SCIENCE

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ADDRESS OF THE PRESIDENT OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.[1]

THE SCIENCE OF EDUCATION.

THE record of the year 1906 exhibits so many kinds and degrees of progress; such evidence of improvement in national and international well-being; such a development of the arts of peace in all lands; such exhibitions of zeal, individual and social, in behalf of corporate and governmental integrity; such abundant industrial and commercial prosperity; and finally such a universal tendency to promote education, to advance science and to foster higher standards of civilization—in short, the year just past is so full of noble endeavor, and endeavor crowned with success, that I stand almost mute in the presence of what ought to be said of the advancement of science, as science grows from more to more, and more and more is applied to the myriad arts of life.

I agree heartily with Huxley and others that there is no valid distinction between pure science and applied science. The final test of the value of what is called science is its applicability, and it is one of the signal triumphs of the last few years that much of what was rated as 'pure science,' and 'pure' because useless, has proved to be invaluable either in widening the boundaries of scientific attainment, or in the development of the useful arts.

All genuine science should be both pure and applied. In a word, let the purity and the application be taken for granted; and

[1] New York meeting, December, 1906.

let every man who finds in the formula of the mathematician, or in the formula of the chemist, or in the formula of the biologist, the key which unlocks the storehouse of nature's secrets; solves a hitherto unsolved problem of matter; or throws light upon one of the hard questions of vegetable or animal life, still claim that his science is pure, when science enables us to invent a new prime mover, to produce a new material of construction, or create a new article of food, let us give credit where credit is due—to science, and to associations which aim to advance all true science and which foster every effort to make that science useful to mankind.

The false, though inherited, notion that polite learning and true culture admit no contact with utility, is, thank Heaven, fast dying out. Occasionally a voice from the 'inner circle' shouts gleefully: "Here's to mathematics! May she never be prostituted to any human use!" But we can afford to smile at the conceit of such a Levite of culture, and pity him for his narrowness and lack of human sympathy. However, those 'pure' scientists often build better than they know. Even the professor who boasted that he had never wittingly either learned or taught anything useful has become the servant of real learning by extending the limits of scientific knowledge, which refuses to be hindered or circumscribed by its mistaken votaries.

There is, as every careful observer can testify, an abundance of useful fruit in every department of scientific research. Note the uses of electricity, chemistry and thermodynamics; of botany in fruit culture; of bacteriology in the warfare for human and animal health; and how the discoveries of science in a hundred fields is made useful in inventions for the transformation, transmission and utilization of energy.

It is not my purpose to point out the progress made during the past year in the discovery of scientific truths, and in their utilization in the various directions indicated by the different sections of this association. The task would be too great for me or for any one man. The printed reports and proceedings of the sections themselves will furnish the best permanent record. It is, however, my purpose to call the attention of the association to the importance of the science and art of education, and to suggest the propriety of creating a new section devoted to the advancement of the science of education.

THE SCIENCE OF GOOD GOVERNMENT.

Before taking up the subject which, for fifty years, has been more or less directly my life and my delight, I desire to express my estimate of the unparalleled achievement of our national government in the interests of peace and international brotherhood. I refer, of course, to our intervention, in accordance with our contract, with Cuba, to restore and maintain peace, order and good government in that long-suffering and badly-educated island. Never before, in the history of the world, did a strong nation go with an army and navy to the aid of a weak and inexperienced nationality when it was torn into factions by jealousies and distrust so deep and bitter as to overcome their desire for good order and self-government; and then, without firing a shot or taking a prisoner, establish order, disarm hostile bands, promote mutual confidence and restore the occupations of peace; and finally, having accomplished this remarkable feat, our army and navy came home again, with no booty, with no trophies, with no captives, with no triumphal procession—with nothing but the consciousness of having done an act of international good-will. The spectacle is one for the world to look upon and admire.

There is most surely a science of good government, and that science we, as a people, are rapidly advancing in this western world.

Let no one try to take away from the essential nobility of this act by pointing to the interest of a few American planters in Cuba. We are glad to have their interests protected, but those interests were relatively unimportant, and I firmly believe that had there not been an American planter or merchant in Cuba, our government's course of action would have been just the same, with the same splendid result. So let not the glory of this transaction be dimmed by unworthy detractions or by neglect. It was a great and noble work two years ago to prevail upon Russia and Japan—when those two nations stood face to face, each with an army of half a million men, ready to crush and slay till the blood of a hundred thousand young men should again stain the soil of Manchuria—to stop fighting, to withdraw their forces, and to submit the issues of their quarrel to a council of peace. That was a great work, and we glory in its accomplishment—but the work done in Cuba is not less fine, though less spectacular. Its modesty, its example of purity and restraint, of justice and respect for law, its vindication of the principles and duties of a republic—all combine to make this year of our Lord 1906 an epoch in international courtesy if not in international law.

EDUCATION IN THE ARTS OF PEACE VS. EDUCATION IN THE ARTS OF WAR.

One word more of immediate interest. The great exposition at St. Louis, in 1904, gave an epitome of the civilizations of all the nations and tribes of the earth. Their representatives dwelt or camped side by side and exhibited with marvelous fidelity and fullness their industries, their commerce, their science, their art, their systems of education and their modes of life. It was, indeed, a great educational institute carried on for seven months in the presence of millions of visitors from every nation under the sun. Probably no human instrumentality was ever more potent in promoting the advancement of science than that exposition. The great congress brought together the best of living men, and they offered their best tributes for the service of science and human progress, and we had the supreme spectacle of the triumphs of the arts of peace.

The exhibit of instruments designed to kill human beings, and of appliances for the destruction of ships and forts, was minimized, and the pageantry of war offered few attractions and claimed small attention. The glory of the exposition was its devotion to education, and the application of science to the useful arts.

I have thus characterized the exposition of 1904, in order to show more clearly what I consider an unfortunate tendency on the part of the management of the proposed Jamestown Exposition at Norfolk, Va., in 1907. I refer to the prominence which military and naval exhibits and evolutions occupy in the prospectus of attractions. The emphasis would seem to be on the science and the art of war, as though the glory of our American manhood lay in our ability to overawe, crush and destroy the very peoples who, two and a half years ago, joined hands with us and with each other in fostering the growth of an international brotherhood which should relegate the waste and horror of war to the pages of history.

Are we not in danger of cultivating overmuch a warlike attitude and of encouraging the growth of a taste for warfare? The maxim, 'In time of peace, prepare for war,' has done infinite mischief. It has misled statesmen, and sent millions upon millions of young men to untimely graves.

It means arsenals and forts, great standing armies and vast fleets of battleships; and yet those are the very things we wish to reduce to the lowest possible terms. I approve of a single military academy and a single naval academy, since both are needed by a modest army and navy; but I do not wish to see military academies multiply, nor would I have the mimicry of war become a pastime in our schools. I doubt if a correct science of education will include the science of shooting our fellow men. The episode of the early Jamestown was not a military campaign nor a naval victory; it was rather a step in the conquest of nature, and a chapter in human progress. I trust it is not too late to give to the Jamestown Exposition a tone less warlike, and to put the emphasis where it must in future belong, upon education, science, industry, commerce and social progress.

EDUCATIONAL THEORIES, ANCIENT AND MODERN.

Coming now to the special message of this address, I propose for your serious consideration the organization of an additional section devoted to the 'science of education.'

As one looks over the history of education he is struck by its chaotic condition. From Aristotle to the men now living, we find the problem of Education discussed from many points of view, with many different objects in mind, and under widely different social conditions.

The Greek idea of education and culture was based upon the existence of a privileged class, fed, clothed and sheltered by the labor of slaves—a real aristocracy devoted to war, art, literature and luxurious living. The sway of the so-called classic idea of education has been and still is one of the marvels of history. The splendor of Greek art, the brilliancy of Greek literature and the keenness of Greek logic have held the world as in a trance, unable to break away from its charms—though it has been unsuited to other peoples and other social conditions.

I need not turn the pages of history to name the writers and teachers who have risen in protest or set forth new doctrines. In many cases the new prophet or teacher has had in mind a privileged individual, or a privileged class, the education of a prince, of a nobleman, of a statesman, a monk, a scholar, a gentleman—always an exceptional person or class. The common people, the toilers in the fields and mines, the rank and file of soldiers and sailors, the builders of houses and ships, the craftsmen at looms and benches—for all such there were no educational theories. Such people had no education and they were supposed to need none beyond that gained in following the occupations or crafts themselves. The assumption was not only that there was no education suited to the common people, but that an interest and participation in the practical arts was degrading to the taste and deadening to the mind. To be sure, a Rabelais, or a Rousseau saw abundant reason for rebelling against the scholasticism of the grammarians, and advocated a return to a study of the external world and the methods of controlling and utilizing the forces of nature, but even they had no science of education, and they had small following.

THE RECOGNITON OF UTILITY AND SCIENCE.

Francis Bacon, more than any other man, showed the inadequacy of the classic method, fine as it was along certain lines, and the comparative worthlessness of scholasticism, and he opened the eyes of the educated people of his time to the wealth of opportunity for interesting and profitable study in the great laboratory of nature; and better than all else, he set forth the dignity and intellectual value of science

study—and he vigorously scouted the idea that the usefulness of scientific truth to any degree detracted from its educational value.

But none of the writers touching on education, with the possible exception of Froebel and Pestalozzi, not even Locke, Milton or Dr. Samuel Johnson, looked at the matter from the scientific standpoint which takes into account: first, the physiological laws which govern the growth and development of the brain; second, the exterior stimuli for promoting that growth most successfully; and thirdly, the kind and quantity of knowledge and skill one must have in order to meet most completely the demands of a carefully-selected occupation.

The history of education is full of the records of whims and fancies, of experiments real and imaginary, conducted in order to prove the worthlessness of some theories and the worthiness of others. Every parent has a dimly-defined theory of how his boy ought to be educated, and every teacher looking back over his own experience as a pupil formulates more or less clearly a 'system' for the proper education of his pupils. It goes without saying that such theories and so-called systems are generally shallow and inadequate, and I say this with no disrespect to either parent or teacher. I am both a parent and a teacher, and I know only too well how inevitably we theorize and plan, and how inevitably we go astray through lack of scientific guidance.

I do not claim to have formulated the science of education, and I know of no one living who has ventured to make such a claim; and yet I believe that a science of education is possible—and it is high time that we set about a systematic study of its essential features with a view to a formal statement of its main principles. Where can that important work be begun and carried on more appropriately and successfully than in the American Association for the Advancement of Science? Here we can bring the results of long experiences under a great variety of conditions, with unequaled opportunities for comparison and elimination.

In his 'Tractate on Education' Milton defined a complete and liberal education to be that 'which fits a man to perform justly, skilfully, and magnanimously all the offices, private and public, of both peace and war.' That is comprehensive enough, yet Milton had in mind only the offices which pertain to the five professions which were then open to liberally educated men, viz., those of the lawyer, the physician, the clergyman, the soldier and the gentleman. A 'gentleman' as defined by Milton was one 'who retires himself to the enjoyments of ease and luxury.' He had no thought then, as had not the educational writers of ancient or medieval days any thought, of the sixth estate, the great mass of the people who are coming to be the characteristic force in the civilization of to-day, viz., those actively doing the world's work, the constructive and distributive, and providing agencies of modern life. We are offering education to-day to every child, a comfortable home to every family, citizenship and self-respect to every graduate of our schools. The education we must study is the universal education of the American people. We have put science, and ever more science, into the world's work; we must now give science and culture and skill to the world's workers.

When a privileged class lived in luxury, relying upon the labor of slaves who were purposely and sometimes legally kept uneducated, and when education for culture and the accomplishments of polite society were natural and logical, it was not surprising that philosophers should hold that practical affairs were degrading. Seneca,

who lived in the first century, was indignant because Posidonius had so far forgotten himself as to credit philosophy with the invention of the arch and the introduction of the uses of metals.

Philosophy, according to Seneca,[1] "had nothing to do with teaching men how to rear arched roofs over their heads; and they were not concerned with the various uses of metals. She teaches us to be independent of all material substances, of all mechanical contrivances." The wise man, said the Roman Philosopher, lives according to nature. Instead of attempting to add to the physical comfort of his species, he regretted that his lot was not cast in that golden age when the human race had no protection against the cold but the skins of wild beasts, no screen from the sun but a cave in the earth. To impute to a philosopher any share in the invention or improvement of a plow, a ship or a mill was an insult. The invention of such things, wrote Seneca, is drudgery for the lowest slaves. Philosophy lies deeper. It is not her office to teach men how to use their hands. The object of her lessons is to form and nourish the soul.

The above wish of Seneca can be fairly paralleled by an utterance of Matthew Arnold in his famous essay on 'Sweetness and Light' (a phrase he borrowed from Swift). Arnold asks, with no evidence of doubt as to the superiority of the 'brave days of old':

> If England were swallowed up by the sea tomorrow, which of the two, a hundred years hence, would most excite the love, interest, and admiration of mankind—the England of the last twenty years, or the England of Elizabeth, a time of splendid spiritual effort, but when coal and our industrial operations depending on coal were very little developed?

That is, he would prefer an age when they had no mills, no canals, no steam engines, no railroads, no steamboats, no manhood suffrage, no common schools, few books, few newspapers and few magazines, because a great majority of the people of England could neither read nor write. *De gustibus non*—as I always say of Ruskin.

I have quoted Seneca at some length because he is a type of a class of people, ancient, medieval and modern, who, living like Seneca in great luxury upon their income, look with disfavor, if not contempt, upon all studies which have, or may have, a positive value in multiplying human comforts and in ameliorating human sufferings.

It is not many years since a president of Princeton University expressed his regret that the higher mathematics had been found useful in the study of electrical appliances, for, said he, 'as the utility of a subject increases its educational value decreases.' Such was the view of the fathers and the disciples of Greek philosophy from Socrates to Patton, but such was not the view of Lord Bacon, and Lord Macaulay, and Professor Huxley, nor is it your view, I trow; certainly it is not mine. I would as soon adopt the educational scheme of Machiavelli as that of Seneca. The former in all frankness and candor pictured the intellectual and moral dishonesty and hypocrisy of his time; but his life was relatively clean. As for Seneca, he sang the praises of virtue and literary culture, and then closed his career by an exhibition of meanness, ingratitude and corruption which threw a blanket of infamy over his fine advocacy of a philosophy which was to form and nourish the soul.

Is it not evident from the standpoint of the subjects to be studied that we need a science of modern education? Educational values are to be determined, taking into consideration age, sex, environment, taste, brain development and probable sphere of usefulness.

[1] Episto, 90.

THE DOCTRINE OF INTEREST.

Here two important subjects crowd upon me for consideration, and they are just the subjects which I wish to lay before a section devoted to the science of education. They are closely related, and I suspect they are strictly modern. I refer to the doctrine of interest, as a valuable or as a harmful characteristic of study; and to the wisdom or the folly of a free election of studies in our secondary schools and colleges. Consider for a moment how much we are at sea and how far we have drifted apart on these two matters—and then you will agree with me as to the need of systematic study and observation that we may find our bearings and lay our courses correctly.

The question of taste and interest is a very perplexing one. Antecedent interest is, we all know, quite accidental and a very unsafe guide. The whims of boys and girls are generally due to the suggestions of companions and of external opportunity. It has been my fortune, as well as my duty, to warn hundreds of parents of boys from fourteen to eighteen years of age not to take seriously their early interest in particular studies or their haphazard plans for future occupation.

Some choice is inevitable, and plans for the distant future are as plenty as castles in Spain, but nothing can be more evident than the unfitness of a boy in his teens to select definitely the course of study best suited to his inherited and acquired capacity; and nothing can be more certain than his practical ignorance of the conditions of a successful career. Hence his declared preferences and elections are to be treated with a loving sympathy, as are a hundred other youthful fancies, but the wise parent and the wise teacher decide to leave open all the avenues of culture and skill, and to hold off the great final choice till the boy has had time and opportunity to make two important discoveries, viz., the intellectual world within him, and the material and spiritual world without. Here we need the pronunciamento of science, telling us how much weight we shall attach to the preferences of a boy of twelve, of fifteen, of eighteen, in regard to the scheme of education and training which shall enable him to make the most of himself and be of the most use to his time and generation.

Every good teacher aims to make his subject as interesting as possible to his pupils. If they fail to take a lively interest in it, something is wrong; either it is not properly presented, or it is over their heads; or it is clearly of no earthly use. Natural lack of capacity on the part of the child is rarely a valid reason for failure, if the child be healthy and normal. I have learned to discredit the truth of the oft-told tale that 'John has no capacity for' such a subject—mathematics, for example. "He never could learn mathematics—he takes no interest in algebra and he hates geometry," etc. Our higher schools and colleges are full of young people who protest vigorously that they never could and never can understand, or take any pleasure in, or gain any profit from, certain studies. On the other hand, I firmly believe that every normal person, at least nine out of ten of the children and youth at school and college, can fairly master and actually enjoy and profit by not only mathematics, but by every subject in the curriculum, if it be properly taught, and under proper conditions as to age and preparation.

I know a man who when a boy was put too early and too rapidly to arithmetic, algebra, geometry, trigonometry and analytics. He must have had the worst possible teachers, for he comprehended nothing of what he glibly recited from memory. So they called him a dunce, reported him home as a dunce, and the boy accepted the

oft-repeated verdict and believed himself a dunce in mathematics. He would have gone through life with that conviction stamped into his brain had not chance thrown a West Point appointment in his way. Spurred by pride and ambition, he resolved to review arithmetic by himself and at least pass the entrance examination to the military academy. To his great surprise he found arithmetic easy to his maturer powers and very interesting, and he entered the military academy with flying colors. Then he took all of the mathematics which he had hated over again. They were a delightful revelation to him. He graduated among the engineers, a fine mathematician, and he is to-day at the head of an engineering school of high grade. I have the story from his lips.

I have had unusual opportunity to observe similar cases, and in a measure to help students who have been the victims of bad judgment on the part of teachers or parents, and so have been led or allowed to dislike subjects which they should have enjoyed, and to underrate their mental faculties because they had attempted to exercise brain cells which were not yet properly developed.

The importance of this subject can not be overestimated. How many lives have been shortened; how many intellects have been dwarfed and stunted; how many careers have been partial failures—all due to early and inconsiderate teaching. Opportunities to redeem and save those of great possibilities, like the one I have mentioned, are rare—and the vast majority of victims never fully recover. In our zeal we have often overshot the mark. The proverbial intellectual strength and vigor of country boys coming up to the university is due not wholly to outdoor life, physical exercise and plain food. I am inclined to believe it is due in part, and perhaps a great part, to their escape from too much schooling and too much crowding. What the country boy needs (and what he often lacks) is not so much longer sessions and rapid promotions as more accomplished teachers.

A word more about the importance of interest as a condition of healthy mental growth. I maintain that attention is as necessary to the growth and development of the brain as exercise is to the development of a muscle; and that interest is the condition of a lively attention. When in a school or lecture room the limit of close attention is reached, the lesson or lecture should close, for the educational process has already stopped. It is not only useless, but it is worse than useless, to go on when the class or audience refuses for any reason to attend. I, therefore, doubt the educational value of subjects which are not, and perhaps can not be, made interesting.

Of course I do not claim that all selected studies can be made equally interesting, or that any one study can be made equally interesting to all pupils, even when the pupils are properly graded; but I do claim that a lively interest is necessary, and that educational progress is very nearly proportional to the strength of that interest.

But all educators do not agree with me here. A Harvard professor recently wrote as follows: "The practical aim of a general education is such training as shall enable a man to devote his faculties intently to matters which of themselves do not interest him. The very fact that the abstractions of mathematics must generally seem repellently lifeless, is part of the secret of their educational value." He praises the 'elder education' which "through daily hours, throughout all their youthful years, compelled boys, in spite of every human reluctance, to fix their attention on matters which, of themselves, could never have held attention for five minutes together."[2]

[2] Professor Wendell, *North American Review*, September, 1904.

This advocacy of ten or twelve years of uninteresting studies, none of which could hold the attention for five minutes unless they were forced upon the student—as the best preparation for dealing with the interesting matters of real life, such as earning one's bread, building a home, rearing a family, contributing to the common weal, and achieving the highest success—this remarkable doctrine is the product of our own age. No ancient or medieval teacher, so far as I am informed, ever promulgated or defended it. The credit or discredit of its authorship belongs to our own day and generation. On the other hand, that veteran and very sensible writer, John Locke, two hundred and fifty years ago, said: "The great skill of a teacher is to get and keep the attention of his scholar. To attain this, he should make the child comprehend the usefulness of what he teaches him, and let him see, by what he has learned, that he can do something which he could not do before; something which gives him some power and real advantage."

I join Professor Wendell in discounting the whims and fancies of children, and in his estimate of the value of an unintelligent choice of studies; but we must part company when he would force me to accept the doctrine that I must be careful not to make my mathematics and mechanics very interesting, lest their educational value be impaired. May I not refer this matter also to a section on education?

FREE ELECTION OF STUDIES.

Closely related to the above is the great question of elective courses of study in our colleges. Personally, I am less concerned with this, since in the school or college of engineering with which I am connected, the curriculum is carefully laid down, and there is no election till the end of the freshman, and generally not till the end of the sophomore, year—and even then only a single election of a carefully prepared line of study is allowed. But I have been a more or less interested observer of the working of a free elective system elsewhere. I am not now going to discuss it, or to weigh it in the balance of experience. Such a discussion of its theory and practise would occupy a full paper before an educational section. Science teachers and scientific men are, or should be, deeply interested in this matter, for, if I mistake not, the rush for certain branches of science, and away from the traditional studies, has led in many cases to the calling of a halt in the freedom of election. My own conviction is that the pendulum has swung too far. The number of required studies should be increased and the later years should be given to a group of subjects selected from a list of groups prearranged by the faculty. It is perhaps not quite safe to condemn a system which permits a student, having entered college on substantially the old requirements, to go through and graduate with honor, without giving during his entire college course a single hour to any one of the three corner-stones of the old curriculum of my college days: Latin, Greek and mathematics—but it certainly raises a question in the mind of every reader of educational history. Is there not a golden mean between predestination and free-will in the matter of studies and educational values?

OTHER EDUCATIONAL QUESTIONS—ATHLETICS.

Never, since the days of Grecian games at Olympia, has physical culture, including field athletics, been so prominent a feature of student life as now. We can truthfully say that to-day athletics is the most conspicuous part of an academic education. Unquestionably the curriculum is out of balance, and a readjustment is necessary. The healthy, normal boy (and I may add, the healthy normal girl) requires and enjoys vigorous exercise in the shape of

games. While I advocate rational athletics, I deeply deplore semi-gladiatorial exhibitions which put the emphasis in the wrong places, and which mislead and demoralize the entire student-body. There has been a drift backward of late years towards a species of barbarism, which we had fancied we had outgrown. It becomes scientific men to restore, or better, to establish, a condition of educational equilibrium.

I can not even mention all the matters of prime importance which would speedily come before an educational section. The organization and functions of boards of education are matters of the greatest moment at the present time, and I suspect they have a perennial interest. It is already on the program of one of your sections.

Some thirty years ago kindergartens were incorporated into the course of instruction of the public schools of St. Louis, and later into the schools of many other cities. The constitution of the state of Missouri—very unwisely, I think—does not allow children under six years of age to attend any form of a public school; yet we shall all agree that the best kindergarten ages are the fifth and sixth years. Nevertheless, nearly every child in St. Louis for the last thirty years has attended kindergarten during his entire seventh year, taking up the primer for the first time upon entering the 'first grade' when seven years old.

In spite of occasional protests and claims that valuable time is thereby wasted, the plan is fairly popular and there is no near prospect of change. The later progress of the relatively mature children in the first grade is remarkable, and many observant principals think that ultimately no time is lost. As for myself, my judgment is in suspense, and yet I have sent five children to the kindergarten. It is always difficult to compare what has been with what might have been, and with what would have been, had things been different. Suppose I refer this all-important matter to scientific educators.

PHYSIOLOGICAL PSYCHOLOGY.

Perhaps the most valuable contribution to the science of education has come through a study of the laws which obtain in the growth and development of the brain, and the conditions under which that growth and development is most healthy and complete. There are times and seasons for the development of the mental and moral faculties as there are of the physical faculties. While such times and seasons are not precisely the same for all children, we find that all attempts at premature development are not only worthless, but are permanently injurious. Precocity is now regarded as a species of brain deformity. Plants and animals may be forced, and unusual and interesting results may be produced by forcing, but no one of us wishes a son or a daughter to be a prodigy in one direction at the cost of normal development in other directions.

The psychologists tell us that the brain cells develop as do other physical organs, not only through thought, but through muscular activity and the exercise of our senses. Accordingly, a healthy and timely growth and development of the brain is to be promoted by an education involving a great variety of activities, skilfully adjusted as to quality and quantity to the mental and physical status of the child. I have often thought, when candidates for admission to Washington University present themselves, that, instead of asking them several sets of questions on a variety of somewhat conventional subjects, I would like to take off their skulls and brain coverings, and see how fully their primal brain cells were developed, and the extent to which the network of intercommunication between cells had been established and was

in good working order. Such an examination would tell far more than any mere written examination. To be sure, I might find it difficult to read and interpret what would be written there, but the record would be there to the minutest particulars.

This branch of my subject outruns both my time and my ability. But there are experts, and they are veritable men of science, and they are most welcome to the companionship and fellowship of this association.

MANUAL TRAINING.

Closely related with this of brain culture is the subject of manual training, which has recently gained a foothold in our scheme of rational education. Its nature and educational value are still under discussion. This relationship is well shown in a paragraph which I take from one whom I am always glad to quote.[3] Said he:

> In man, the size of the motor area in the brain depends far more on the complexity of the movements affected by a group of muscles, and on the fine coordination of these movements, than on the mere mass of the muscles involved. Physical energy implies a good motor brain area. The man of energy is a man of brains, no less really than the man of thought.
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> Physiologists distinguish muscles as 'fundamental' and 'accessory.' The fundamental muscles are the large masses of muscles used in locomotion and in performing movements requiring strength rather than fine adjustments and delicate coordinations. They are, for the most part, the muscles which we have in common with the lower animals and which we have probably inherited from our forefathers who dwelt in trees. The accessory muscles are those which involve fine coordinations. They are principally the muscles of the forearm and hand, and those of the vocal organs. Now it might be argued that manual training is not necessary for the development of the motor centers in the brain, on the ground that gymnastics and outdoor physical exercise are quite adequate to accomplish it. The answer to this objection is the fact that gymnastics and physical exercise in general, appeal almost exclusively to the fundamental muscles and their brain centers, and rarely to the accessories. Nothing short of manual training will reach effectively the important brain cells governing the fine motor adjustments of the muscles of the hand, as nothing short of actual speaking and actual singing can ever effectively develop the equally important brain cells governing the muscles of the vocal organs. The motor cells of the brain controlling the muscles of the joints nearest the trunk develop first, and later, in regular order, those which control the muscles of the more distant joints. Education ought to follow this order of growth; it should avoid training the fingers to make finely coordinated movements at a period when nature has not yet got beyond developing brain cells to make the coarser adjustments of the shoulder and elbow joints. Physical training, which appeals to these more fundamental muscles of the proximal joints, should at first precede manual training, which appeals especially to the muscles of the forearm, hand and fingers.

[3] Professor Thomas M. Balliet, of the University of New York.

We have in the above statement a scientific explanation of the educational value of manual training, so far as it relates to the growth and development of the brain.

As some of you know, I have had something to do with the introduction and defense of manual training as an educational feature. There was from the first no question of its economic value to the great mass of American boys, and largely for that reason it met with favor among people who were more concerned with the work the boy would be given to do after his brain and hands had been developed, than with the means and activities by which the finest and most useful development of the whole boy could be secured.

A study of the whole field of education, classical and technical, led me, in 1879, to organize a school for boys of high-school age in which manual training should be combined with intellectual training; to put the liberal arts and the mechanic arts side by side in the same curriculum; to deal simultaneously with material forces and appliances and with spiritual forces and appliances; to cultivate not alone or chiefly

the memory and the understanding, the eye to read and the mouth to speak, but the judgment and the executive faculties as well; to extend the humanities so as to include human interests and human activities as they exist now and here. Many wise and excellent educators had grave fears as to the result of the experiment. It was thought that the introduction of tools, machinery, materials, the theories of construction, and draughting, might not only break up the orderly program of the school, but they would lower its intellectual and moral tone. It is now known that all such fears were groundless. Manual training, when properly adapted to the boy's status of brain development, and when incorporated into the daily and weekly program with due regard to the other essential features, has proved to be a more valuable element in education than even the most sanguine advocate dared to expect. The moral, intellectual and economic fruit of this combination, as shown in the characters and careers of the boys who formed the first classes in the pioneer schools, is the best possible evidence of its value. The gloomy predictions made of its effect upon the pupils, and upon our American system of schools, have been forgotten, and early opponents are fast friends and enthusiastic advocates.

This is no place nor time for me to give an exposition of manual training; I have preached its gospel elsewhere and often. But I mention it as one of the important matters which must be carefully weighed and adjusted. We must defend it from frivolity on the one hand, and from misdirection and undue emphasis on the other. At first it was suspected that our motives were sordid; that we were likely to degrade our schools, to teach narrow trades, and to turn out 'mere mechanics' instead of educated men. On the other hand, a recent report of a Massachusetts commission (for whose membership I cherish high respect) regards the manual training movement as almost exclusively educational and not sufficiently industrial. I suppose the earlier and the later estimates are still held by many sincere and able teachers. One does not easily lay aside the convictions of a lifetime. The manual training movement stands inevitably as a criticism upon the system of education which came down the ages through the fathers to us, and naturally the latter stands on the defensive. It is also a standing reproof to the old wasteful, unscientific method of teaching to apprentices the theory and uses of tools. It is for educational science to justify the ways of progress which lays aside the idols of the past and erects new temples and opens new kingdoms. Of all the temples, none is finer, none is more glorious and none should be more scientifically planned and reared than that of education. While no section of this association can enforce the dictates of science, it would be helpful if we were able to establish these two things as true, viz:

1. That usefulness does not impair educational values.

2. That a so-called culture-study like Latin may properly stand side by side with manual training in the curriculum.

We are all pleased (though perhaps surprised) when we learn that a man who reads blue-prints, and can make and use a diamond-point machine-tool, is also a linguist and at home in the calculus; and yet we are more than likely to assume that the boys who are studying the theory and use of tools have little need of literature; and that the student of the classics is wasting his time in a laboratory of the mechanic arts.

"What are these boys studying Latin for?" said an English visitor at the manual training school as he looked in upon a class reading Cæsar.

"What did you study Latin for?" was my illogical but American response.

"Why, I am a bachelor of arts!" was his prompt reply, with the air of one who had given a conclusive answer.

"Perhaps these boys will be bachelors of arts by and by," I added cheerfully.

"Then, what in the world are they in a manual training school for?" he exclaimed, with almost a sneer at my evident lack of acquaintance with the etiquette of educational values.

I tried to explain my theory of an all-round education—and my practise of 'putting the whole boy to school'—but he would not be convinced. He could not see the propriety of mixing utility and tool dexterity with culture. Our visitors are not all Englishmen; yet I venture the estimate that fully one half of the bachelors of arts who look through our study rooms and our work rooms have about the same prejudice as the Englishman had, though they do not so openly express it.

THE NEW EDUCATION.

The evolution of the fully fledged technical school, or the technical department of the university, has taken place during the last half century, and yet its broad stimulating, attractive features have a following which bids fair to double the attendance of college and university students. This does not mean that letters and polite learning are being neglected, but that a new constituency is eager for the new education. This new education, though it recognizes at all points a high order of usefulness, and contains little that is conventional, is only remotely professional. If ever its curriculum becomes narrow, it is quickly condemned by the best representatives of an education which combines utility with culture. No longer can the 'Levites of culture,' as Huxley calls them, claim to monopolize liberal education. The new education can be as liberal as the old, and both can be narrow. Fortunately, they flourish side by side and the future shall choose the excellencies of each. An adequate science of twentieth-century education will evaluate the characteristics of each, and bring the wisdom of the past, not its foolishness, to nourish the wisdom of the future.

In conclusion, let us not fear to lay the foundations of the science of education broad enough to carry and to advance our twentieth-century civilization. Let us not fear to strike out for ourselves when the age presents new demands. Progress is essential to life, as Browning says:

> What comes to perfection perishes.

I see nowhere, in either ancient or modern times a people whose youth have been trained as our Americans should be trained. Neither Greece nor Rome with their pinnacles of culture resting on the barbarous foundation of human slavery, nor the blooded aristocracies of modern times, can teach us how to educate, train and adorn an American citizen. We must not expect all our students to rule, nor yet all to be ruled; to direct, nor yet to be directed; to employ, nor to be employed. They must be capable of all these things. No narrow, selfish aim, no prejudice of caste, no false claim of high culture which scorns service, must mislead the growing, expanding minds. Give them a generous, symmetrical training; open wide the avenues to usefulness, to happiness, to power; and this age of scientific progress and material wealth shall be also an age of high intellectual and social achievement.

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