SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 7, 1903.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*EDUCATION AND THE WORLD'S WORK OF TO-DAY.**

IT is a time-honored custom in connection with the commencement exercises of our American colleges to read an address, for the benefit especially of those who are about to pass from the limited duties and responsibilities of studentship to the wider duties and responsibilities of citizenship. An opportunity is thus afforded for some last words of friendly counsel, and for a review of those ancient academic ideals which, while they have animated generation after generation of our predecessors, have survived them all, and are still a source of inspiration to our contemporaries. But appropriate as this sort of baccalaureate address may have been in the past, it now appears to be somewhat too scholastic for the happy day which marks the end of a college course of study and the joyful entrance of the graduates into the activities of professional and business life. Moreover, a just appreciation of good advice and a generous susceptibility to lofty ideals require a degree of physical comfort and a degree of mental repose rarely attainable in the heat of our average summer day. The solemn lessons of antiquity are losing their force, also, by reason of iteration and reiteration from the commencement plat-

* Commencement address read at Rose Polytechnic Institute, June 11, 1903.

form; so that one may no longer expect to strike a responsive chord, even in classical colleges, by an appeal to the ideas and the ideals of our distinguished ancestors.

It has seemed to me best, therefore, to depart from the beaten track, and to invite your attention to a subject which lies closer at hand; and as the merchant acts wisely in taking stock at the end of his fiscal year, so I trust we, teachers and students alike, may utilize advantageously the end of this academic year to enquire what education is and to what extent it meets the demands of our times.

We all know, of course, in a general way, what education means; but most of us would hesitate, I think, if called upon to give a concise definition of the word. Indeed, those of us engaged in the profession of teaching might be held to be ill-qualified to explain the import of the word. We are so near to the business and so much occupied with its details that we may fail to see it in its true proportions, and hence fail to estimate aright its effects and tendencies. On the other hand, those unacquainted with the elaborate machinery of educational affairs are plainly disqualified, for they lack the precise and intimate knowledge essential to define so comprehensive a term. If we appeal, American fashion, to the majority, it will be found that the consensus of public opinion regards education as a series of routine performances, carried on by means of more or less elaborate methods, involving tasks which students sometimes undertake with joy and sometimes with sorrow, and ending for those who complete the program with a ceremony called graduation. At any rate, this is what we usually mean by elementary education, and we all believe that its administration is desirable, if not essential, to the average boy or girl. And yet I think it would be found troublesome to explain just what is accomplished by this process and why a person subjected to it may be called educated and why one not so fortunate may be called uneducated. Of course, the easy explanation is at hand. We justify the process by its results. These are found to be on the whole elevating to the majority, and so we drift on with the current of public opinion, forgetting, commonly, that while this democratic leveling of intelligence has certain obvious advantages, it has also certain, though perhaps less obvious, disadvantages. And if we enquire what factors should enter into a scheme of elementary education, we at once meet with a confusing diversity of opinion and with the bewildering fact that the schemes already elaborated are so crowded with subjects that there is little chance of adding anything new, and so tenaciously maintained that there is little chance of omitting anything old.

But if we encounter difficulty in defining precisely the meaning and scope of elementary education there would appear to be still greater difficulty in formulating clear ideas as to the meaning and scope of higher education; for with respect to the latter we have to deal with a diversity of opinions which are to a large extent crystallized. Ask the average college-bred man what is the best line of work to pursue in a college course, and he is pretty sure to answer, if he replies spontaneously, that the line he himself pursued is probably the best, or, perhaps, unquestionably the best. Since the average collegian belongs to the traditional school, the average opinion is as unanimous as it is unilateral; and he who expresses it may justly fortify his view by pointing to the excellent results which have come from the pursuit of the time-honored literary curriculum, or, as he would prefer to put it, from the pursuit of the 'classics and the humanities.' Quite

recently, however, in the historical sense, there has arisen a new form of learning, under the name of science, which has now come to be generally recognized as worthy, at least, of a good share of our attention, if it is not comparable in value with the ancient learning; while some of the bolder advocates of science would give it first place in any scheme of education. This new learning, in the comprehensive sense now implied by the word science, is only about thirty years old. But to understand fully its meaning and to appreciate how profoundly it has affected educational matters, one needs to have lived in the prescientific as well as in the present epoch. Suffice it to say here that the advent of science in education was not accomplished without a struggle, which rose at times to a fierceness not altogether creditable to the combatants involved. But though the storm and stress of that struggle, happily, have died away, there remain some controverted questions whose adjustment must be left, perhaps, to you of the present generation to bring about; for we of the prescientific epoch can not discuss them without arousing prejudice which is attributed either to irrational conservatism, on the one hand, or to sweeping iconoclasm, on the other.

I may allude, in passing, to certain forms of this prejudice, and suggest that our sense of humor should help much to dissipate the intellectual fogs which obscure these matters of controversy, and hence lead to solutions which will rest on foundations of merit alone. Thus, even at the present day, many of the older school of education hold, tacitly, if not openly, that studies may be divided into sharply defined categories designated as 'liberal,' 'humanistic,' 'scientific,' 'professional,' 'technical,' etc.; and men and women are said to have had 'a liberal training,' 'a professional training' or 'a technical training,' as the case may be. They say, by implication at least, that mathematics, when pursued a little way, just far enough to make a student entertain the egotistic but erroneous notion that he knows something of the subject, is an element of liberal training. On the other hand, if the student goes further, and acquires a working knowledge of mathematics, his training is called professional or technical. Similarly, studies which include the memorabilia of Xenophon and Cæsar, the poetry of Homer and Virgil and Dante and Shakespeare, or, in short, the so-called polite literature of ancient and modern times, are said to lead to breadth and culture; while studies which include the works of Archimedes, Hipparchus, Galileo, Huygens, Newton, Laplace and Darwin are said to lead to narrowness and specialism; as if the first class of authors were somehow possessed of humanistic traits, and the other class of demoniacal tendencies. So far, indeed, are these distinctions carried that higher moral qualities are not uncommonly attributed to the young man who studies Latin and Greek in order that he may earn a living by teaching them than are attributed to the young man who studies engineering in order that he may earn a living by building bridges which will not fall down and kill folks.

But, you may ask, is it not possible, in spite of tradition, prejudice and conflict of opinion, to lay down some practical precept or working hypothesis that will enable us to proceed along different routes toward the common goal with reasonable hopes of success? Experience during the past thirty years has given, I think, an affirmative answer to this question. We need only to enlarge our definition of education in order to include all that is good in the new learning and to retain all that is good in the old learning. The only im-

perative restrictions are that we must not prescribe the same curriculum for all students, and that we must not entertain invidious distinctions with respect to any of the curricula. According to this view, then, the formal education of schools and colleges does not consist, as many well-educated people seem to think, in the pursuit of certain studies, but rather in the pursuit of some studies thoroughly well. Herein, it seems to me, is the theoretical as well as the practical solution of the whole matter of the conflict of studies. Provisionally, we have pretty generally reached this conclusion in America. It only remains to replace the narrowness which is willing to accept the traditional limits of learning by a breadth which would hesitate to set any such limits.

If we accept this enlargement of our intellectual horizon, and there seems to be no doubt that we shall soon do so, it will be easy to brush away the distinctions which have long clouded our minds, and still affect our judgments, in the classification of studies. The adjectives liberal, technical, humanistic and professional, as commonly used to denote differences or to mark invidious distinctions, will be found to be, usually, misleading or meaningless. All studies conscientiously and laboriously pursued will be seen to be liberalizing and humanizing, whether they be pursued with or without a technical or professional end in view. That it is any more creditable to study the works of Dante and Shakespeare than it is to study the works of Galileo and Darwin will be found to be a frail figment of the imagination, growing out of the supposed holiness of metaphysics and the supposed unholiness of physics.

In the educational transformation that has come about in the last three decades, our schools of science and technology have played an important rôle. It goes without saying that they have demonstrated their right to existence, that they have come to stay, and that they should play a still more important educational rôle in the future. They have won their way to prominence in spite of all opposition; and I think it may be justly said that in thoroughness of work and in the development of the spirit of energy and independence essential to the successful and useful citizen they have already surpassed the older classical colleges. But the strength of their position is measured not so much by academic standards as by the achievements of their graduates. The world no longer asks where and how men have been trained; it goes straight to the point and enquires what they can do. This is the supreme test. That the graduates of our technical schools have met this test successfully is proved by their efficiency in nearly every walk of life. The prominence of their work is especially noteworthy in the great industrial progress of our times. The civil, the chemical, the electrical, the mining, the metallurgical, the naval and the sanitary engineer have established a claim to recognition among the learned professions. Astronomers, botanists, chemists, geologists, geodesists, physicians, zoologists and other so-called specialists have also demonstrated by actual achievements that a scientific training fits men well for the work of the world.

In the meantime great changes have likewise taken place in the curricula and in the attitude towards science of our classical colleges. Most of them have given place in their required or elective studies for the principal sciences. Many of them have limited the requirements in the classical languages to a minimum; while a few of our leading institutions have gone so far as to give the degree of A.B. without any requirement in Latin or Greek.

It is a significant fact, also, that the scientific method and the scientific spirit of investigation have worked striking changes in attitude toward their own specialties among the devotees to ancient learning. Thus they speak of the science of history and the science of theology, and even of laboratory methods in these sciences; and among themselves, teachers of the classics are not infrequently referred to as scientific or archaic, according as they are animated by modern or mediæval ideas. A few eminent educators deplore these tendencies and write regretfully of the vanishing monastic features of college life. A few rail bitterly against what they call 'the materialism of science,' and charge that the perfume of the Attic violet is being stifled by the mephitic odors of the laboratory. Others assert that, while science may be good enough for engineers who build railroads and dig canals, the classics and the humanities are alone fit for the scholar and the gentleman. But the trend of progress is clearly visible in these as well as in other signs of our times. Mediæval methods, customs and ideals are slowly yielding to the reason of modern thought.

Once free from the bias and the restrictions of inherited opinions, education must appeal to us with a broader and a deeper significance. In the best sense of the word, education is a process which should begin in infancy and end only in advanced age. Science has demonstrated that man is a part of, and not apart from, the universe in which we live; and education in the comprehensive meaning of the word is the process of development which fits us to play well our parts in the infinite variety of phenomena which mold us and which we in turn help to mold. Hence the question of education is a many-sided and a far-reaching one, to the larger aspects of which we even who are engaged with some of its formal details can only point the way. Schools and colleges serve only to give the student a start, whence he enters the 'University of the Universe,' from which there are no graduates. Each may choose his own field, and if he would be a master in it he must become a specialist. Of course there are those who decry the present as an age of specialists and speak and write ruefully of former times when the more learned minds were able to compass the entire domain of accepted learning. But those were times when accepted learning was mostly of the kind called 'polite,' times when the rapidly rising sciences and their devotees were referred to with anything but terms of politeness. The change from this not very remote past is irrevocable, however, and it is plainly our duty to make the best of the new conditions, full as they are of novelties and perplexities. The recent great increase in the quantity of indispensable knowledge forces us to a hitherto unheard of division of labor in the educational field. The specialist is, therefore, a necessity, though there never was a time when the qualifications of a specialist were so numerous and so exacting. In fact, it may be truly said that one's training now must be broadly liberal in order that it may be minutely special.

The age in which we live is preeminently the age of educational opportunities. The school, the college, the university, the library and the museum were never so numerous, so free and so efficient as at the present time. Hundreds of experts, in the study and in the laboratory, in the office and in the field, are contributing by their researches to the world's stock of knowledge. Hundreds of literary, historical, scientific and other technical societies are annually swelling the published volume of the world's best learning; while, in a pop-

ular way, the newspaper, the journal and the magazine bring daily, weekly and monthly instalments of this best learning to him who can read it aright. Intercommunication by post and by telegraph, and quick transportation over land and sea are rapidly dissipating class prejudices and supplanting them by friendly rivalries in the common educational advance. The illusions which some eastern institutions have long held with respect to their superiority over institutions in other localities, are rapidly vanishing before the tests of merit and achievement. Indeed, if one may judge from the picked men who pursue work for the higher degrees in our graduate schools, it would appear that the center of education, like the center of population, is no longer east of the Appalachian Mountains.

So far then as opportunities go, the college student of to-day has great advantages over his predecessor of thirty or forty years ago. Verily, no one need thirst in vain for knowledge, for the fountains thereof are to be found flowing on every hand. But, to paraphrase an old saying, while we may point out the fountains of learning we may not be certain that men will drink deeply or effectively therefrom. It seems proper, therefore, to enquire to what extent these available advantages are appreciated and utilized by the average student of to-day.

It would be quite unreasonable, of course, to suppose that the student of the present day is very different from or much abler than the student of a generation or two ago. The capacity of the human mind, like astronomical phenomena, is subject mainly to secular variations. There is no doubt, however, that the great increase in knowledge and the enlarged means for its diffusion, in recent times, have led to a perceptible quickening as well as to a perceptible broadening of the intellectual faculties of men. What may be called the experience of life, and this is, in general, the most important part of education, is begun earlier and is realized in larger measure than ever before. Coming thus to the college or university better acquainted with men and things and pursuing a broader and a more laborious course of study, the graduate of to-day is, as a rule, a better equipped and a more efficient man for the work of the world than any of his forerunners. More is expected of him, more is required of him and more is accomplished by him than in any preceding age.

But while this is the character we may justly attribute to the majority of our college men, there is a noisy minority of them who have succeeded, apparently, in convincing the public, and to a large extent college authorities, that one of the principal functions of an educational institution is the cultivation of muscle and the conduct of athletic sports. Along with the growth of this minority there has sprung up, also, a class of less strenuous men, who, taking advantage of the elective system, are pursuing courses of aimless discontinuity involving a minimum of work and a maximum of play. They toil not, except to avoid hard labor; neither do they spin, except yarns of small talk over their pipes and their bowls. I need not explain to you that these types of men are well known in natural history. From time immemorial the gladiator and the Miss Nancy have received much of that fleeting attention which the careless crowd bestows on the gaudily attired tumblers of the circus and on the transparent masks of pretenders. It is not so well known, however, that these types of men—prospective bachelors of athletics and degree-hunting dudes—are now wielding an influence distinctly

inimical to academic ideals and distinctly debasing to academic morals.

Pray do not misunderstand me. I am not opposed to physical culture and athletic sports. Scarcely any element of education is so important as the attainment of a healthy balance between the intellectual and the physical functions of men. The ancient maxim of a sound mind in a sound body is more fitting now than ever before. We know or ought to know much better than our ancestors to what extent clear thought and right action depend on good lungs, sound hearts and unclogged livers. My protest is not against school and college athletics as such, but against athletics as they are now generally carried on, and especially against intercollegiate contests. As now practiced, athletics seem to me to defeat the object they are intended to attain. They cultivate almost exclusively the men who are usually more in need of intellectual training, and they ignore almost completely the men who are physically defective. The latter are only permitted to stand by and whoop for their alma mater and for her gladiators. Strangely enough, too, the advisers and trainers of our teams and crews are not always men to whom good judgment would commit the training of youth, but they are often men as ignorant of physical culture as they are of mental and moral culture; their names, indeed, are commonly better known to the patrons of the turf and the ring than they are to the patrons of the cap and the gown.

The usually keen American sense of humor seems to have failed us in these matters. Thus the reporters appear to think it essential to state that every distinguished college graduate who dies was a noted athlete in his day, and they often ascribe great prowess to men of a notably opposite physique. One might infer also, from the prominence given to the small number of 'punters' and 'half-backs' of the day, that they are the only college men who are likely to succeed in life. The sporting populace and the sporting alumni go wild with enthusiasm over intercollegiate contests, while the press, in a fashion similar to that followed in describing prize fights, devotes much more space to these ephemeral events than it does to all other educational affairs combined. It is no wonder then that the light-headed undergraduate attires himself like a stable-boy and affects the manners and vices of a cowboy without aspiring to the virtues of either. He may be excused also for entertaining the hypothesis that colleges are athletic clubs, and that his professors, as suggested by Mr. Dooley, will proceed leisurely to take for him the requisite minimum of formalities leading to a degree.

There is a darker side of this question which calls for something more than a quickened sense of humor. It is the vast expense entailed by these extra-academic operations. Fifty to a hundred thousand dollars per annum are certainly not needed by a college or a university to provide adequate physical training for a few athletes and amusement for a few hundreds of men who can not find health and pleasure in more useful occupations. In so far as educational institutions tacitly encourage the practice of this sort of political economy by students, the majority of whom have yet to try their hands at self-support, they must be held guilty of promoting a degree of extravagance which in other walks of life is usually associated with open corruption.

But the fashions, the follies and the fads of college men, like those of any other limited community, play an insignificant rôle in the larger drama of life. However im-

portant to his little circle a student may have been as an undergraduate, he is likely to meet with a chilly reception unless he is well qualified for arduous service in the work of the world. Those who have thus qualified, however, may go forth with confidence; for as ours is preeminently the age of educational opportunity, so is it preeminently the age of professional and business opportunity. There never was a time when talent, energy and enterprise in young men were so much in demand as at present. Men who can plan and execute; men who can work out knotty problems in engineering, in transportation, in sanitation and in finance; and men who can study aright the mighty questions of industrial and social economy now confronting us, are everywhere needed. Above all, there is a demand for men who can see straight, and who can live lives free from moral obliquity; men who can expose the frauds of politicians and the tricks of boodlers and grafters; and men who can demonstrate, by example as well as by precept, that the homely virtues of honesty, industry and sobriety are not dying out in our land.

The world demands men who are not afraid of hard labor; those who would work during a portion, only, of their leisure time, need not apply. The world demands men who are patient and enduring; those who can not find pleasure in business, but who would make a business of pleasure, are not wanted. The world demands men of courage and convictions; those who vacillate and temporize are sure to be beaten in the race of life.

Young men often wonder why they get on so slowly and why the world puts so low an estimate on their abilities. While the element of chance is not wholly negligible in these matters, and while 'influence' and 'pull,' especially in politics, sometimes interfere with 'natural selection,' the reason is generally plain in any individual case. The simple fact is that the world sets severely high requirements for the competent and the trustworthy, and in nine cases out of ten the men who are rejected have failed to pass in these requirements.

Along with the great advantages now afforded for education, and along with the inspiring fields of work now open to educated men there should go a correspondingly high sense of duty on the part of our college graduates. They are in no sense aristocrats, and they would become ridiculous in the assumption of any unproved superiority. Nevertheless, if they are too sensitively possessed of that modesty which is born of a knowledge of things, we may say for them *noblesse oblige* without undue hesitancy. You who go forth to-day, therefore, must assume, if you bear well your responsibilities, new and increasing obligations, obligations to your college, obligations to your country and obligations to your fellow men of the world.

Those of you who have caught the spirit of progress which animates modern science have a special duty to perform. Ours is the epoch of unparalleled improvements and advances. In all that makes for the permanent progress of humanity, the contributions of science in the nineteenth century alone are held by competent judges to compare favorably with those from all other sources throughout historic time. You are among the heirs of these contributions, and it rests with you, in part, to determine what use may be made of them. A flood of light is available, but it would appear to illuminate the intelligence of only a small fraction of our race. When we consider to what extent superstition and error prevail at the present day with the most enlightened peoples of the world, it is plain that the scientific habit of mind is

none too common. We smile, for example, at the folly of the sailor whose fears may be drowned in a pot of beer and who commits his fate to a rusty horseshoe nailed over the entrance to his forecastle. And yet, our 'city fathers' permit epidemics of typhoid fever to prevail with startling frequency and with frightful mortality. Think, too, for a moment of the shocking waste of health and wealth to which the alluring advertisements of quacks and other charlatans bear testimony in the daily and weekly press. Think also of the waste of time and money which comes from the habit of gambling so common in all races from the lowest to the highest. All such vices are deeply rooted in the human family and fortified by our superstitious tendencies to accept without proof anything which promises the marvelous. No mere literary training can help much to overcome this. deplorable inheritance. Nothing short of the scientific frame of mind and habits of thought can prevail against such ancestral traits.

There is endless scope, therefore, for additional improvements and advances along the lines your training in science has fitted you to follow. Science bids you look forward, then, with confident optimism. But you should waste no time in idle contemplation of the splendid achievements already attained. The price of progress, like that of liberty, is eternal vigilance. One must be ever active, ever patiently persistent, proving all things and holding fast to that which is good.

R. S. WOODWARD.

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*THE RELATION OF SCIENCE TO COMMON LIFE.**

I HAVE been honored by being selected to speak to you on the present occasion. The high ideals of this society demand that I should attempt to leave my restricted field of study for a time, and that I should speak of those broader questions that agitate general scientific thought—that I should drop the rôle of the botanist, and assume that of the scientist and the man.

My theme is 'The Relation of Science to Common Life,' the life of the mass of individuals, of the nation, if you will. A very unacademic subject, you will say, as measured by the older standards. I chose it on that account. In not a few university centers, the time has not long gone when such a subject would have been curtly dismissed with the remark, 'We have nothing to do with common life; we follow our own high educational aims.' Too often the universities have stood aside in cold and unsympathetic isolation—shall I not also say in helpless disfavor—while the busy thinking world outside has carried forward the beacon lights of truth and progress. Listen to Whewell when, as Master of Trinity College (Cambridge), he went up to London fifty years ago to deliver his notable address before the Royal Institution. Speaking on 'The Influence of the History of Science upon Intellectual Education,' he said: "I venture to address you, relying upon an indulgence which I have more than once experienced. Of such indulgence I strongly feel the need, on various accounts, but especially that, being so unfrequently in this metropolis, I do not know what trains of thought are passing in the minds of the greater part of my audience who live in the midst of a stimulation produced by the lively interchange of opinion and discussion on the prominent questions of the day." Uttered soon after the exhibition of 1851, and when the scientific world was entering on new conquests, such an apology may seem unaccountable. Happily, our university presidents of to-

* Sigma Xi Society address, June 18, 1903, before the chapter of the University of Pennsylvania.