

SCIENCE

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FRIDAY, MARCH 30, 1900.

EDUCATIONAL VALUES.*

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HISTORY is always an attractive subject because it appeals to our sympathies. There is not one of us who has not been spurred to effort by the hope of reward, intellectual, moral, social, or material. Every one has at times enjoyed the consciousness of success, or suffered the sting of failure. The history of the race is the collective history of individuals. Every individual can in imagination put himself into the place of the actors who have left strong impressions on the world and been enrolled among the makers of history.

The history of education appeals less strongly to our feelings than does the recital of deeds that determined or destroyed men's leadership in the control of their fellows. But all of us have a very real interest in some of the educational problems of the day. From some points of view it is fortunate, from others, unfortunate, that the consideration of these problems implies conflict. We have all heard about a conflict, which is said to be very sanguinary, between the advocates of scientific study and those of liberal culture. I must confess that in my earliest manhood I rushed into this affray with all the joy and enthusiasm and self-confidence that a young man feels when he knows that he must be inflicting hard blows upon the adversary,

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even if the adversary does not think them very hard. I had spent several years in mastering a certain amount of Latin, Greek, mathematics and a few other subjects of supposed minor importance. In regard to educational values my opinions were soon very decided; and the decision was by no means in favor of the curriculum through which I had been guided by my respected but mistaken friends, the professors. It is a familiar saying that "history repeats itself." Having stepped some years ago out of the young man's shoes into those of the professor, I am now at liberty to wonder how many students will go forth from this institution next summer, ready to prove that not only I myself, but all of my esteemed friends, my colleagues in this faculty, are old fogies.

The world cannot get along without young men. Perhaps it could, but it does not, get along without the old fogies. We have all heard of the man who was born tired. I have actually seen a good many men who were born old fogies, and who became superannuated before reaching middle age. I have seen others who had passed their three score years and ten without losing the passion for progress, the willingness to take in new ideas, the intellectual alertness of their youth. But certain it is that most of us need contact with young men to keep us from becoming too self-satisfied. The college professor has other duties besides pouring out knowledge and testing his students by written examinations. He must be tested by them; he must let them see that the reciprocity is not all on one side. As soon as he begins to think that he has nothing to learn from them, it becomes the proper time for him to step aside. They are his teachers so long as he retains the capacity to learn. They may make mistakes; but so does he. They are generally disposed to be progressive, if their independence has not been stifled by too great

success in acquiring the habit of depending upon authority. If there is any one characteristic by which the scientific education of to-day is conspicuously in contrast with the so-called liberal education of two generations ago, it is found in the modern inculcation of the duty to be independent and manly, to use authorities as means and not as ends, and to accept no authority whatever as beyond question.

Let us go back for a moment then into ancient history and inquire into the origin of the worship which some of us were taught to offer to the fair goddess of liberal culture, the worship of a name while the actual culture was anything but liberal. It is not my wish to criticise our own conditions here; for happily the Washington and Lee University of to-day is so different from the Washington College of our grandfathers that they would find themselves much puzzled, perhaps even shocked, if they could step forth from their graves and visit us. The idea with which they were saturated was that the chief end of all education was discipline, and that a certain small number of subjects were inherently better for discipline than all else that related to human interests. If the young man were drilled until he could memorize a Greek play, a Latin oration, and a chapter of calculus, he was conventionally the possessor of liberal culture. The allowance was, as we now believe, very illiberal; but it was all that he could get. There were three liberal professions, divinity, law, and medicine, one of which he must select, but not one of which involved any special application of what he had studied in college. Vicarious discipline was, therefore, the sacred means by which he was to attain his earthly salvation.

Such an idea of education was accepted quite generally and cheerfully, because it was traditional and therefore respectable. It had been usual not only during the pre-

vious generation but during a hundred generations. Among the ancient Greeks the body was educated by gymnastic exercises, but this was confined chiefly to the aristocracy; for useful labor, involving bodily exercise and hence muscular development, was looked upon as menial and degrading. Intellectual education was regarded from the same standpoint. It might be a badge of gentility, but to seek useful knowledge was no more an educational object than to learn useful arts. Intellectual gymnastics for its own sake was a source of pleasure. To regard it as a source of profit would be to degrade it. "Not the game, but the excitement of the chase; not the truth, but the exhilaration of its pursuit, were the mottoes of culture. Under these circumstances no vulgar question of economy could arise; mental power was ostentatiously wasted, and with the necessary consequences,—truth unsought was not found; the ends of culture being ignored, there was neither conquest of nature nor progress of society."

Such ideals have continued potent to the present day. In mediæval times they were cultivated in the monasteries. It was for the support of them that universities gradually became organized. They are still dominant at Oxford and Cambridge in England, and in the universities of Germany, France and Italy. Their great value is readily conceded. If they constituted all that could be included in modern education, they would still be worth preserving and fostering. Under such ideals were educated some of the greatest men whose labors have advanced physical science, such as Newton, Huyghens and Laplace. The craving of humanity for intellectual exercise without reference to bread winning is as natural as the craving for food, or bodily activity, or companionship, the love of home, of family, or of country. The love of literature, of art, of science for its own sake, is conspicu-

ously worthy of all commendation and encouragement. To know the best that has been thought and spoken and written, to appreciate the noblest and purest that the painter's brush has left upon canvas, to be capable of taking in the ideas and complex emotions that are conveyed in song and symphony, to apprehend the order and harmony that pervades a universe that is continually undergoing evolution in accordance with law—these are objects well worthy of our best efforts, irrespective of the remuneration that can be expressed in money or material power.

But the culture so eminently worthy of our seeking is not all that the world is justified in holding to be valuable. Why should such training be given in youth? It is not merely because the young are non-producers in society, but because they are more capable of modification than after maturity is reached. That the education to be given in youth should be a preparation for manhood is an idea that does not seem to have been well grasped by the educators in ancient or even comparatively recent times. Education was long reserved for the priesthood, rather than for the manhood of the people. Its underlying idea was the preservation of scholastic authority rather than the development of intellectual independence and moral power. It was intended to be a luxury for the few, while the masses were expected to keep on toiling in ignorance as had been done throughout untold centuries. The education of the English universities, even of this year 1900, is essentially aristocratic. Great stress is laid upon certain subjects, not because they afford the best culture, but because they are traditionally genteel, not because they confer power, but because they have long been fostered by the nobility. Even the army, officered by aristocrats who substituted gentility for military knowledge, has been this winter betraying its organic weak-

ness in South Africa; and the liberally educated English have yet (February 14, 1900) to herald their first victory over the despised Boers, after four months of disastrous grappling. They will in time be victorious, but not by the application of what they have been taught through genteel traditions.

The educational system of a country should be adjusted to the needs of the majority of its people, and not be controlled by the nobility, whether this term be applied to the aristocracy of inherited rank, as in England, or of wealth, as in America. As soon as the question of educational values arises, therefore, we must ask ourselves, with candor and with utter disregard of genteel traditions, what kinds of knowledge are best fitted to develop mental, moral, and material power in our young men, recognizing the conditions of civilization as they exist to-day in the most prosperous parts of America. We are not to decry liberal culture; but we are abundantly justified in criticising the traditional limitations which have restricted the name of liberal culture quite arbitrarily to a certain group of studies. What is the ground upon which these studies have been called liberal? It is that they are now, and have long been, genteel; that they do not aim to help their votaries to make money; that their object is to produce such intellectual and social polish as money can not buy; that the stored-up capital which they represent must not yield interest in money, but only in culture; it must be totally independent of all commercial values.

This ideal was almost completely fulfilled during the many centuries of its dominance up to the nineteenth century. But commerce is stronger than an ideal. Is literary culture to-day without its pecuniary rewards? Is fine art practiced purely for the purpose of expressing the beautiful? So far as activity is expended for the cultiva-

tion of the true, the beautiful, and the good, the culture is liberal. So soon as the results of such activity cease to be given freely to the world, and become devoted to the acquisition of money, the name liberal ceases to be applicable. There are hundreds of men and women whose interests in college were concentrated upon literature, classics and history, and who apply the results of the mental discipline thus acquired, and the knowledge thus stored up, directly to the money-making business of writing novels. There are thousands more who are well paid for contributing to the newspapers such fiction as is euphemistically called news. All of it is called literary work, and the writers receive the credit of dwelling in an atmosphere of liberal culture. Fortunes have been made by judicious response to the popular demand for light literature, and the liberal culture disseminated is directly proportional to the liberal payment laid down in silver and gold. On the other hand there is an increasing number of young men who annually come forth from American universities, and yet more from German universities, whose time has been devoted to studies that by contrast are called scientific. They spend time and labor in the pursuit of science for its own sake. The results of their investigations are published in journals for which the general public has no use; and they receive no compensation for such contributions except the satisfaction of making themselves and their work known to the so-called scientific world. Their inquiries relate to subjects which have no commercial importance, and their object is without pay to enlarge the boundaries of human knowledge. Their stimulus is the pleasure of discovery, of investigation, of successful intellectual activity. The recognition they receive is such as money cannot possibly buy.

Nor have these scientific investigators been confined to the present century. New-

ton's *Principia* marked an epoch in science. It brought no money to its author, though succeeding generations have built upon it the remunerative science of navigation. Huyghens, Young, and Fresnel established the wave theory of light, the foundation of the now useful science of optics. They gave the products of their labor freely to the world, living economically, and dying with very small possessions. Gauss and Weber established the modern science of magnetism, while Volta, Oerstedt, Ampere, Ohm, Faraday, Henry, and Maxwell worked together and in succession to make electricity an exact science. They received no pecuniary rewards, but we to-day are reaping the fruits of their labors in the electrical industries that afford employment to a million of men and absorb hundreds of millions of capital. Shall we declare that these original investigators, these men of genius, were not representatives of liberal culture, merely because the subjects upon which their brain power was expended happened not to relate to literature, or linguistics, or art, or history? Some of these much decried scientific men, such as Tyndall, Huxley, and Darwin proved themselves to be adepts in the art of writing clear and forcible English. Were they devoid of culture? Tyndall knew little of Latin and nothing of Greek, but in the battle where tradition was arrayed against truth he displayed such culture and such vigor as to make him a match for more than one classically educated bishop.

The attempt to establish a line of division between science and liberal culture is an anachronism. We have outgrown the authority of our fathers who accepted the exclusive gentility of a certain group of studies and shrugged their shoulders at the young parvenue whom they called science. Let me here express my sympathy with the protest directed against the abuse of this comprehensive word, science. If the mean-

ing of a word is determined by etymology, science merely means knowledge. It makes no difference whether the subject be chemistry, physics, economics, or philosophy; if the knowledge be definite, consistent and organized, it is science. If it be vague, if mere fancy is accepted as a substitute for fact, if dogma is balanced against demonstration, it is not science, it is not knowledge, though it may be brilliant imagination. But the meanings popularly attached to words are not determined by etymology. Whether rightly or wrongly, the word science has become restricted by tacit popular agreement to our knowledge of things in contrast with our knowledge of words or our speculations about ideals. When we appeal to nature our conclusions need verification before final acceptance. Those methods of investigation which imply verification are conventionally called scientific. If they become successfully applied to any subject whatever, the knowledge thus acquired becomes scientific.

Thanks to the scientific spirit that has leavened all modern institutions of learning, the scientific method is now increasingly applied to subjects which were formerly bound down by the shackles of tradition. It has raised to a high and dignified level subjects which were not recognized a generation ago as having any place in a liberal education. Prominent among these new sciences, these new elements of liberal culture, are political science and economics, equal in importance with physics and chemistry, even if they do not call for laboratory work. These new sister sciences may not be so traditionally genteel as the prim old sisters called classics and mathematics, but they are fresh, smiling and apparently quite irresistible.

The extent to which the old and traditional culture studies are giving place to modern and equally liberal culture studies is well shown by reference to last year's

statistics at Yale University, an institution which was long one of the strongholds of conservatism. In all the higher educational institutions of the present day more or less liberty is accorded the student to elect at least some of the studies to which his time is to be devoted. The most popular subject at Yale last year was political economy, which was elected by 957 students. History was elected by 822, English by 529, philosophy by 398, modern languages by 266, classics, including both Latin and Greek by 172, and mathematics by 37. Under the head of natural science, including astronomy, physics, chemistry, geology and biology, the number of elections was 257. This certainly does not look as if the representatives of science, using this term in its conventional sense, are in a position to smile, either contemptuously or patronizingly, upon the devotees to so-called liberal culture.

The object of education is to make each one of us as nearly perfect a human being as he is capable of becoming. The great majority of those who begin to receive an education are restricted to elementary work. The determination of educational values depends in every case upon individual needs. Good mental discipline can be acquired by the systematic and earnest study of any subject whatever if the student has a living conviction of its importance, and the teacher has brains, enthusiasm, and skill. Any subject may be made a means of liberal culture if both teacher and student are stimulated by the love of knowledge. The law school, the medical school, the technological school are as necessary for the higher grades of professional culture as the college is for general culture. The student is not harmed but healthfully stimulated by his recognition of the vital importance to himself of what is drawing forth his best efforts. Let us welcome every new opportunity that is

given our young men to adapt themselves to the requirements of modern life. No amount of declamation or invective can displace physical science from its present high position. Those of us who are devoted to science are willing and glad to clasp hands with all who are ready to go with us onward and upward.

No classification of educational values has been given that is superior to that that was expressed about forty years ago by one of the greatest of modern thinkers, Herbert Spencer. In the order of their relative importance the leading kinds of activity which constitute human life are grouped as follows :

1. Those which directly minister to self-preservation.
2. Those which, by securing the necessities of life, indirectly minister to self-preservation.
3. Those which have for their object the rearing and training of the young.
4. Those which are involved in the maintenance of proper social and political relations.
5. Those which make up the leisure part of life, devoted to the gratification of the tastes and feelings.

The best education is the best preparation for all of these activities, its aim being to maintain a due proportion between the degrees of preparation in each. The order of relative importance is obviously the inverse of the order of diversity and complexity. It is not surprising therefore that up to a very recent time the work of educators has been confined chiefly to the last one of the groups of activities enumerated by Spencer. But in spite of educational traditions the world has lately been demanding attention to the other groups, and modern science as taught in our foremost universities and technical schools is the response to that demand. Mr. Spencer considers the educational needs implied for the best exer-

cise of all these activities; and in answer to the question—What knowledge is most worth?—the answer is Science.

"For direct self-preservation, or the maintenance of life and health, the all important knowledge is—science. For that indirect self-preservation which we call gaining a livelihood, the knowledge of greatest value is—science. For the due discharge of parental functions, the proper guidance is to be found only in—science. For that interpretation of national life, past and present, without which the citizen cannot rightly regulate his conduct, the indispensable key is—science."—economics and political science. "For the most perfect production and highest enjoyment of art in all its forms the needful preparation is still—science. And for purposes of discipline, intellectual, moral, religious, the most efficient study is still—science."

It is not to be expected that these conclusions will be accepted by all to whom they are addressed. I should be the last to decry the importance of language study, of history, art, and philosophy. I emphatically emphasize the importance of national education in economics and political science. We are sadly in need of better political teachers than a majority of those who during the last few years have been the leaders in American politics. But I protest against the implication that liberal culture is suffering at the hands of either the active workers or the leading teachers in science. So long as human needs and human tastes are diversified must there be corresponding diversity in education. Let each of us recognize what is good in our neighbor, let us cheerfully and cordially acknowledge the value of his contribution to human welfare. Let us remember that there are others besides scientific men who are progressive, and that the boundaries of knowledge are without limit.

Within the present century one of the

greatest mathematicians and astronomers that the world has ever known, Laplace, lay on his dying bed in Paris. His last words were: "Ce que nous savons est peu de choses; ce que nous ignorons est immense." It takes a philosopher to recognize the immensity of his own ignorance. If Laplace could use those words as he fell asleep, why can we not at least follow him and remain at peace with each other while striving to do our share in increasing human knowledge? Linguist and engineer, historian and chemist, economist and physicist, metaphysician and mathematician, our aims radiate from a common center; but friendly and faithful as we may be to each other, our ignorance will still continue to be immense.

W. LE CONTE STEVENS.

*PICTURES PRODUCED ON PHOTOGRAPHIC PLATES IN THE DARK.**

I THINK I may fairly assume that every one in this theater has had his photograph taken, and consequently must have some idea of the nature of the process employed. I have, therefore, only to add, with regard to what is not visible in the process of taking the picture, that the photographic plate is a piece of glass or such like body, coated on one side by an adhesive paste which is acted on by light, and acted on in a very remarkable manner. No visible change is produced, and the picture might remain latent for years, but place this acted-on plate in a solution, of, say pyrogallol, and the picture appears. The subsequent treatment of the plate with sodium hyposulphite is for another purpose, simply to prevent the continuance of the action when the plate is brought into the light. Now, what I purpose demonstrating to you to-night is that there are other ways of producing pictures on photographic plates than by acting on them by light, and that by these other

* Address before the Royal Institution of Great Britain.