

SCIENTIFIC EDUCATION, EXACT AND INEXACT.

IN the most recent monument of pontifical wisdom which Leo XIII. has issued on the Study of the Sacred Scriptures, the following sentence occurs: "Since there are those who, besides having the grace of the Catholic faith, are gifted by a benign Providence with a happy talent (for the pursuit of science external to the Holy Scriptures), and they can lend much assistance to the cause of religion, every one should choose for himself a suitable line of research amid the studies which are brought to bear with such animosity on Scriptural interpretation; that each one attaining a degree of excellence in his own line, they may turn the arms of a perverted science into weapons of defence, not without glory to themselves."

The science thus proposed for our attainment is the slow result of a special and profound scientific formation. This formation, which suits mature men, more or less specialists in their departments, is a very different thing from that general process of instruction for the young which is rather ostentatiously paraded as a "scientific education." Beyond the fact that the courses are really derived from the subject-matter of the sciences, there is little that is scientific about it. As an education, it is utterly unscientific. Even as a qualification for entering on some useful career of life, it is dubiously useful in one way and is positively harmful in another.

For a commercial life, merchants tell us that mere apprenticeship in a business and any style of preparatory instruction which partakes of the character of apprenticeship will not serve the purposes of modern business; since, in the ever-changing conditions of trade now-a-days, there must be a much higher degree of mental culture brought into service, better capacities for reasoning and a wider power of observation, than the mere technical lessons of past experience or any other form of apprenticeship can possibly supply. For the higher courses of science we hear it averred by medical authorities, by mathematicians, chemists, astronomers, that a preparatory training in chemistry, mathematics and other such courses, to the prejudice of literary and classical training, throws into their advanced classes a set of unformed, unawakened minds, who are quickly left behind by other students not "coached" for these specialties, but educated "all round." For the more advanced courses of literature and philology, scientific though these may be in no small degree, the same incapacity results from the

so-called "scientific" education. And it is evident that for literature in its proper sense, for the art of writing and of speaking, for the cultivation of taste and criticism, there is no training whatever in such a system; while the talents for philosophy and theology are out of question altogether. Hence it appears, on the strength of concordant testimony, which we may have occasion to refer to more particularly before we close, the scientific method of education is but dubiously useful as an introduction into any of the "useful" careers of life.

It is positively hurtful in many ways. It takes up the time and place of a genuine system of culture. It narrows the field of vision and cramps the faculties, so that when the expansive and elastic period of life is passed, and youths have become men, they cannot, however much they desire it, pick up the lost culture and acquire a liberal way of thinking, nor can they even possess themselves with credit of the fruits of other liberal minds. The inquiry is made: How can I supply the want of a liberal, a literary, a classical education? The answer is: You cannot; it is too late. How can I befit myself for logic or philosophy? The reply must be: An apprentice who has graduated into a mining school or a chemist's laboratory, or into the office of a civil engineer or an architect, cannot handle logic or philosophy; for the rest of his life he must drift helplessly about among the theories of newspaper scribblers and review writers, and take his chances there where his lot has been cast. It has been cast in the conditions of his environment, and he will remain the creature of it in his mature age, as he was the victim of it in the plastic time of his youth.

There was no reason why any system of Catholic education that pretends to be a true method of culture should ever have thrown itself into the scientific form. In the United States we are not in the grip of a State bureau of public instruction. Careers are not barred by examinations that have emanated from the peculiar conceptions of very peculiar men. We are under no constraint to form our pedagogical views on the wisdom of that pedagogical literature, tons of which do not seem to contain as much practical or theoretic wisdom as may be found in a dozen pages of old Quintillian. One thing there is in the air, and that we must charge with many of the educational phenomena which appear in the annual publications called catalogues; it is the notion of competition.

Now, competition is very good if there is anything worth while competing with. It was the soul of education in the great universities of the Middle Ages. It animated the centres of literary education which covered several countries of Europe before the great revolution. It is the life of learned societies to-day, whatever be

the specialty which marks them. It should be an incentive to enhanced excellence and increased efficiency among institutions of sound education. But what place has it, amid systems or institutions that are unsound in their methods and unsatisfactory in their results?

In point of fact, the method of pedagogical instruction prevalent in this country is that which is called, in a general way, the "scientific." It is the same which has been pointed out as a triumph of Prussian educational tactics. But Prussian authorities, who regarded it awhile with favor, or at least tolerated it, have retreated from their position. It is the same which has been recorded as the advance of science in French programmes of instruction. But French programmes have been changing every few years, and now, in the course of one unfortunate century, the twenty-first programme has been imposed on an unfortunate people. In England a similar scientific movement has begun in the face of a storm of protests, and it would appear as if the protests were being rapidly justified by results; for it is a question whether the possession and use of the English language itself will adorn the culture of the future, if only the results which are now threatening continue to work themselves out to a final issue.

In the light of these facts, we may examine with profit what is meant by the prevalent system of education; what is meant by a true scientific method; and how far, by correct means and sound views, we may co-operate in this new world, the world of the future, with the purposes expressed in the interests of all high education, when Leo XIII. calls for men of excellent science to turn the arms of attack on divine revelation into weapons of defence.

I.

We have before us several expositions of the modern method. The title of the first explains itself: "The Culture Demanded by Modern Life; a series of addresses and arguments on the claims of scientific education; with an introduction on mental discipline in education, by E. L. Youmans, 1881." The choice part of this volume is the introduction, written by the editor. He selects all that suits his purpose from the two dozen addresses which follow, and he has selected them all for a purpose. His style suits his purpose. He declaims. With no little credulity, he amasses whole paragraphs of great names, of events, of epochs, to prove what he intends, whether they prove it or not. Mathematics, which forms the purest form of true science, he rails against, because it has always held a place of honor in traditional systems of culture. Metaphysics is so far within his ken that he knows its name, to buffet it. Logic he is innocent of, both in theory and in practice.

But in all the odd gymnastics which his polemical vein leads him to indulge in through the fifty-six pages of his contribution to modern pedagogics, two things stand out with marvelous plainness: one thing which he does not want, and another thing which he does. He wants no grammar nor literature. He does want biology and chemistry. The literary specimen before us is an admirable product of the modern instructed mind. It is fluent and disconnected; it skims subjects and slips over difficulties, and it appears wondrously profound; at due intervals he turns round and contradicts what he said before, and, above all, he revels in the vague.

It is only one specimen. A swarm of such books are in the air, which is made dismal by their presence. Their authors labor under a radical impossibility of seeing anything but what comes within their limited sphere of vision. They look through the tube of a telescope or a microscope, and talk of the vast field which they see there. That is called "science"; the rest, which they do not see, is dubbed literature, or metaphysics, or religion, or whatever name they write their book against. They look through their tube, and their tube is fixed, and they are looking with one eye. Thus we have "The Conflict of Science with Religion." Or, as in the case before us, we have "Scientific Education."

Prof. Youmans is far from being unknown in the scientific world. Besides publishing a well-known text-book on chemistry, he has contributed to the cause of our enlightenment his labors as editor of the *Popular Science Monthly*, that same publication which has given a place of honor, these late years, to Dr. Andrew White's "New Chapters in the Warfare of Science (with Religion)." The fraternity of views between the doctor and the professor, between the author and the editor, should prepare us to expect a kinship of methods, as in fact we find to be the case; the same accumulation of nebulous statements, *cirrus*, *cumulus* and *nimbus*, as they speak in the science of the clouds, which, gathering over the devoted head of religion here, or literature there, at last discharges its thunderbolt at the name they have set up to smite. Then the sky clears up and science smiles serene. Two dozen addresses in the volume before us radiate their benignant illumination on scientific education. And the system, as summed up by the professor, stands forth illumined in this guise:

First, object-lessons for the child, as the means of developing a faculty of observation, by getting into the mind a set of facts from without. Then mathematics, not as a mental discipline, but as a mere key to "universal science;" or else physics, which cultivates the reasoning faculty to the practice of broad inductions, including "generalizations, by which wide-reaching principles replace or

represent an infinitude of details"; or else chemistry, which, with physics, not only cultivates in the child the faculty of wide inductions, but also, like physics and mathematics together, "affords a discipline in deductive reasoning." Then we pass on to the study of the biological sciences, botany, zoology, physiology, geology. Here the theorist becomes eloquent, and glows with his subject. For here we have passed out of the range of exact sciences and have entered on the inexact. Experiment or active observation, which played so important a part in physics and chemistry, and enabled a broad inductive mind to "compel a revelation of nature's secrets," is now greatly limited, and "sources of error become more numerous and fallacies more insidious," and hence "a subtler exercise of the reason is demanded—more circumspection in weighing evidence and checking conclusions, and a severer necessity for suspension of judgment." Thus, "reasoning from analogy is practiced, a powerful but perilous mode of proceeding; one which we are compelled constantly to adopt in our mental treatment of the concerns of life, and for which biological studies are eminently suited to give the requisite discipline. Another advantage of these studies is the comprehensiveness of their classifications." To meet the manifold emergencies of our social experience, we need "such a training in the fundamental organic sciences as shall constitute a thorough biological discipline."

This is a true liberal education for the boy's mind, which is now rendered able to cope with higher studies. "The discipline and the knowledge conferred by study of the preceding group of sciences form the true preparation for that higher class of studies, mental, moral, political, and literary, which completes the course of a true, liberal education." "Physiology passes insensibly into psychology, the central science, upon which hinge logic, sociology, political economy, history, ethics, æsthetics, and literature."

In all this vast scheme of science, proposed as a pedagogical training for the young, there is no overloading of the mind, because "the student is not expected to grasp the details of the various sciences, but only to master their leading principles. At least one science, however, should be thoroughly acquired by every well-educated person—should be carried into detail, pursued experimentally, and pushed to its boundaries." That is to say, in a somewhat different sense from what Leo XIII. means, every well-educated person should be a chemist, or physiologist, or physicist, or the like. Secondly, "this scheme is not too extended, because its arrangement economizes mental power in the highest degree." This is an interesting statement; for it means that the mental discipline afforded is copious and well conceived. He explains it, therefore: "Wasting no force for mere discipline, it gives

the entire energies of the mind to the direct attainment of knowledge." That is to say, it affords no mental discipline whatever, but merely busies itself with heaping up facts in the mind.

And what about language in all this? Ah! that is only a vehicle of thought, a mere tool. And, "the sensible mechanic remembers that his tools are for nothing but use, and hence spends the least possible time in grinding and polishing them." That is true, when the man has the tools and is using them. But how is the young scholar to get his tools, this vehicle of thought, this art of arts, this power of expression, which reacts so logically and artistically on the development of thought itself, that a finished style is considered to be the accomplished expression of a finished mind? Not a word in reply except this piece of vagueness: "So much of the study of languages, and in such forms as are necessary to its intelligent use, is demanded in education; but, while this places the study upon explicit grounds of utility, by the principle of utility should it be limited." Hence, the student is to get it where he can; but, above all things, he is to use it; for it does really seem that this Professor acknowledges language to be somehow useful and necessary. But that is only a by-play. It is nature that educates—chemistry and biology. And he indulges in the usual hopes: "When nature becomes the subject of study, the love of nature its stimulus, and the order of nature its guide, then will results in education rival the achievements in science in the fields of its noblest triumphs." And so forth. His own achievement he entitles, "Mental Discipline in Education."

II.

After this sample of the results of scientific education on a modern mind, we proceed in the next place to a much wider field, and mean to exhibit the outcome of such pedagogics in popular education. This we shall do with the help of another modern mind, that of the President of Harvard, who has unbosomed himself recently in the *Forum* on the topic, "Wherein Popular Education has Failed."¹ But, as the intellectual lineaments of these and other pedagogical authorities favor one another somewhat remarkably, we pause a moment to characterize the family likeness, which belongs to the school of science, exact and inexact.

The true notion of science is the knowledge of things by their causes or principles. Thus, leaving philosophy and logic aside, which treat of the ultimate principles of all things mental and physical, we observe that mathematics is the only perfect science, because from a few self-evident axioms regarding quantity it de-

¹ *Forum*, December, 1892.

duces by perfectly rational steps an endless number of relations and properties affecting all forms of quantity. Every step is perfectly intelligible to the reasoning mind. No person can demonstrate a proposition of Euclid without the most perspicuous use of deductive reasoning, otherwise called the syllogism; and every one can perform a few of the simpler demonstrations in plane geometry. It is only when processes are gone through which have been elaborated by others, with methods and terms and formulas to be applied according to definite set rules, that mathematics loses its character of a true science, at least for pedagogical purposes, and becomes a mere art. Thus, arithmetic, as learnt and practiced, thus algebra, and all the higher forms of geometry, are applied as technical arts. A few principles underlying them are more or less understood; a formula, which issues forth at the end, is "interpreted"; but all between the beginning and the end is a matter of practice, adroitness, and patience.

These are also called exact sciences, because they deal with abstract relations which the various notions of quantity include in themselves, without application to any subject-matter. The moment a relation of quantity is considered in some definite matter—as by astronomy, in the stars and planets; by physics, in the attributes of matter, such as heat and light; by chemistry, in the combination of elements that go to make up bodies—the mathematical calculation is liable to error, since there is introduced a question of fact. And fact depends upon fallible observation. Still, astronomy and physics generally are sufficiently accurate to merit the title of exact sciences. But chemistry is scarcely a science at all; it has no general principles to fall back on, either deductive or inductive; that is to say, it never deduces anything from a general principle set down, and it never discovers by induction from facts any premises which it can use as principles, except in the partial, limited processes, by which it finds out the definite properties of some definite element; and, having tabulated them, thenceforth it uses its table.

To be sure, chemists endeavor to cure the radical vice of their craft by going behind what they observe and talking about the ultimate constituents of matter—atoms and forces. But in this they are no longer chemists; they are playing at metaphysics, and a sorry figure they make of it. "Physics, beware of metaphysics!" cried Newton. But all in vain. There would be only a moderate amount of chemistry to-day in the world, there would be little biology, and absolutely no theory of evolution, were it not for the unquenchable thirst of mankind to drink at the springs of metaphysics and satisfy a burning desire regarding their origin and destiny, in a certain philosophical way of their own.

As to all the forms of biology, they are utterly unscientific, outside of some mathematical calculations, and some other chemical processes, which are so far scientific as chemistry itself is, and no more. Biologists understand nothing whatever about life in the organic body or life in the organic cell. Chemistry itself enters into a cloud of enigma when it mixes with life in the protoplasm. The biological chemist falls back on explanations which do not belong to his specialty, and he becomes, as usual, a metaphysician; and neither metaphysics nor biology derives profit from the performance.

When economical or social science is touched there is still a minute point of contact with science properly so called. It is because all things material—even men, who have material bodies—present a side of their being to the calculations of mathematics. They can be counted, weighed, measured. Their births and their deaths, their external acts and vicissitudes, all lend themselves to calculation; and as men are uniform in their nature, if conditions also are uniform, or are reduced in any given social problem to some common denomination, which can furnish a basis to a mathematical calculation, of course an arithmetical or algebraic reckoning can be set up. Thus, a life insurance company exploits the statistical tables of mortality, and reckons its chances. And all the science that is to be found in political or social economy is just the amount which serves the purposes of the calculating clerks in an insurance office or a secretary in the Bureau of the Interior.

For drawing out the mind of the young and enabling it to put two and two together with logical accuracy, the science of plane geometry according to the method of Euclid has always held a place of high honor. That method uses no technical formulas or algebraic processes, but argues from plain principles, by plain steps, to evident conclusions. It is the perfect demonstrative method of the logical syllogism, and it avails itself of other forms of logical argument which are reducible to the syllogism. Hence, for the admirable discipline which it furnishes in the way of accurate thought, no pupils of either sex need be dispensed from performing a few of the simpler demonstrations. The train of reasoning here is called "deductive," because it advances from premises which implicitly contain the inference to the inference which stands out distinct from the premises. And the principles or premises themselves are already in the child's mind, as, for instance, the notion of a line, an angle, a triangle. So that this form of mathematics satisfies the requirements of education, which means "drawing out" the faculties by the strength which is native to them and on subject-matter which is more or less domesticated with them.

Carried too far, it is notorious that mathematical methods exert a cramping influence on the mind. They do not include any elements of positive fact, and they are prone to engender a contempt for the slow and uncertain observation or "induction" of facts. Facts are extremely variable; where the factor of life intervenes, as in all biology, they are dim in their outline; and if free-will interposes, as in all science pertaining to ethical and social life, the facts themselves are positively uncertain. Still, these same ethical and social phenomena are the most interesting and important affairs in the universe. Here the mathematical bent plays havoc with all problems. It must needs lay down its axioms and its definitions, its postulates and its principles; it must construct its geometrical plans, and if any mortal men or methods, any histories of human kind or political forms of government do not fit into the plan, so much the worse for them. Pascal, himself an eminent mathematician, remarks: "It is rare that mathematicians are observant, or that observant minds are mathematical, because mathematicians would treat matters of observation by rule of mathematics, and they make themselves ridiculous by attempting to commence with definitions and principles."

To this is added another inconvenience, which has much to do with bringing about the present disorganized state of society, moral and political. Entering with his mathematical qualifications into the field of philosophical, social, and political problems, the mathematician must adopt some positive premises or other, on which his mathematical mill is to work. Now, it is a matter of the veriest chance what premises or principles he will adopt; for he is lacking in the acumen which other studies impart to the mind for discerning the value of complicated phenomena, historical data, philosophical truths, religious principles, or, as in the case before us, the factors of true education. In his helplessness, he accepts, passively, the principles floating about in the air, or the suggestions whispered to him by his passions. As Dugald Stewart has observed, "In the course of my own experience, I have not met with a mere mathematician who was not credulous to a fault; credulous not only with respect to human testimony, but credulous also in matters of opinion; and prone, on all subjects which he had not carefully studied, to repose too much faith in illustrations and consecrated names."¹ Then, his premises being taken, though at hap-hazard, his mill begins to work. Never does it grind more pitilessly than when the mathematical faculty has been highly cultivated by the sublime forms of analysis. And it grinds exquisitely. A scientific writer tells us, with some complacency,

¹ *Youmans*, Introduction, p. 12, note.

that "mathematical analysis is often compared to a mill; throw in the wheat and you will get flour; granaries might groan with the richest harvests without helping much the stomachs of men, if the grain could not be turned into flour."¹

Now, we just remarked that this mathematical bent had much to do with bringing about the revolutionary state of society which marks the present century. Given the principles of the Revolution, the geometrical spirit accorded perfectly with the tendencies of men who delighted in abstract generalities, and in figures without substance, and who wanted nothing less than the substance of things that were, the facts which constituted society as it was, the traditions which had built it up, and the forms of education which had been handed down by Christian practice and antecedent. The ascendancy of mathematical philosophers over the movements preparatory to the great revolution is an unquestioned fact in history. The Voltairian encyclopædists took their philosophy from the times, and repaid it by bringing their geometry into everything. Mathematical chemists, in particular, seem to have been irrepressible then, as they are dominant now. D'Alembert would have it, that, "if geometry were taught to children betimes, he doubted not but that prodigies, and precocious talents of this kind (that is, of his own kind), would be more frequent." The mathematical chemists, who posed as statesmen in the *Corps Legislatif*, proposed that the young generations, now belonging to the revolution, should be brought up on problems of algebra and the nomenclatures of plants and animals. For this advance, however, the times were not yet ripe; and the inventors of the new pedagogics themselves dropped the project for awhile. Chaptal, who was put in charge of the new device, called "Public Instruction," by the Consul Napoleon, laid it down, that "anatomy and physiology ought to be the *basis* of all education; and, if such had been the line of march in the ages which have gone before us, we should never have seen unbridled imaginations create imaginary worlds (of religion and God), and substitute phantoms for realities. . . . The resemblance between our physical structure and the greater part of the beings of nature, marks well enough our place (the same as Professor Huxley's conception of "Man's Place in Nature"); and shows us what we ought to think of those prerogatives (of spirituality, immortality, and morality), which the delirium of ignorant pride has attributed to the human species," etc.²

¹ Moutier, "La Thermodynamique," *Revue des Questions Scientifique*, t. xx., p. 188, "L'Application de l'Analyse Mathématique aux autres Sciences," par Franc. Iniguez.

² *De L'Université Nouvelle, Fille Aînée de la Révolution*. 1828. "Documents Concernant la Comp. de Jesus," tome iii., p. 25.

Progress, arrested awhile, in those days of simplicity, was not to be balked in the long run, nor has it been; and the plans proposed by such mathematicians, or chemists, or constitutional bishops, or madmen, as D'Alembert and Bancal, Talleyrand and Grégoire, Lepelletier and Robespierre, have worked their way steadily amid revolutionized generations, until "classical and literary studies giving way to scientific courses, then scientific courses to industrial applications, there has been a steady movement from the compass to the plough, from mathematics to industrial arts, from the sciences themselves to the brute matter which they merely number and measure. . . . As abstract sciences, geometry and algebra, when they are taken as the exclusive means of culture, make men forget the Gospel and morality, revelation and history; as sciences applied, they make men think only of matter."¹

This spirit is little, and it is irreligious, and, because irreligious, it sinks into the differential category of the infinitesimally little. Shut up in its formulas from first to last, the moment its credulity takes infidelity into its calculations as one of the blindest of its formulas, its mill goes on grinding and grinding long after the last particle of logic or sense has passed through; and, when a century has run its course, the product is indescribable.

It is not the true scientific spirit that is irreligious. All the great founders of modern science have been most religiously-minded in their own way. Galileo, the father of modern mechanics; Copernicus, Kepler, and Newton, the prominent figures in the science of astronomy; Boyle and Pascal, the active spirits in developing hydrostatics, have all been led, in their search for God's laws impressed on nature, to bow with increased reverence before the divine wisdom which invented and impressed such laws.² These were inductive minds, gifted with the talent of finding out nature. And had Darwin set himself to find out nature in truth, there is little reason to fear that he would have died an atheist. But he set himself to find out a falsehood, and he got it, because he put it there.

Other minds which are not inductive in their bent, and which have not been refreshed, after a struggle through the twilight of their weak conceptions, with the sudden revelation, like a broad sunlight, of God's evident providence and His palpable presence, may rehearse the same inductive processes, as children can do, and feel none of that overpowering grasp of the Mightier Mind which lifted up the original discoverer to catch a glimpse of the

¹ P. Arsène Cahour, d. C. d. J., *Des Études Classiques et Des Études Professionnelles*, 1853, p. 25.

² Compare W. Whewell, *Astronomy and General Physics Compared with Reference to Natural Theology*, 1836, part iii., "Religious Views."

infinite. And, as to deductive processes, those which start with principles or formulas, and thenceforward merely turn them inside out and up and down, and create sciences of perfect truth, but all abstractions, their effect seems to be to create a craving for the formula everywhere, whether it can be had or not. Formulas that know nothing of shades and tints, of conditions, persons, and times, must be made to comprehend the science of life, society, politics, in all their varied and manifold relations, as if everything were on a plane of only two dimensions, or on a line of only one direction, or at a point which has neither length nor direction nor magnitude. Said Laplace: "An intelligence which, at a given instant, should know all the forces by which nature is urged, and the respective situation of the beings of which nature is composed, if moreover it were comprehensive enough to subject these data to calculation, would include in the *same formula* the movements of the large bodies of the universe and those of the smallest atom." So far correct. He adds: "Nothing would be uncertain to such an intelligence, and the future not less than the past would be present to its eyes"—a statement which requires modification if free will is included. But a formula knows of no such modification, and the little mind will not tolerate adjustment. Hence, when this same mathematician was appointed by Napoleon to the Ministry of the Interior, he gave no satisfaction. "He searched for subtleties in every subject," wrote the emperor in his personal memoirs; "he carried into his official duties the spirit of infinitesimally small quantities; he apprehended no question under its proper point of view."

We have seen that the mathematical or "scientific" bent is, of itself, a narrow and mechanical turn of mind; it disqualifies for liberal views of life, and for the sciences which treat of human affairs. We have added the important consideration that, as it takes its principles somewhere, and then only rigidly applies them and deduces consequences from them, if the principles are wrong, like that of infidelity, or revolution, or socialism, or anything similarly perverse, it will need only time and opportunity for all kinds of perverse conclusions to establish themselves in the mind and to propagate themselves around in the mass of society. We add here only one further consideration as bearing, in particular, on the subject of theoretic education or pedagogics. It is that, among the false principles thus assumed, one which stands conspicuous is the idea of utility which aims at ready results, at products ready-made, like manufactured articles; which fights shy of thorough mental discipline because that takes time, and produces its fruits only at a remoter period in the training of developed faculties; and which, finally, in the spirit of envy at the splendid results

of a truly developing or liberal education, does not scruple to appropriate the name of "liberal" to itself, and so gloss over the narrowing, belittling, and slipshod processes of its own utilitarian instruction.

We could quote at length illustrations of this utilitarian fallacy from the Introduction of Prof. Youmans, whose plea we considered awhile ago. But, as we go on now to President Eliot, we quote from the former only a passage or two. He says: "In the world of business, where results become quickly apparent, and wrong policy works speedy disaster, the notion of discipline *for* a special activity, and not *through* it, could not be entertained, and it only lingers in the world of education because the effects are more remote, complex, and indefinite." This means that every child should be worked as an apprentice from the first in the line of activity which he is to follow in after-life—"discipline *through* a special activity"; and he need not have his faculties developed all round to make him a qualified man, whatever his future line of life may happen to be; this he calls "discipline *for* a special activity." The reason he gives is worthy of his school. It is, that when a man is already a man, and has his business in hand, there is no question any longer of developing his faculties all round; he had better mind his business. Therefore the child, who is yet in the formative process, whence are to issue results in the future, "more remote, complex, and indefinite," should also mind some business, though he has none yet, and should leave education alone, as if he had got it already. He is to be put up quickly, like a ready-made article, duly packed and addressed. He is on the same footing as the ten-year-old boy working in the coal-mine, and using up a constitution which he has not yet acquired. That is the utilitarian principle of education.

We may also give an illustration of the infidel tendency in the American chemist's mind. Mathematician as he is, he decries pure mathematics, in the same breath with which he berates literature and grammar. Both mathematics and grammar, he says, "begin with the unquestioning acceptance of data—axioms, definitions, rules; both reason deductively from foregone assumptions, and therefore both habituate to the passive acceptance of authority—the highest mental desideratum in the theological ages and establishments, which gave rise to the traditional curriculum." This is very interesting. A scientific man runs down the purest form of science, because the scientific habit of mind which it engenders is precisely in accordance with theology, religion, and faith! A splendid testimony from the infidel!

We may add another passage, to show the breadth of mind, and accuracy of historical lore, which graces the utilitarian and infidel

mind of an analytical chemist. He dismisses the traditional system of liberal culture, because it comes down from ancient times, when it was summed up in the Trivium and Quadrivium, as they were called; that is to say, grammar, logic, and rhetoric, arithmetic, geometry, astronomy, and music—making seven branches or arts in all. And he delivers his argument thus: “The predominant culture of modern times had its origin, more than eight hundred years ago, in a superstition of the middle ages. A mystical reverence was attached to the number *seven*, which was supposed to be a key to the order of the universe. That there were seven cardinal virtues (!), seven deadly sins, seven sacraments, seven days in the week, seven metals, seven planets, and seven apertures in a man’s head, was believed to afford sufficient reason for making the course of liberal study consist of seven arts, and occupy seven years.” The gentleman seems to be talking seriously.

At all events, he is terribly in earnest, when he despatches all intuitive processes of the scientific mind, and cries out: “The primary question is, What are the facts, the pertinent facts, and all the facts which bear upon the inquiry? This is the supreme step; for, until this is done, reasoning is futile; and it may be added that, when this is done, the formation of conclusions is a comparatively simple process.” Whereupon he performs the extremely simple process of requiring the facts of biology as the true discipline of the mind in education, without paying much attention to the facts of the question, or entangling himself in superfluous reasoning.

III.

Eleven years later than the publication of Prof. Youmans’ pre-tentious claims, President Eliot of Harvard has come forward to examine results. His verdict is sufficiently intimated in the title of his article, “Wherein Popular Education Has Failed.” According to his presentation, it seems to have failed utterly. And this is the more noteworthy as coming from one, who by the weight of his authority and the activity of his pen has been a power for many years in the cause of utilitarian education. Yet, not to be too sombre in his view of the situation, he sets it off with a couple of relieving features. One is the possibility that certain agreeable facts in our present state of society may be in part due to popular education, as now carried on. The other is the conviction which he expresses, that, if the means are adopted which he proposes for the improvement of such education, an amelioration may follow in the results. It so happens that the means which he suggests are not substantially different from the principles in actual opera-

tion. Still he concludes hopefully, in the usual style: "Such are some of the measures which we may reasonably hope will make popular education in the future more successful than it has been in the past in developing universal reasonableness."¹ Universal reasonableness! The tone is certainly modest. It is no longer a glorious sunshine of intellectual results, but a bit of common reasonableness that will be thankfully received!

The eminent president, himself a chemist, reviews in several gloomy pages all the expectations that had been entertained regarding the fruits of popular education; and all of which have been frustrated. "Public education should mean the systematic training of all children for the duties of life; and it seems as if this systematic training could work almost a revolution in human society in two or three generations, if wisely and faithfully conducted. Why has it not? It seems to provide directly for a general increase of power to reason and, therefore, of actual reasonableness in the conduct of life. Why is it possible to doubt whether any appreciable gain has thus far been made in these respects?" "Disquieting questions," as he calls them!

Still he claims that the "indictments against universal education as a cure for ancient wrongs and evils leave out of sight great improvements in social condition which the last two generations have seen." Accordingly, he tabulates a number of "beneficent changes" regarding the mitigation of human miseries in prisons and elsewhere; the formation of habits of industry by savings-banks and the like; improvement in the condition of wage-earners, touching their income, lodging, food, clothing, "and the means of education for their children." By-the-way, it is hard to see how this last is a "beneficent change" if "popular education has failed." He notes how superstitions have been abolished, and civil order extended over regions once desolate or dangerous; how family and school discipline have been mitigated within two generations, "and how all sorts of abuses and cruelties are checked and prevented (?) by the publicity of modern life, a publicity which depends on the universal capacity to read." So that the villainies perpetrated by the press, promulgated and communicated to simple populations, are among the "beneficent changes" of the time! He recalls that all business now-a-days is conducted on trust and mutual confidence, which is protected by the "publicity" of the press; that the United States have spread across a continent, that Italy has been made one nation, etc.; that the different classes of society and the different nations have lately made some approach towards realizing the general truth of the New Testament saying:

¹ *The Forum*, December, 1892.

"We are members one of another." He adds, conscientiously: "It would not be just to contend that popular education has brought to pass all these improvements and ameliorations." No, it would not be just, at all; for popular education seems to have had nothing to do with any, except those among the "improvements," which are decidedly mischievous. Still, he goes on apologetically: "It has undoubtedly contributed to them all." That we should like to see proved, not assumed; for some perverse minds might assume the very opposite and prove it.

So far there is nothing that has a real bearing on the science of education. But at last, after the weary platitudes, we light upon two sentences that touch education—that prove, as he says, "increased intelligence in large masses of people." This is what we want, and thus it reads: "If war has not ceased, soldiers are certainly more intelligent than they used to be, else they could not use the arms of precision with which armies are now supplied. The same is true of all industry and trade—they require more intelligence than formerly in all the work-people."

Not being gifted with a chemical mind ourselves, we find this astounding. To sight a rifle and pull a trigger argues greater intelligence, because the rifle is more precise than it used to be, and its maker, no doubt, must have been more intelligent! To work a crank, or grease a rod, for ten mortal hours a day, and to become a living automaton in some big automatic machine, shows greater intelligence than formerly, though it is always the identical pin-head or ground-button, or bit of some other machine that the two automata, the living and the dead one, are turning out by the thousands per week!

As this passes our own intelligence we refer for light to a great authority. And we find a just principle stated.¹ "The perfection of the mechanical and other arts among us," says Whewell, "proves the advanced condition of our sciences, only in so far as these arts have been perfected by the application of some great truth, with a clear insight into its nature. . . . But what distinct theoretical principle is illustrated by the beautiful manufactures of porcelain, or steel, or glass? A chemical view of these compounds, which would explain the conditions of success and failure in their manufacture, would be of great value in art; and it would also be a novelty in chemical theory; so little is the present condition of these processes a triumph of science, shedding intellectual glory on our age!" It is, indeed, notorious, that the advance of science, even in those who advance it, has little to do with science, and a

¹ Whewell, *History of the Inductive Sciences*, vol. i, p. 242: *Physical Science in the Middle Ages*, ch. 5.

great deal to do with a happy knack of invention or manipulation. What, then, have the poor workmen to do with science or scientific "general intelligence," when they only work the blow-pipes or trim the products?

And, if invention and manipulation do manifest "general intelligence," what shall we say of former ages which had none of the mechanical conveniences of our time, not even coal? Whewell sums up some of them:¹ "Parchment and paper, printing and engraving, improved glass and steel, gunpowder, clocks, telescopes, the mariner's compass, the reformed calendar, the decimal notation, algebra, trigonometry, chemistry, counterpoint, an invention equivalent to a new creation of music—these are all possessions which we inherit from that which has been so disparagingly termed the Stationary Period. Above all, let us look at the monuments of architecture of this period; the admiration and the despair of modern architects, not only for their beauty, but for the skill disclosed in their construction."

Hence, President Eliot has not succeeded in pointing to a single beneficent result of popular education. So, making the best of the case as it stands, "he thinks he perceives in popular education, as generally conducted until recently, an inadequacy and a misdirection which supply a partial answer to these disquieting questions."

His critical strictures fall chiefly on the new system of education—that advocated so gloriously by Professor Youmans—only the system has not been properly worked. Therefore he suggests improvements, and the principles he starts from are almost identical with those of the professor, while his "improvements" are identical with the measures which have actually failed. Of course, it cannot be otherwise when principles and measures are astray.

We need not rehearse his somewhat lengthy arraignment of the prevalent system and his decidedly hackneyed improvements. Still, there are some good things that he says. Speaking of the higher class of schools, he remarks that "among the subjects other than languages there will generally be found several which seem to be taught for the purpose of giving information rather than of imparting power. Such are the common high-school and academy topics in history, natural history, psychology, astronomy, political economy, civil government, mechanics, constitutional law and commercial law. These subjects, as they are now taught, seldom train any power but that of memory. As a rule, the feebler a high school or academy is, the more these information-subjects figure in its programme, and when a strong school offers sev-

¹ *Ibid.*, p. 239.

eral distinct courses, the shorter and weaker courses are sure to exhibit an undue number of these subjects. . . . The pupil is practically required to commit to memory a primer or a small elementary manual for the sake of the information it contains. There can be no training of the reason in such a process." This is perfectly true, and if educational authorities would ponder over this reflection, they would make two applications of the wisdom which it contains. First, they would take notice that all scientific education, as it is actually carried on, goes precisely on these lines, all mere information of facts heaped in from without; and that it cannot ever be otherwise as a means of education for the young; that it does not educate or draw out the faculties, but sets up a show-window to catch the eye of examiners, and, like a show-window, it is for no other use but to catch the eye. Secondly, our Catholic pedagogical authorities would take note of the uniform simplicity which has characterized all Catholic systems of education up to late years; they would note that whether in primary schools or in academies or in colleges, there has been uniformly a central line of studies to follow, straight, thorough and complete, to which other subjects were merely secondary and subsidiary; and that the central line has not been a flimsy tissue of so-called science. Such is still the system in Catholic institutions, where traditional wisdom survives, and where the profound knowledge of a child's needs, so well apprehended by Catholic wisdom and instincts, has not been spirited out of sight by the phantom or nightmare called competition.

The president discerns the same unsatisfactory results in the lowest grades of schools, with their reading, spelling, writing, geography and arithmetic; but he does not commit the intellectual absurdity of implying that such practical arts can be held up as, in any sense, an intellectual culture of mankind.

Thus, the lowest stratum of studies being quite incompetent to develop mental capacities, and the middle stage being out of order, he mounts to the highest series, and "finds the same condition of things in most American institutions. The cultivation of memory predominates: that of the observing, inferring and reasoning faculties is subordinated." Yet, as we may remember, this power of observation, inference and reason, is the very fruit so fondly anticipated of scientific education. "No amount of *memoriter* study of languages or of the natural sciences, and no attainment in arithmetic, will protect a man or woman, except imperfectly, through a certain indirect cultivation of general intelligence, from succumbing to the first plausible delusion or sophism he or she may encounter." He then gives examples of the delusions which run riot in our times and country. They are instructive as indi-

cating the trend of thought which these pedagogical authorities are indulging in, while we suppose them, and they suppose themselves, to be treating of education for the young. He adduces the sophisms of astrology, theosophy, free silver, strikes, boycotts, persecutions of Jews and Mormons, the violent exclusion of non-union men from employment. He refers to paper money and national wealth, to American wages and English wages, to Bessemer steel and public debts. He says: "The publication made in 1891 by the Commissioner of Labor at Washington, concerning the cost of producing iron and steel, is the first real attempt to determine the facts upon which the theory of a single group of important items in our tariff might have been based. This admirable production is a volume of 1400 pages—mostly statistical tables." This is the kind of atmosphere in which the thought of our educational authorities moves when they do not confine themselves, as true mathematicians and chemists should do, to their own province of algebraic formulas and biological analyses. And from this unreal and hazy mist of thought they descend to legislate about education. However, the admissions, at least, of a candid mind like that of the president's are useful: "There are many educated people who have little better protection against delusions and sophisms than the uneducated, for the simple reason that their education, though prolonged and elaborated, was still not of a kind to train their judgment and reasoning powers."

Such is the outcome of the new pedagogics. But the dismal spectacle does not arrest the progress of the pedagogical scientists. They plod on their own way, they work the machine, and are ever turning out new projects. To quote one sentence more from the President of Harvard: "In the higher part of the system of public instruction two difficult subjects deserve a much larger share of attention than they now obtain—political economy and sociology. They should be studied, however, not as information-subjects, but as training or disciplinary subjects," etc. On which we remark, that matters pertaining to politics and statesmanship are subjects for mature educated minds, and can neither train, nor drill, nor discipline, nor draw out any faculties whatever of a young mind, but can only fill them with odds and ends of numbers from census reports, as foreign to education as the "1400 pages of the admirable publication of the Commissioner of Labor at Washington on the cost of producing iron and steel." And further we remark, quoting a profound reflection of the same eminent gentleman of Harvard: "These subjects seldom train any power but that of memory. As a rule, the feebler any system is the more these information-subjects figure in its programme." This "scientific" system labors under a feebleness which belongs to the last degree of atrophy—

feeble in reason, feeble in logic, feeble in its intuition as to the constitution of the young mind and character, and therefore abounding in subjects for its programmes, in programmes for its theories, and in theories that shoot up like the weeds of spring under the glorious sun of scientific enlightenment.

IV.

It might be expected, after this critical and somewhat negative analysis of scientific methods, that we should present a constructive view of sound education, and lead up steadily from first principles and first stages in the instruction of the young to that ideal of scientific excellence which Leo XIII., whom we quoted at the beginning, desires to see conspicuous and effective in the ranks of Christ's faithful. But that would be another subject, for its basis is literature. Besides, there is not room for it on the present occasion; nor from our point of view is it necessary, since, on a former occasion, we endeavored to expound in this REVIEW the traditional principles of sound education.¹ Then it was the same President of Harvard who, in the controversy on liberal education, advocating, as is usual with him, the scientific claims, provoked or intensified the public discussion of that date. We have nothing to add now to what we said then. But the literature of the subject has received since then important accessions from the treasury of practical results in Germany, Austria, France, England, Ireland, and the results furnish no subject for congratulation.²

On this literary issue we can discover no contributions whatever to either pedagogical principle or pedagogical practice from the scientific school. Beyond those declamations of Prof. Youmans against the traditional method of culture, and besides those very logical sallies of his against the seven liberal arts which have been handed down to us only because the number seven was sacred and sacramental in the benighted Middle Ages, all that we can discover in the treatises of either president or professor on the subject of literary formation amounts to this :

Language is necessary; use it, therefore. Style, to be perfect, requires a power of observation, such as Tennyson shows; write, therefore, like Tennyson.³ Scientific conscientiousness, the scrupulously accurate statement of facts observed, is as good a training of the conscience as secular education can furnish; ⁴ therefore, vivid

¹ "What is a Liberal Education?" AMERICAN CATHOLIC QUARTERLY REVIEW, January, 1885, vol. x., pp. 18-35.

² Compare Rev. John Gerard, S. J., on "Education and School"; *The Month*, 1886, vol. lvi, pp. 163-179, 353-363.

³ Eliot, *Forum*, p. 420.

⁴ *Ib.*, p. 419.

and accurate records of all things observed, seen, felt, done, suffered, should be made by the child; and this, for the benefit of the community, as well as for its own benefit, when the time arrives for it to be a scientist. But, as no power of description is of use without the reasoning faculty, this faculty, as exercised in "argumentative composition," is to be cultivated assiduously. For the rest, "in cultivating any field of knowledge, this power of expression can be won if the right means are used; and, if these means are neglected, it will not be won in any field."¹

This is, no doubt, a singularly profound treatment of the literary question in liberal education. But a writer of the University of Wisconsin, who comes to the assistance of the president of Harvard, takes the palm for literary acumen and criticism from even so eminent a colleague.² He says, that the mental processes involved in translating a paragraph from Cicero correctly, "are hardly more numerous or more important, from a practical point of view, than those employed in putting together a *Chinese puzzle*." In the hands of this volunteer, the whole science and art of education becomes a most curious tissue of kindergarten practices, debating-club methods, magazine references, and thumbing of census reports, of the back records of law courts, of Whewell's "History of the Inductive Sciences," and of theories on the "Nibelungenlied." This course of his "would take its place in the school and college curriculum by the side of the natural and the mental sciences, history, literature, and the languages. It would not crowd the others out." Why? First, because it is indispensable. Secondly, because it is supplementary. Thirdly, because it develops "other functions of the mind equally important in their way, for instance, the power of observation, and, above all, the *emotions!*" But, especially, it would not crowd the others out, because, "whatever else might have to be neglected or dropped from the curriculum, for want of time, its claims should be honored to their full extent"; that is, *because it should crowd the others out!*³ And this contributor to the *Educational Review* entitles his lucubration, "Teaching Reasoning as a Fine Art." Surely, it has become a fine art—if by fine we mean rare. But we trust that Catholic education, whether in universities or academies, will never sink so low as to give to the light of publicity, on a serious subject, contributions so ill-written, with a style so puerile, and reasoning so inept, as we have seen are to be credited to some prominent institutions and publications.

We have no reason to believe that Catholic institutions of edu-

¹ *Ib.*, p. 419.

² *Educational Review*, December, 1893, p. 494. "Teaching Reasoning as a Fine Art."

³ *Ib.*, p. 497.

cation, which are now grown to be such a power in numbers, resources, and repute for moral training, have fallen away in pedagogical instinct and wisdom from what they were forty years ago. At that time, Dr. Henry Barnard, speaking of one class of our schools, could risk his reputation and authority before a Protestant public by saying in his "Journal of Education",¹ "The only way, in our country and in this age, to 'put down' such schools, which have their roots in the past, and which have been matured, after profound study, by men who have made teaching the business of their life from a sense of religious duty, is to multiply institutions of a better quality, and bring them within the reach of poor but talented children." What he said of one class of schools, we say of all; that the Catholic instincts and traditions, which are their life, have roots in the past, and have matured amid all the graces of charity, self-sacrifice, and duty. And, at the time when he wrote thus, old and wise traditions had not yet vanished from the educational institutions of the country at large. Now, we may say, all is gone. And, as in so many other affairs, the light and warmth and invigorating influences of the Christian spirit have steadily lessened their sphere of activity in the world at large, and have shrunk back within the strict limits of the Catholic Church and her institutions alone.

Hence, in the practical conduct of education, no doubt "information-courses" are pleasant and useful, but only as a variety and a dessert to the central and solid course, which, according to their degree, must be served up as the mental diet of the young. In the higher institutions of learning, which prepare the mind in a liberal way for all subsequent studies and specialties, the teaching of the sciences must remain within the limits of what is essential to them, so far as their processes are intelligent and liberalizing, not so far as to become technical and specializing. "Initiation into scientific methods, in which consists the educating value of the sciences, does not demand all the sciences; it can be effected by a few well-chosen specimens; it depends much more on its quality than on the quantity of matter conveyed. In the sciences, as in letters, the amassing of knowledge is not an end in itself; it is the means of education." Such are the words of a government professor of mathematics, drawing up the report of a scientific committee of studies appointed by the French republic.²

If the mania for competing with some vague phantom of a state system of public instruction only served to intensify the quality of

¹ *The American Journal of Education*, June, 1858, vol. v., p. 228. "The Jesuits and their Schools."

² "Réformes Scolaires," by Le R. P. De Gabriac, in the *Études*, Avril, 1890, t. 49, p. 582.

educational work in Catholic institutions, it would be serving as a spice which whets the appetite. But we may inquire whether the words of Prof. Mahaffy, in his government report on the Irish Endowed Schools, have no application to what is visible about us:¹ "It appeared to me all over Ireland, and in England also, that the majority of boys, without being overworked, *were addled by the multiplicity of their subjects*, and, instead of increasing their knowledge, had utterly confused it. I heard everywhere from the masters the same complaint. Whenever I asked them to point me out a brilliant boy, they replied that the race had died out; that brilliant boys could no longer be found. . . . I sought in vain for bright promise, for quick intelligence, for keen sympathy with their studies. It is the result of the present boa-constrictor system of competitive examination which is strangling our youth in its fatal embrace."

We have nothing to learn from such a system except to avoid it. Avoiding it, we hold fast to our traditional solidity, and, where nature has been benign, we develop youthful brilliancy. The initiation into scientific methods, as the French commissioner expressed *himself*, prepares the young mind, thus liberally treated, for the specialties which are to follow in practical and professional life. *And thus*, at the end, we reach the conception of Leo XIII., which *we quoted* on starting: "Those who are gifted with a happy talent for science can lend much assistance to religion, and turn the arms of *perverted* knowledge into weapons of defence."

THOMAS HUGHES, S. J.

¹ Gerard, *Month ubi supra*, p. 360.