

# School Science

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VOL. III.]

DECEMBER, 1903.

[No. 6

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## SCIENCE AND CHARACTER.\*

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The first president of the Indiana Science Teachers' Association, however unintentionally it may have been done, established a precedent which grants each succeeding president the privilege of discussing any subject he may have resting upon his mind. This view was no doubt taken a few years ago when "Science and Culture" was so ably discussed. Also more remotely when "Science and National Character" was presented in an equally admirable manner. I wish, therefore, in connection with what has been said along these very similar lines, to call your attention for a time to the influence a study of the sciences may have in determining individual character. Individual character has been called one of the greatest motive powers in the world. Indeed, it is the power that fashions all forms of institutions and governments and determines their period of usefulness among men.

No institution or government, as is well understood, ever terminated itself by any inherent power of its own, but its termination has always come through the individuals of which it is composed. To build, therefore, for national longevity or national prosperity and greatness is to work within the individual, to place about him such environments as will enable him to acquire for himself that intellectual acumen, accompanied by the kind of moral fiber that fosters national virtue, honesty, and integrity.

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\*The President's address delivered before the Association of the Science Teachers of Indiana, May 24, 1903.

The dead nations of the past are striking examples of this truth. As long as the individual was in harmony with the right and labored to uphold and advance the general good, prosperity was a result of the effort; but when the individual became so debased in character that it was impossible to discriminate closely between right and wrong, downfall and decay inevitably followed.

Sound character is necessary not only to national stability, but it is also most essential to individual freedom; freedom from vice and from the degrading results of ignorance and menial servitude. History contains many examples of individuals who were slaves to all forms of masters; slaves to political ambitions, to unbridled passions, and to false social customs. Since history is said to be constantly repeating itself, these conditions therefore exist today as well as in former times. The Skimpoles of society are children still, though believing themselves to be enjoying the greatest individual freedom, while the Calibans are only waiting to "lick the shoe" of some one who is able to grant them favor.

The question naturally arises, How may these conditions be adjusted to be comparable with our highest ideals? The answer, we believe, is in a great measure through the schools. The germs of character come with birth, but the development of the perfect product is wrought out by means of external influences brought to bear upon the expanding life of the individual.

The time appears to be passing when a large number of the boys and girls are longer able, at home and under accompanying influences, to obtain that training which leads to character of sterling worth. As a result of this condition the public is placing more responsibility than ever before upon the teacher in regard to the proper training of its youth, while the parent is becoming more and more a neutral factor. Superintendent Charles R. Skinner, whom we know as the great exponent of moral training in the schools, has called attention to this fact in that "formerly we relied chiefly upon the home and church to train our youth along ethical and moral lines, the recognized province of the schools being to give intellectual training and incidentally to supplement the work of the other two agencies, rather than to take the initiative. But there seems to be," he further says, "a continual transition in progress, by which

the former function of church and home—as related to moral and ethical training—have more and more devolved upon the schools.” The causes producing these conditions it is not the purpose of this paper to discuss, but that they exist is sufficient reason why effort should be made to meet them.

Not only the demand of the parent is becoming greater, but also that of the business world. Recently a circular letter was sent out by the New York State Teachers’ Association to the leading professional and business men of New York City, relative to the kind of training boys should receive which would best fit them for useful employment. Over four hundred replies were received in which these men were unanimous that in training to this end “great stress should be laid upon character building upon the training of the morals and manners and inculcating an ability to follow instruction.”

There are various means in the school of developing character. Its general atmosphere has an ennobling or depressing influence upon its members. The bearing of the teacher; his quiet and impressive manner; his keen and unfailing interest; his firm yet guiding hand, all have a potent influence for good along this line. Again, the companion-choosing power of the pupil is a feature of no small consequence, and should be carefully directed by those who have a longer range of vision than the average pupil has in such matters. How often boys and girls enter the high school with a stock of ability valued above par and go completely to pieces because of the selection of companions, not necessarily vicious, but whose habits of study were loose, and whose general bearing was not in harmony with the best interests of the school. These things, together with many others that might be named, constitute the environments of the pupil, all of which have a powerful influence in shaping character.

One of the greatest sources of power, however, to this end comes through work; through the formation of habits to persistent and rigid effort. Work has been called one of the best educators of practical character. It evokes and disciplines obedience, self-control, attention, application, and perseverance. It matters not so much what the work may be, whether manual or intellectual, if it is

good, true, honest effort, done with an enthusiastic interest, it leaves a lasting impress upon the worker. The boy who has not made a collection of stamps or old coins, or who has not observed the nesting places of birds and the things upon which they feed, has lost something from his makeup that can not easily be restored.

Much discussion has taken place of late in regard to the relative value of the different subjects of study in the curriculum. This is no doubt due to the fact that it is impossible to study all, although there are many constructionists who seem to regret the fact that there are so few and hope that others might yet become available. It must be admitted, however, that some subjects possess greater developing power than others, yet anything that calls forth the attention and interest of the learner, whether it be the jingle of the nursery rhymes or the study of differential calculus, or anything between these wide extremes, it never fails in the development of that power which goes to make character.

There is a tendency on the part of many teachers to regard the subjects which they teach as the most far-reaching in its culture and disciplinary value. This is certainly not the broadest view of the question to be taken. There are, however, so many educators and writers of prominence who have held such decided opinions, on one side or the other, as to whether classical or scientific training is of more worth, that the question is always a very interesting one.

The January and February numbers of *Education* contained a very excellent paper on "The Advantages Which Accrue from a Classical Education." While the writer would not advise the removal of any subject from the curriculum, yet the greatest emphasis is placed upon the "paramount advantage of a classical education for any profession or vocation in life." As a conclusion the writer states: "If it is true that education is not a knowledge of practicability, but a development, and with the help of eminent scholars we have reasoned correctly that this is best gained by the Greek and Latin authors; that they give the greatest appreciation of the English language and literature, and best fit one for all the responsibilities of life, then must we not conclude that the advantages which accrue from a classical education are far superior to those of any other?" Goethe and Schiller, Mathew Arnold and other English

writers, together with many college men of today, are quoted as believing strongly in the superiority of the classics as subjects of study, and the opinions of such men are not to be ignored. But we have scores of men equally as strong—and this is what gives the question its decided interest—who hold the opinion that the sciences, if properly studied, will result in all the good that can possibly be obtained from the classics and more.

Tyndall and Alexander Bain, as every one knows, were both anti-classical in their views. Each regarding that the training obtained from a study of Greek and Latin was obtained at too great a cost, also that the student, for the length of time usually devoted to these studies, is not duly impressed with the thoughts of Greek and Roman writers. The attitude taken upon this question by Herbert Spencer, Agassiz, Kelvin and Jordan are too well known to here receive more than a passing reference.

Dr. Ernst Mach in his recent book of *Scientific Lectures*—one of which has for its subject, “The Relative Educational Value of the Classics and Mathematico-Physical Sciences in Colleges and High Schools,” has certainly treated the subjects fairly and impartially, as might be expected from a man of his breadth of culture. Yet he says, “more strongly than ever are authoritative voices now raised against the preponderance of instruction in the classics and in favor of an education more suited to the needs of the times, especially for a more generous treatment of mathematics and the natural sciences.” In pointing out the necessity for a study of these subjects, he says that “without at least an elementary mathematical and scientific education a man remains a total stranger in the world in which he lives, a stranger in the civilization of the time that bears him. Whatever he meets in nature or in the industrial world either does not appeal to him at all, from his having neither eye nor ear for it, or it speaks to him in a totally unintelligible language.” In dwelling upon the value that comes to the young student from scientific study he lays special emphasis upon the influence these studies have in strengthening the reasoning and judging faculties and giving vigorous exercise to the imagination.

It depends in a great measure upon the inclinations of the

student; upon the general bent of his mind, as to what course he shall pursue. If he has a natural dislike for the classical language and is unable to place himself in more agreeable relations with that kind of work, then his development may best be accomplished by devoting his attention studiously to other lines, to those in which he takes the greater natural interest. The sciences usually offer such a field as this. A very small percentage of the boys and girls who take up the study of any branch of science ever find it a tiresome line of work, for which reason it becomes a most valuable instrument in the development of the individual.

George W. Earle, in the vice-presidential address before the Eastern Association of Physics Teachers, has said, "What could assist in character building more than hard and honest work in the laboratory at some difficult quantitative experiment where the pupil must rely upon his own efforts and depend for success upon truthful observations, accurate readings, and a strict following out of directions?" "Does not every laboratory teacher," he further says, "feel from his own experience that no subject taught in the public schools has greater influence in training pupils to thoughtfulness, reliability and to the importance of obeying orders than the study of science?"

The most important acquirement, however, in science teaching is a true scientific spirit; without which, on the part of the pupil, the efforts of the science teacher will fall largely upon barren soil. This expression has been used so often by scientific men that it possesses a degree of triteness, yet it means so much and conveys the meaning so well of that which is desired, that we may not expect it soon to become obsolete. Many attempts have been made to define the term, but it has been found a difficult task. It is, however, we believe, to learn the language of nature, to know the truth as found in nature and not in books, and to possess a thoroughness in the work at hand. It induces the student to seek the laboratory at the earliest possible moment, to remain there as long as other work will consistently allow, to devote an undivided attention to the requirements of the problem and to become actually forgetful of self and surroundings. Such a spirit as this goes far beyond the mere handling of apparatus because

it is odd in its construction, or the careless accumulation of data from which may be drawn erroneous conclusions. It has for its results the proper development of those peculiar characteristics which in the end makes a man a man.

The sciences are peculiar in the development they offer, and differ from most other subjects of study in that they employ the hands as well as the mind. How true it is that in many other subjects one may read a page and on having completed it may be forcibly impressed with the fact that he knows little or nothing of its contents. This is especially true of boys and girls whose minds are not yet trained to any degree of concentration. The permission thus granted the mind to go astray will in time result in habits most detrimental to the pupil.

With the sciences this is rarely the case. The work demands such constant attention in first obtaining a clear conception of what is to be done and then in the proper arrangement of apparatus and the collection of data, that the mind has little time, if indeed it should have the desire, to run away from the work in hand. Any subject of study that may thus tend to discourage rather than to foster these mental aberrations is certainly fruitful in the kind of development desired.

One of the faculties of the intellect which has a most important bearing upon the character of the individual is the imagination. By means of it he is constantly forming new ideals of life, ideals of what he may hope to be, ideals which he may never reach, but without which it would be impossible for him to be even what he is.

The imagination is influenced by what it feeds upon. If it grovels in the lower forms of thought, the ideals of its creation are mean and ignoble. If it soars to loftier heights, they may be pure and sublime. The mere fact that the individual possesses these ideals of a pure and noble type raises him above the lower levels of his nature and places him in a realm of beauty and purity of thought. Every activity of the mind is developed by being brought into activity, the imagination being no exception to the rule, and that upon which it delights to dwell has a reflex influence in that it tends, if good, to make it still loftier in the

products of its creation. The poet is master over the image world which he creates only because of the familiarity which results from long continued practice in calling up its objects and molding them at his will.

The poetic mind finds in nature endless forms which readily become symbols of thought and feeling; insensate matter is transformed into living objects by the magic touch of the poet's genius. Shelley, Wordsworth and Byron loved nature, and they found in her not only a realm of delightful pleasures but a powerful stimulus to their imaginations which enabled them to express their thoughts in such poetic beauty. Nature is varied in her mood and appeals to all the varied temperaments of men. She is joyous for the gay, sad for the sorrowing, beautiful for the aesthetic, sublime for the strong and courageous. So in the differences of character between man and man we see their attitude toward nature. Wordsworth was a dreamer. He lived under the "habitual sway" of nature and admiring the beautiful as he did, found it in nature's most insignificant objects, as the violet, daisy and buttercup. "To me," he says, "the meanest flower that blows can give thoughts that too often lie too deep for tears." These small things he regarded as worthy of his poetic art and described them in beautiful phrases.

Byron, on the other hand, was intense in everything he said and did. He passed unnoticed the flowers, the rippling waters and the quiet shade, around which many other poets of nature love to linger, and devoted his thoughts to majestic mountains, ragged moss covered rocks and rushing waterfalls. We discern his attitude toward nature in lines like these:

"The horrid crags by toppling convent crowned,  
The cork-trees hoar that clothed the shaggy steep,  
The mountain moss by scorching skies imbrown'd,  
The shrunken glen whose sunless shrubs must weep,  
The tender azure of the unruffled deep,  
The orange tint that gild the greenest bough,  
The torrents that from cliff to valley leap,  
The vine on high, the willow branch below,  
Mix'd in one mighty scene, with varied beauty glow."



Shelley's treatment of nature may be said to combine both the sublime and beautiful. His verse has been compared to the "ever changing movements of an oratorio by one of the old masters of the sublime, now grand and majestic as the rolling of the spheres, fiercely sweeping as to the clang of trumpets, as if heaven were at war, anon hurrying impetuously onward like the dashing of a mountain torrent, and at last subsiding into the gentle murmur of the brook, laughing amid bees and flowers, and listening to the fairy warbling of the birds."

While these represent the various attitudes of the poet toward nature, yet these very attitudes are for the most part produced by the influence that nature has upon the mind of her constant devotee. Shelley himself in "The Revolt of Islam" very beautifully points out the various aspects of nature which early had a marked influence in molding his young imagination.

Every hypothesis and law of science is the result of vivid imagination. Newton's mind passed from that historic apple to the moon, and assuming that it also fell toward the earth, later calculated exactly how much that fall amounted to per unit of time.

The geologist requires a vivid imagination in the construction of prehistoric forms and geological ages. The discovery of a planet; the construction of an entire skeleton from a single bone; the invention of a machine that seems to possess almost the intelligence of man; all these are the results of an imagination of only the rarest keenness.

That which is a result of the mind's activity, as before stated, may have a reflex influence upon the mind to further increase its power. This follows not only to the author of these conceptions but to anyone who may studiously pursue them in their various relations. It follows then that scientific study is most efficient in the development of imaginative power, and if this kind of work is pursued with joy and gladness by the pupils of our schools, it will ever result in higher and nobler ideals of life.

The imagination, however, must at all times be held subservient to reason, else it becomes fantastic in its creations, in which case true scientific progress becomes impossible.

Since this relation exists between these two faculties of the mind, and the former is so strongly influenced by scientific pursuits, it might be asked whether the latter is equally quickened. The ability to reason well is one of the essential requirements of scientific study and since the relations between scientific phenomena are usually more obvious than between those of many other lines of work, science becomes a valuable instrument in disciplining this faculty of the mind.

It is claimed upon good authority that an intelligent study of Darwin's "Origin of Species" is not inferior to a study of elementary geometry, and in one respect it is regarded as superior from the fact that the reasoning of natural science is more nearly akin, than that of mathematics, to the reasoning of practical life. All laboratory work, in whatever branch of science it may be, if properly executed requires a process of sound reasoning to accomplish any definite ends. A logical interpretation of the observed phenomena is always necessary in order that the greatest value may be obtained from the experiment.

A study of the sciences is also most efficient in developing the judgment of the individual. Judgment in fact lies at the basis of all science. The sciences are developed by generalization and reasoning and judgment is involved in both of these. No scientific thought would be possible without the faculty of the judgment.

It should therefore be one of the leading objects in the training of young people to aid them in acquiring the habit of forming judgments. They should be trained to see things in their relations and then to put these relations into definite propositions. Faraday has said that the most common intellectual fault is a deficiency of judgment. He further claims that society is not only ignorant in regard to the education of the judgment, but that it is ignorant of its ignorance. The cause of this state of things he ascribes to a lack of scientific culture. We dare not question this conclusion when we bear in mind the fact that a correct judgment of all surrounding events and consequences is possible only in so far as we have comprehensive knowledge of the way in which surrounding phenomena depend upon each other.

The method that science offers of drawing conclusions from data and—taking nothing for granted—verifying these conclusions by rigid experiment is a source of discipline of great value to the judgment and reasoning power of the pupil.

A strong will is also essential to a high and noble character. We admire the man of clear cut opinions and unfaltering purpose, and detest, or rather pity, the man who is always guided by the opinions of others. A bold and courageous rascal has some traits of character more to be desired than those of a cowardly and vacillating saint. One element of greatness in the president of the United States and the reason he is so greatly admired by even his political opponents, is his high sense of justice, and his unwavering determination in carrying out his convictions even in the face of all opposition.

That which rightly cultivates the will power of the individual then, tends to give strength and dignity to character.

Nature study may not be as proficient in this kind of development as the mathematical sciences, but the latter certainly hold first rank in the cultivation of this faculty of the mind. There is hope for the future of a boy who applies himself to a lesson simply because it is difficult, who refuses aid, and is willing to study late at night rather than be defeated in the undertaking. Such as he is cultivating a force of will that will be of inestimable value in after life. Prof. D. W. Dennis has said, "The fact that our first and last presidents were brought up in wealth, while Lincoln was reared in poverty made little difference in the outcome. Wealth and poverty were both accidents. It was work that made the men." Hard mental labor beset by many difficulties; delays in experimental work for something to transpire or be completed, and painstaking repetitions, because of inaccuracies in previously determined data; all these require efforts of the will, the result of which, along with moral goodness and sound judgment, will produce a successful worker in any field.

Away with the nonsense that school work should be made easy, and that the boys and girls should be allowed to have a good time, as some school men would fain teach. Nothing is more debilitating to the character of the pupil, or more detrimental

to the proper government of the school than methods of this kind. The work should be made interesting and highly attractive but it should have enough of severity about it to command respect and be worthy of the time and attention of the pupil.

. A study of the sciences also furnishes sound ethical training. It teaches accuracy, neatness, promptness and integrity. All of which are not only essential to sound character but also to the highest success in life. It is true that science study will not reclaim a depraved nature, but any student who may come into possession of the true scientific spirit, the spirit of unselfish, honest and thoughtful truth seeking will experience a general moral uplifting.

E. Benjamin Andrews in speaking of the great need of true moral character on the part of the individual, and in pointing out the means for its proper development, has said: "True scientific study is rich in moral promptings. Instance the love of right for right's sake, the idea of simple truth, irrespective of consequences, which has come into being almost solely from the inculcation of exact science. This is a result for which those who love righteousness should be grateful to the positive philosophy. In this respect the positivists have, without thinking of it, become powerful ethical teachers. They have insisted, as has never been done before, upon the importance of laying aside prejudice and interest, and getting at simple, unalloyed facts. There has been called into existence thus, a new, distinct and most beautiful form of the love of truth. This noble phase of virtue is emphasized and nourished today in every scientific laboratory and classroom throughout the world." Truth is the foundation of the whole superstructure of science. The latter is so exact in all her methods of operation that to the thoughtful mind is afforded a constant source of admiration.

This exactness made it possible for Le Verrier, after careful mathematical calculation, to say to a working astronomer, "Point your telescope to a certain small area in the heavens, within which you should find a new major planet." He did so and, marvelous as it may seem, Neptune was within the telescopic field. It also made it possible for Pasteur to inoculate twenty-five sheep from

a flock of fifty with attenuated virus of anthrax, and in a few days inoculate the whole flock with unattenuated virus and exclaim, "At a certain time tomorrow the twenty-five sheep which had not previously been inoculated with the attenuated virus will be dead, while the others will be grazing in the pasture." The time for the test arrived and, to the surprise of all, the truth had been foretold.

These are but two of the many illustrations that might be given to show with what unerring exactness nature executes all her decrees. There are no shams in nature; all is truth. The flower that blooms where feet have never trod has just as sweet perfume, and is just as beautiful to the eye, as any in the public gardens. There are roses on the other side of the bush as well as on the side next you. The lark that sings in the face of the sun sings just as sweetly as it would within our range of hearing. This is not always true in the affairs of life. Here shams creep in not only where convenient, but where it is at all possible. There are shams in politics, shams in "courts of chancery," shams in art and architecture, and shams in social customs. On Indian ridge and at the base of it in Mt. Auburn cemetery in Cambridge, Mass., lie the remains of our great poets, Longfellow and Lowell. These graves are marked by the plainest of marble slabs. In view of these sacred spots, but a short distance away, is erected a grand mausoleum of costly marble over the remains of a liquor dealer of very small renown. As one stands in silence and views these different graves, he is impressed with the truth that the good these men have done in the world bears an inverse ratio to the amount of marble that marks their last resting place. Longfellow and Lowell need no monument. Their monuments have been erected in our hearts and lives, while on the other hand some colossal structure is essential to perpetuate even a memory.

In the last place, the youths of our schools may form more sturdy characters by a careful study of the lives of scientific men. President Thwing has said "We should read great books of great men." If we are able to influence those under our instruction to follow such advice as this we shall have accomplished something

that will be to them an everlasting joy. But to fail even here is to fall short of one of the many privileges of the teacher of science in the development of pure and noble lives.

Very recently the writer made some investigations as to the kind of reading the members of his classes had done within the last few months and found in almost every case that the strongest in scholarship and the most trustworthy in the school were able to present the best list of books. It is very reasonable to conclude that this is true not because they are the strongest in the school, but that they are the strongest in the school because, along with other things, they have acquired a taste for this kind of reading.

To read and study the lives of men who have accomplished something by hard and honest toil inspires one to greater effort, and encourages the formation of higher ideals in life. The scientific characters of history who stand out before us with any degree of prominence have been indefatigable workers. Faraday, when asked the secret of his success as a scientific investigator, replied: "The secret is comprised in three words: Work, Finish, Publish." The secret of Edison's fame is his unremitting toil and his persistency in carrying a thing to some definite end. Darwin has said in a letter to his friend, Mr. Fox: "I was wishing to hear about you, but have been in such an absorbed, slavish, overworked state, that I had not the heart without compulsion to write to anyone or do anything beyond my daily work."

The mottos or maxims of men often reveal their characters. The motto of Sir Walter Scott was "Never to be doing nothing." And that of Voltaire, "Toujours au Travail."

The claim that the pupils of our schools are over worked, especially those of the high school, is the greatest scholastic nonsense. This view, however, is taken not so much by those who have the supervision of the work, or by the broader minded class of parents, but by those who over indulge their children in seeking lines of the least resistance and in forming habits that dissipate their energies. A few, it is true, do drop out of school who are physically incompetent to further continue their work, but upon investigation it is found that ninety-nine per cent of those who are compelled to thus leave the ranks do so because of out-

side disturbances, rather than good wholesome and well regulated study.

Again a study of the lives of men of science will teach patience, cheerfulness and simplicity. These traits of character were very marked in Galileo, Laplace and Newton, Berzelius, Liebig and Dumas.

Who can study thoughtfully the lives of Agassiz or Pasteur and, discovering there such matchless elements of character, not be lifted to a higher plane of living? A comparative study of biography will show conclusively that immorality has not held much prominence in the ranks of scientific men. Far less than among men whose lives have been devoted to literature and art. These may arouse the baser passions, but scientific truth is never impure. In conclusion then, is it wise to regard any one subject of study as alone suitable to furnish the proper development in the lives of our pupils, or does it show a fullness of vision on our own part to conclude that the subject which we teach is of "paramount" importance in this developing process? But rather shall it not be said that good, honest, unselfish and persistent effort in any line, so far as work is concerned in the question, is one great means at least of determining good, strong, stalwart, honest character in the boys and girls of our American schools.