copernican astronomy rejects the apparently plain evidence of the senses—it concludes that the phenomena of the moving heavens and the seemingly stable earth are illusions—it shows by *reason* that the *senses* are wrong, that the earth is in constant revolution round the sun and on its own axis, and that, far from being the centre of the universe, we are not so much as the centre of our own little solar system. Similarly, to take another familiar example, it is well known that vision, to all appearance the most acute and trustworthy of our senses, assuredly does not show us things as they really are, either as regards their position to ourselves or their position to one another. The apparent phenomena of vision require to be interpreted by reason, acting through experience, before we can project the field of sight

outside the eyeball, combine the double visual spectra into single ones, and place in its proper position the inverted map of the retina. In these, therefore, as in many other instances, we have on the one side *sense* and *appearance*, and on the other side *reason* and *reality*. In these cases, there has been no hesitation amongst scientific men as to which side is to be chosen ; but it can hardly be said that they have invariably followed the guidance of the same principle of choice. Whilst recognizing that the senses have led men totally wrong as to the real sequence and nature of some of the most stupendous, and at the same time most familiar, phenomena of the material universe, they have implicitly followed the guidance of the same senses as regards the interpretation of other phenomena of a kindred nature. When overmastered by strongly-held theoretical convictions, it is true of all men,—of men of science as of the profane vulgar,—that “*populus vult decipi, et decipiatur.*”

Leaving theoretical questions in the meanwhile for others more practical, it may here be pointed out that the Sciences are twofold in aspect and constitution, and are adapted to play a double part in the complicated machinery of education. The *data* of the sciences, the facts which each embraces, are learnable by the senses, and are not truly or properly learnable by any other channel. It is possible, of course, to learn some or all of the known facts of a given science out of books, by memory alone, and without having submitted one of these facts to the test of the senses. It is possible to do this ; but, from the very definition of what Science in its essence is, it must be evident that no real knowledge can be obtained in this fashion ; and the Sciences, if they are to be learnt, or taught, after this method, assuredly present no special advantages over many other studies. On the other hand, the Sciences, as we have seen, have the peculiarity, as compared with the non-scientific branches of study, that they are grounded in the sensuous and natural life of the human being. They reach the higher spiritual plane of the organism through the senses, and it is properly through “the five gateways of knowledge” that scientific truths should be imparted to the learner. Hence, the Sciences present, to begin with, the advantage that they can be taught, as regards their simpler and more fundamental data, at a time when the higher mental faculties are comparatively undeveloped and in abeyance. Whether purposely taught, indeed, or not, every individual of our race, from the moment that he opens his eyes upon the world, commences perforce such a course of scientific education, which is none the less complete because it is involuntary and guided only by the

instincts. In post-infantile life, science may be, and often is, so taught as to deprive it of its native and inherent advantages; but this is clearly the fault of the teacher or the system of teaching; and it remains certain that the *practical* teaching of Science can be commenced at an earlier period than can profitably be attempted with the more ordinary branches of education—if only upon the ground that the senses attain their working powers much sooner than do the intellectual faculties.

Whilst the data of the Sciences have their foundation in the senses, the deductions from these data are purely intellectual; and hence Science, in this second aspect of its twofold constitution, stands in precisely the same educational position as any non-scientific branch of knowledge. The *facts* of the Sciences can only be discovered, in the first place, through the medium of the senses; and even after they have been thus discovered, and have become common property, they should, nevertheless, be mainly handed down from individual to individual through the same channel. On the other hand, the *generalizations* of Science are super-sensual, and are the result of purely intellectual operations. The observation of the celestial phenomena which constitute the groundwork of the science of astronomy can be carried out solely through the sense of sight; but no acuteness of vision, no complexity of apparatus, no repetition of investigation or experiment would lead to the discovery of the law that the radius vector describes equal areas in equal times. We pass here from the region of sense into the more ethereal atmosphere of rational mind and intellect. The physical properties and phenomena of a thistle are presumably as well known to a donkey as they are to the highest of human beings, in so far, at any rate, as the senses of the two are equally efficient; but the latter can draw certain deductions from the facts which he knows about the thistle which might perhaps embrace the constitution of the solar system in their scope, and which, in their humblest extension, are entirely undreamed of in the philosophy of the latter. In the alembic of Reason, the lowest facts of the Sciences take their proper place as parts of an infinite whole. It may be repeated, then, that Science, from an educational point of view, is fundamentally a duality, as composed of two distinct but closely-related departments. Its facts are most suitably taught to the young, in whom the senses are most acute. Its deductions, acquired by the working of the mind on the facts presented to it by the senses, are rather fitted for later periods of life, when the senses may be less active, but the higher intellectual faculties are more matured.

If we now consider more closely what are the specific objects to be aimed at by any rational System of Education, we find that they may be naturally discussed under three heads:—(1) *Discipline*, or the training and development of the mental and physical faculties as so many instruments of the human organism: (2) *Practical Utility*, or the acquisition of certain knowledges, which will be of actual practical value to the individual in his struggle for existence, and will secondarily enable him to be of use to his fellow-creatures: (3) *Spiritual Culture*, or the improvement and development of the higher moral and emotional faculties, together with the unfolding of the æsthetic capabilities of the individual. In considering the educational value of Science under the above three heads, no digression will be made into the controversy as to whether the above objects of all sound education are attained more perfectly by a scientific or a non-scientific training alone, or by a judicious intermingling of the two. All that will be attempted here is to show, very briefly, that Science has strong claims to be regarded as an educational power in all of these three departments. No unprejudiced thinker can hesitate to admit, most fully, that an ideal education is many-sided, and that no knowledge, however profound, of a *single* subject, entitles any man to the honourable designation of “educated,” in the widest and truest sense of the word. The learned German philologist who failed to recognize what potatoes were, on seeing them in their native condition, in spite of his enormous erudition, was “uneducated,” in the same sense as is the man of science who is wholly devoid of literary culture. To be altogether “*teres atque rotundus*” one must know something of many things, and everything of something. We have to deal, however, with a state of matters very far removed from the ideal. The only real practical question lies in determining whether those individuals—and there are unfortunately many of them—who have time and opportunity for examining but one of the facets of the crystal of knowledge, should rather attend to the scientific or to the non-scientific branches of study. Into this much-vexed question, no excursion need be made here and now. No further general conclusion seems to be safe, except that even the most elementary education should have some flavouring and tincture of *both* kinds of knowledge; and it might be predicted, without rashness, that the Sciences are likely very materially to alter their complexion, before this question will be really ripe for solution in any final sense. All that is proposed here is to cursorily examine how far the Sciences fulfil the three great objects of education, without

entering into any accurate comparison of their value as contrasted with other departments of study.

Firstly, as regards *Discipline*, very little need be said as to the value of scientific studies. That the study of Physical and Natural Science is of the highest efficacy in developing and training the mental powers in their lower plane, may be assumed, without danger, as being generally admitted. Witness—if witness be needed—the unchallenged position occupied by mathematics, at once the handmaiden and the mother of so many of the sciences. From one point of view, however, Science has a special value as a disciplinary agent; since its training is of a twofold character. The labour, namely, necessary for acquiring the *facts* of Nature develops and increases the powers of observation and sharpens the senses; whilst the study of the *generalizations* of Science constitutes one of the severest forms of intellectual training. It may be claimed, therefore, with some show of reason, that the educational discipline afforded by scientific studies presents certain advantages over that which can be derived from other branches of knowledge. Even if this be admitted, it can only be with the strong assurance that these advantages cannot be realized unless Science be taught *practically*. It is not enough for the teacher to rely upon books, either for his own knowledge or in his teaching. He must himself have a personal knowledge of his subject; and the facts which he brings before the learner must be illustrated by actual examples from the world around him. So far, at any rate, as concerns the young, it may be doubted if science-teaching is of any avail, unless it be carried out in the laboratory and the museum, on the hill-side or by the seashore, by the living voice of Nature rather than by diagrams and technicalities. When so taught, Science yields to no other study as a means of mental discipline; and its value as an educational agent cannot be fairly estimated when it is taught otherwise.

If we inquire, in the second place, what educational standing Science can claim on the score of *Utility*, here, again, it would appear that its pretensions are well-founded and undeniable. Always admitting that the ideal education would consist in a judicious intermixture of the scientific and non-scientific knowledges, we must remember that the time allotted by the majority of mankind to learning is too short to admit of this general culture, and that the average schoolboy is not likely to conquer with any thoroughness more than one department of knowledge. Having painfully mastered “the three r’s,” the ordinary schoolboy is driven to make choice as to what set of studies he will more especially pursue; and his choice is,

or ought to be, guided by a due consideration as to what knowledge will be most *useful* to him in later life. If the limitation of his choice to *one* set of knowledges be an absolute necessity, then the claims of Science in this respect can hardly be denied. Most men in civilized communities lead lives of an eminently practical character; and it is no exaggeration to describe human existence as being in its essence, and primarily, an incessant struggle with the natural forces with which the human being is environed. The more intelligently this struggle is carried out, the more thoroughly man succeeds in bending the material forces of the universe to his imperious will,—the higher is the stage of civilization which is attained to, and every victory in this fight raises man nearer to his ideal condition. I am far from saying that the satisfaction of his material wants is all that man requires for his happiness and welfare, or that the highest and best elements of civilization are merely material. Man is more than an animal, and his wants other than those of the day. Nevertheless, all that we know of savage life, and of the worse than savage life of certain classes in so-called civilized communities, teaches us that no conspicuous spiritual progress is possible where man's material wants remain unsatisfied. Too certain is it that the higher faculties of humanity will assuredly be allowed to lie fallow, or will be perverted, if all the available energies of the organism have to be devoted to securing a bare and hazardous existence. It is useless, then, to hope for a high mental development, unless we can first satisfy the primary and clamant wants of the bodily frame; and we cannot satisfy these unless we can bring about a more or less complete harmony between man and nature.

And how can this harmony be brought about? Surely in no other way than by instilling into the plastic minds of our children some knowledge of the world they live in, some love for the wonders of Nature by which they are surrounded, some acquaintance with the laws which govern the universe. Most men, as I have said before, lead lives of an eminently practical character. In winning their bread, they are brought into daily contact with natural productions; they conduct operations depending entirely upon natural laws, or they have to deal with artificial products or machinery removed by the skill of man but one stage from the raw material of nature. It were an easy matter to unroll the long list of scientific achievements of which our present civilization is the crown and superstructure; but there is no necessity for this. The common working life of man pre-eminently demands a knowledge of common things; and this knowledge can only be obtained from Science. How,

then, can we doubt the *utility* of science in education? I will only draw attention, in this connection, to one further consideration. Apart from the actual practical value of scientific knowledge to those who have to lead hard practical lives, and who have not time to devote themselves to the attainment of a general education—apart from this, no one but a medical man can estimate, even imperfectly, the amount of misery, disease, and even vice, which may be justly attributed to a gross public ignorance of the commonest scientific laws, and which might be more or less completely removed by a more general diffusion of scientific knowledge. How many lives might be preserved, if mothers in general had but some knowledge of physiology, or had any accurate acquaintance with the structure and functions of the animal body? How much suffering might be obviated, if there existed any generally-diffused knowledge of the laws of health. How many of the ills to which humanity is heir might be mitigated or altogether abolished, if sanitary science were at all generally understood by those who frame municipal laws?

Higher and deeper, however, than either discipline or utility is *Culture*, by which in its most general sense may be understood the bringing of man into harmony with the spiritual world, in which he truly lives and has his being. What can science claim as an apparatus of education on *this* score? Taking science as it is at present, I think it may be at once conceded that it is in this respect markedly inferior to other non-scientific branches of study, with, however, the important proviso that the studies in question cannot claim any superiority in this matter, unless they are carried beyond a certain point, which is certainly not commonly reached in school life. The literary appreciation of Homer and Æschylus, of Juvenal and Tacitus, of Shakespeare and Tennyson, of Goethe and Schiller, presupposes a high culture—much higher than mere science can afford—as much higher, in fact, as the spiritual part of the organism is higher than the merely natural. To yield this culture, however, the study of literature must be carried far enough to develop the higher faculties, to unfold the laws of our spiritual being, to elevate and purify our moral natures by communion with the great souls who have lived and laboured and passed away. When studied for mere commercial or utilitarian ends, literature is no better than the driest and most repulsive of the sciences. It may very much be doubted if it be not worse.

It may be willingly conceded, then, that the prosecution of literary studies, in their higher walks, gives rise to a form of culture, which is more elevated, more polished, and more spiritual

than that engendered by the study of the sciences pure and simple. It may, also, be freely conceded that the too exclusive study of natural and physical science is apt, in certain temperaments, to harden the mind, to close the eyes to the higher and less tangible elements of human life, and to disturb the true balance between the intellectual and emotional faculties. Science, however, when rightly pursued, yields a culture in which these are by no means necessary or inevitable defects, and which, if *sui generis*, is, nevertheless, real and abiding. It brings man into harmony with the natural world in which his present lot is cast; it shows him, on the one hand, how profoundly ignorant he is of the real essence of even the material things around him; and, on the other hand, it leads him from Nature to Nature's God, and teaches him to find below the rind and surface of the cosmos the Divine Spirit that dwells in the innermost recesses of natural phenomena. To the religious temperament, the study of science must ever conduce to the highest of all forms of culture—the culture that is implied by *reverence*. Relegated to its true place in the educational system, the scales removed from its eyes, and its self-imposed fetters struck off, Science will yet see that its true mission is only partially discharged when men have learnt the laws and investigated the phenomena of the material. A larger and by far more important portion of its task must consist in developing a profounder admiration for the wondrous works of the Creator as displayed in the visible universe, a truer insight into the real objects of human life, and a more intelligent and helpful compassion for those who ignorantly sin against the inevitable laws of existence.

Nor need we think that the capabilities of science as a means of culture are exhausted, or so much perhaps as dimly guessed at, by the present generation. In demonstrating to us that all which we can learn by the senses is but the sequence of phenomena, Science at the same time leaves the field clear to philosophy, to show us that below the phenomenal is the real. That man's sensuous nature is, to a certain extent and in a certain sense, at discord with his higher spiritual nature, is true; and the same truth is expressed, in other language, by saying that there is an apparent discord between Science and Religion. Assuredly, however, this discord is but apparent, and will vanish as our vision becomes more enlightened, and our knowledge more widely extended. For many generations now, some of the highest intellects of which humanity can boast have occupied themselves with the study of natural phenomena. With passionate patience, uncompromising labour, uncalculating

self-denial, and boundless enthusiasm, men have sought to wrest from Nature her inmost mysteries, and are just beginning to learn that the real secrets of the universe are not to be dragged forth by the retort, the scalpel, and the microscope. If in this blind and fervid impulse to solve "the riddle of the painful earth," men have sometimes reached the despairing conclusion that probably there is no riddle after all, or that, if there be, it is not worth our while to try and solve it, who shall wonder? There will always be those who, like Faust's "Famulus," dig with eager hands for treasure, and rejoice if they come upon an earthworm. Only to the chiefs of our race is it given to use "the hammer for building"; but any apprentice can wield "the torch for burning."

Surely, however, it is no mean thing if we at last learn—even though it be by the painful process of beating our heads against the walls—that the province of Science, though a mighty and a noble domain, is one limited by the strictest confines. No experience will be too dearly purchased, if we thereby convince ourselves that Science alone is powerless to satisfy the wants of human nature. Modern science has long been trying to establish a "law of necessity" to embrace all things natural, the quick as well as the dead; and there are not wanting those who would place the things which we somewhat misleadingly call *super-natural*, under the heel of the same iron despotism. The free human soul, however, imperiously demands freedom, not only for itself, but still more for the power by which the universe is governed. Man is not a dead machine, nor is the universe a lifeless system; and the formulæ of the schools are of no avail as opposed to the triumphant instincts of humanity.

Nor is this freedom in any way incompatible with the theory that the universe is strictly governed by law, and even by unvarying law. That every event in nature, every event in human life, is strictly the result of an antecedent event, as its cause, and gives rise to some succeeding event, as its effect, may be most fully admitted without any involved or implied denial of freedom. The freedom of a spiritual being of known character and nature must be as strictly reducible to law as the automatic working of a machine—though the law of its action may be infinitely more difficult to discover. We may protest, therefore, against the assumption by which Prof. Draper's remarkable work on "The Conflict between Religion and Science" is saturated, and its conclusions vitiated—the assumption, namely, that "Science" demands that the world shall be governed by immutable laws, whilst "Religion" demands that it shall be controlled by "discontinuous, disconnected, arbitrary

interventions of God." It is simply not correct to state that there are *two* conceptions of the government of the world, one by *Providence*, the other by *Law*; and that Religion favours the former, and Science the latter. It is not correct to state this, because the statement involves the conception that there is something radically incompatible and antagonistic between the conception of *Providence* and the conception of *Law*. No such antagonism exists, however, and there is a *third* conception,—namely, that the government of the world is by *Providence, acting through and by secondary causes and according to invariable laws*. The true state of the case, therefore, may be put thus:—Certain forms of *Theology* maintain that the world is governed by incessant, arbitrary interventions of Providence. Pure *Science* maintains that the world is governed by necessary *Law*—in so far as the human mind may be supposed capable of conceiving that "Law" can exist or subsist without the existence or subsistence of a "Law-maker." Rational *Religion* maintains that the world is governed by Providence acting through secondary causes, and through laws which are necessarily invariable, as they must be supposed to be laws of the Divine nature itself.* Dr. Draper appears to hold the second of these views; but his strictures fall harmless at the feet of Religion, however hardly they affect the views of Theology, against certain dogmas of which they are rightly directed. He does not appear to rightly comprehend what the views of *Religion*, properly so-called, really are upon this subject; and he has, therefore, necessarily left these views untouched and unaffected by his arguments. His work ought to have been entitled the "Conflict between Science and certain Forms of Theology." Its present title is simply a misnomer; and, in spite of the great ability of the work, there is thus betrayed a total misconception of the fundamental point at issue.

For my own part, I think there are not wanting indications that Science is, at last, approaching the point at which it will be able to confer upon the world, if not its last, at any rate its greatest

* No being, even though his powers should extend to what is ordinarily called "Omnipotence," can be conceived of as endowed with the power of acting *against* the laws and constitution of his own nature. The laws of Divine action *must*, therefore, be invariable, as grounded in the nature of a Being in whom there is "no variableness or shadow of turning." For the same reason, the material universe, regarded as the product of Divine love and wisdom, *must* be governed by invariable laws. Any departure from invariable law can but be apparent, and can simply be the result of the intervention of a higher law, equally invariable in its operation with the lower law which it supersedes.

service, by discovering that, though its own powers are strictly limited to the region of the phenomenal, there exists outside and above the phenomenal another world of existences—the only real one—which requires the employment of non-scientific faculties for its investigation and apprehension. Nor will Science, in making this discovery, be in any proper sense committing a “happy dispatch” upon itself. On the contrary, Science will not know its true strength, nor attain its full stature, till it has entered into an alliance with Religion, and is reconciled with Reason. It must learn to admit its own limitations, and to recognize the comparatively small field which it covers; it must feel that it deals only with the husk and the shell, and that the kernel and the life-blood belong to something higher and deeper; it must recognize, in the imperishable words of Teufelsdröckh, that “the universe is not dead and demoniacal, a charnel-house with spectres, but God-like and our Father’s.”

In considering the true position which Science ought to occupy as an educational agent, it is perhaps to be admitted with regret, that, if studied in accordance with some of its prevalent doctrines at the present day, it does not greatly conduce to a higher culture—certainly not so much so as it ought to do. The work of destruction, however, is always easier than that of construction, and is, moreover, sometimes an essential preliminary to it. You cannot put new wine into old bottles; and the failure of Science as an apparatus of culture is a temporary accident, and not a permanent necessity. This failure is inevitable so long as Science is held to be exclusively concerned with phenomena alone, and to have no secondary interest in causes and ends—so long as it is held that she is to exclude or deny all but material explanations or ideas, to sever herself from the emotions, and to keep herself estranged from her sisters, Philosophy and Religion. The laws of Science, however, are but the laws of the moral world in a lower plane, and embodied in the natural sphere. Science may, if she pleases, confine herself to the study of the series of effects, of which Nature is the sum; but it is at her own risk, if she ignore the corresponding series of causes which form the domain of Philosophy, or the corresponding series of ends, with which Religion has more especially to deal. Once united with these higher departments of knowledge, as assuredly she will be, Science will enter upon a new and higher life, and will be prepared to play her proper part in the development and regeneration of humanity.

The age of gold has passed away, and man no longer walks

the earth clad, as with a garment, in primeval innocence. The original order has been reversed, and natural truth has now become the groundwork and basis of all truth. We live, as has been truly said, but weakly lamented, in a "mechanical age"; but humanity need not, on that account, despair of its future. Properly speaking, "mechanics" deals with machinery, and, therefore, with "forms"; but there are living and spiritual forms, as well as dead and material ones; and the laws of mechanics are, in all strictness, laws of the infinite, and partake of infinite perfection. The great problem of the future is to translate the laws of material mechanics into those of spiritual mechanics—to show, in other words, that the laws of Matter and the laws of Spirit are not laws of a different *order* but of a different *degree*. When we can do this, the Spirit of the Age, mechanical though it be, will be justified of its children. The claims of philosophy to its own proper estates will no longer be disputed, for they will rest upon an unassailable foundation of scientific truth. We shall hear no more of the discordance between Science and Religion, and Theology will again be reinstated in the respect and affection of thoughtful men, by acquiring a natural basis, and becoming indissolubly connected with the truths of the material universe.

It may be that we are yet far from this happy consummation; that we must yet fight through a long period of spiritual unrest and disturbance before the lion can lie down with the lamb, and the higher and lower notes of the mighty organ of the universe can be brought into complete accord. No man dare prophesy on such matters, but the signs of the times are clear to read. I would only say, in conclusion, that it appears to me to be of the utmost importance in the investigation of truths of whatever order, to maintain an affirmative rather than a negative mood of mind. It may be regarded as tolerably certain that the greatest intellectual discoveries have been made by men, to whom affirmation was more easy and more natural than negation. There is no gift, no endowment of genius, which the student of truth should so earnestly endeavour to preserve as that positive mental habit which we all possess in childhood, but which we frequently cast away in later life as useless or pernicious. It is not a good thing to hold beliefs so tightly that we cannot give them up if need be, and if the evidence against them be sufficient. We should not even hold our beliefs in any way which would render us unwilling to examine the grounds on which they rest and to patiently listen to all that can be urged against them. We may rest assured that as no truth is without its modicum of human fallibility and human error, so

no error has ever been widely accepted, save when it contained some grains of truth. Experience teaches us that those who hold opposite or apparently conflicting beliefs, are, in many instances, but looking with too fixed and immovable a gaze upon different aspects of the same object. The shield is golden on the one side, on the other it is of silver. Above all, transcendental speculations are not to be lightly entered upon, since they are not only barren in themselves, but deserve their self-chosen title by wholly transcending the limits of our finite faculties. No pseudo-philosophy ought to be allowed to seduce us into questioning the validity of our senses, or doubting the reality of the external world. Nature is the living garment of the Deity, and the veil of the temple—not the mere phantom of a diseased imagination. *There*, we stand on firm and solid ground, and *there* long generations to come will find scope and verge enough for the rational employment of those faculties, in virtue of which alone man claims the noble and inalienable title of “Homo sapiens.”

The CHAIRMAN (the Master of the Charterhouse) said, he was sure the meeting would approve a vote of thanks, both to the Author of the paper and the Member who had so kindly read it.

Mr. T. HARRIOT adverted to the degrading influences to which this world was still subject, in spite of the advances of Science: influences which we might suppose would characterize a world in its infancy rather than our own. Such a state of things could only be the result of a want of Faith, the absence of which prevented man placing himself under the guidance of that Unseen Power, Who controlled the Universe and gave true wisdom to people to comprehend His laws and see harmony where there now sometimes appeared to be discord.

Mr. L. T. DIBDIN considered that the study of mathematical science would be more useful as a training of the mind if it were accompanied by practical illustrations. Cambridge University was considered to be the great centre of scientific education in England, and when he went through the mathematical course there, he found that practical Experimental Science was very little taught, in fact almost neglected by the great bulk of the undergraduates. He was glad to say that the Duke of Devonshire had lately founded a splendid laboratory at Cambridge, with the most complete arrangements for work in experimental science; but at present the use of the laboratory was virtually restricted to graduates; hence it could hardly be regarded as an Educational Establishment. Professor Challis, who gave an annual series of lectures on Magnetism, Electricity, and Practical Astronomy, had frequently found it impossible to get together enough men to form a class;

and in his (Mr. Dibdin's) year it was a positive fact that his own was the only name entered for these lectures: he need hardly add that if Professor Challis was unable to get men to come and hear him on these subjects, no other man in the university was likely to do so. He believed that such a result was mainly due to the high-pressure system of examinations. In order to pass successfully *in honours*, a man was obliged to study solely with a view to the examination, instead of his first object being to master the subjects in which he had to be examined. This was particularly the case in regard to Mathematics; some of those who passed *tripos* most successfully had not studied experimental science at all; and in regard to Astronomy he had actually heard the objection made, that going to the Observatory at all and examining the instruments tended to confuse the mind in calculations relative to those instruments. As regards Professor Nicholson's remarks on miracles, he did not think his definition of them satisfactory—that mode of treatment would do away with miracles altogether; because if, using a mathematical illustration, miracles were merely exceptional terms in a series of which the other terms were the ordinary course of Nature, the exceptional terms being the same in everything but the frequency of their recurrence with the ordinary terms, it followed that miracles were events as *natural* as any other events, and differing from other events only in this, that they seldom occurred. He himself preferred Professor Westcott's definition of a miracle, which was—speaking from memory—anything which suggested the active interference of a *Personal God*.*

The CHAIRMAN thought the point which had been brought forward by Mr. Dibdin, with reference to the mode of instruction at Cambridge University, deserved considerable attention. Certainly, at Cambridge the mathematical studies of undergraduates had been, for the most part, directed to the acquirement of the knowledge of what have been called Pure Mathematics, independent of observation, and to mastering all the processes of reasoning and calculation by which the results obtained by our greatest mathematicians had been arrived at. It was to his mind a question of considerable doubt, whether it was essential to unite with the teaching of pure mathematics a constant observation of phenomena. The two things were quite separate, and it was questionable whether they should not be considered separately. In the study of Astronomy it was no doubt true that some men would not go to the Observatory, but would confine themselves to abstruse calculations; but at any rate that mode of study was not without its value, for the great

* Professor B. F. Westcott, D.D., writes:—"These words give a fair general view of the definition of a miracle, and I prefer it to any other. The exact words which I have used, are, that a miracle is 'an event or phenomenon which is fitted to suggest to us the action of a personal spiritual power. . . Its essence lies not so much in what it is in itself as in what it is calculated to indicate. . . .' The points on which I wish to lay stress are, (1) that a 'miracle' involves an *interpretation* of facts observed; and (2) that it *assumes* the existence of a spiritual power adequate to produce the effects."

discovery of Professor Adams was made by calculations. His work was a great work of pure mathematics and calculation, and no one could deny, after such an example, that there was a great utility in the study of mathematical science independently of the observation of phenomena. The question was, whether it is not better first to store the mind with a knowledge of pure science and then proceed to the observation of phenomena, rather than to begin with the observation of phenomena and then proceed to derive our laws and calculations. It would, he thought, be impossible to study phenomena with any advantage, without a considerable acquaintance with pure mathematics to begin with. A person who wished to make calculations or observations in Astronomy must be acquainted with many common mathematical rules quite independent of observation; rules, he thought, must be learnt before observation could be productive of any good. No doubt boys were often to be found rushing to observe phenomena, but they did it in an offhand and superficial manner through lack of the necessary preliminary knowledge, and there they stopped, for they were just in the position of a person who attempted to learn a language without studying its grammar. He wished to know how far this applied to Science, and whether there was not some danger in pressing the young mind too quickly into the field of phenomenal observations.

Rev. T. M. GORMAN.—With regard to the question of miracles, Professor Nicholson had attached an important note to one part of his paper. He said :—

“No being, even though his powers should extend to what is ordinarily called ‘Omnipotence,’ can be conceived of as endowed with the power of acting *against* the laws and constitution of his own nature. The laws of Divine action *must*, therefore, be invariable, as grounded in the nature of a Being in whom there is ‘no variableness or shadow of turning.’ For the same reason, the material universe, regarded as the product of Divine love and wisdom, *must* be governed by invariable laws. Any departure from invariable law can but be apparent, and can simply be the result of the intervention of a higher law, equally invariable in its operation with the lower law which it supersedes.”

In this passage Professor Nicholson evidently referred to miracles, and laid it down as an axiom that no being could act against its own constitution, and applied that axiom to the Infinite Being. Therefore, as the laws of the universe were the laws of God’s divine power and wisdom, there might be things in these laws which totally transcended the natural sphere, and these laws transcending the natural sphere would appear to us to be miracles and against law, although they were really under law. In this view he thoroughly agreed with Professor Nicholson. The difficulty which non-Christians or atheists felt about miracles was owing to the fact that they never ascended out of the natural sphere into the spiritual sphere. The argument of Professor Draper, for instance, had no meaning, for it did not belong to true theology to suppose that the world was “controlled by discontinuous, dis-

connected, arbitrary interventions of God." God could do nothing that was arbitrary, for all that He did was in the exercise of the highest wisdom. He did not act intermittently, but with the omniscience of One who saw from eternity to eternity. One of the most valuable portions of the paper was that one in which Professor Nicholson pointed out that—

"The great problem of the future is to translate the laws of material mechanics into those of spiritual mechanics—to show, in other words, that the laws of Matter and the laws of Spirit are not laws of a different order but of a different *degree*."

In fact, there was the material world, and there was another, a higher and an inner world, which was governed by another set of laws. There were two great regions of existence, the natural and the spiritual, and they corresponded, the one being a symbol of the other. There was not a single idea of the super-sensual kind which was capable of being expressed at all, except by some idea in the things of nature. All things in the natural world corresponded to all things in the spiritual world, and the great problem was to translate the material world and its phenomena into the terms of the spiritual world in reference to spiritual things.

The Rev. T. C. BEASLEY said that one of the most interesting points in the paper was the relative value of learning from books and from actual sight. In his experience he had often felt that it would have been a great help, could he have *seen* or *heard* illustrations of the truths of science. That, however, was not always possible, and even if it were, it would not always be the greatest help. The greatest help would be to work the two systems together in combination. For instance, a clear conception of a steam-engine could only be obtained from description, accompanied by diagrams and a working model; and the possession of a sextant would be of little avail, without some acquaintance with Trigonometry, joined with a *vivâ voce* explanation and practical illustrations of the method of using the instrument.

A MEMBER thought that one could learn equations, for instance, with nothing but a paper and pencil, but not the construction of machinery; the one was *Pure*, the other was *Experimental or Practical Science*.

The meeting was then adjourned.

PROFESSOR NICHOLSON'S REPLY.—Professor Nicholson writes to express his thanks for the opportunity of adding any remarks to the discussion: he adds, "On reading it over, however, I do not find anything to say that would be of any importance excepting that the remarks made by the Chairman, as to the value of the purely theoretical study of Mathematics (apart from observation) do not touch the point at which I was aiming in my paper. Mathematics stands in a perfectly unique position in this respect, and, in so far as it does so, it is hardly a true *Science*. I was alluding to the *Natural and Physical Sciences*, which certainly cannot be properly taught or learnt except upon a previously-acquired basis of actual observation of phenomena."