

methods by which they can attain this desire. Every man who acquires a taste for learning and is imbued with the desire to acquire more of it becomes more valuable as a citizen, because he is more intelligent and perceptive. As Shakespeare says:

"Learning is but an adjunct to ourself. . .  
It adds a precious seeing to the eye."

It is this addition of "a precious seeing to the eye" which produces progress in science. Of the five gateways of knowledge, the "eye gate" is not opened indifferently to all. The range of vision of the bat and of the eagle is very different. The most familiar objects to man, like air and water, are nothing more to the untutored intellect of man than the primrose was to Peter Bell:

"A primrose by a river's brim  
A yellow primrose was to him,  
And it was nothing more."

Before the mind of man learns to question Nature, he is apt to look for the explanations of phenomena to the intellectual conceptions of his own untutored mind. When he knows how to put an experimental question to Nature he is on the high road to knowledge, "*Prudens quæstio dimidium scientiæ est*"—"A wise question is half of knowledge."

Thales, who flourished in the seventh century before Christ, was among the first philosophers to speculate upon the constitution of the universe. He thought everything was made out of water. The sun dipped in the evening below the western wave, and rose out of the ocean in the east mightily refreshed by its huge drink—so the sun was made out of water. Water, as the river Nile, overflowed the land of Egypt and crops grew in luxuriance—so plants were made out of water. The ocean, when it was stormy, was en-

gaged in the manufacture of earth, and the proof is that after a storm new sand and pebbles are heaped on the shore. The real nature of water was only discovered at the end of the last century.

How little our ancestors knew about air, and how little we yet know about it in the nineteenth century! Yet, if mere observation could suffice to know a thing, air should be better understood than anything in the world. When the first man drew his first breath he began his familiarity with air. In each phase of his life man meets it at every turn. It fans him with gentle breezes and it buffets him with storms. It is never absent from every act of his existence, and the last act of his life is his inability to respire it. The first philosopher who studied air in a scientific way was Anaximenes. He lived 548 years before Christ, and men have been studying air ever since, and have laboriously brought up our knowledge to our present position. Aristotle brought his shrewd powers of observation upon air, and established that it was a material and not a spirit. A wonderful Saracen, called Alhazen, found that it had weight, and showed that it was heavier at the bottom of a mountain than at its top. Galileo again took up the study of air in 1630, and made important discoveries which led Torricelli and others to the discovery of the barometer.

It is scarcely more than a century since mankind gave up air as an element, and it is only during my lifetime that we have been taught the true chemical nature of air, and that its relation to the great phenomena of vegetable and animal life have been explained. When I was first a student of chemistry, air consisted of nitrogen and oxygen with watery vapor. During my life carbonic acid, ammonia, nitric acid, ozone, and the wide range of bacteria and like organisms

have been discovered. We now know that all the foulness of the living and the products of the dead pass into the air, and are changed into the food of plants, so that the great abounding atmosphere becomes the grave of organic death and the candle of organic life. Plants and animals mutually feed on each other and the death and dissolution of one generation is needful for the growth of a succeeding one.

You see how slowly intellectual conceptions of the most common object gather round it. When we give a lecture to an ignorant audience on such subjects as air and water, we treat them from the platform of our own times—the nineteenth century. But our audience is not yet on that plane. In my old professorial days, in lecturing to classes of working men, I sometimes put myself on the platform on which Anaximenes stood 548 years before Christ, and argued as he did for the theory of the nature of air, and then mounted the ladders, taking my hearers with me, from platform to platform of discovery, till I reached that of the present day. This historical mode of illustration gave the working men a better notion of the methods of scientific discovery, and taught them more completely that science consists of conceptions obtained by a slow but steady questioning of Nature. In ancient times there was little science, because philosophers put the questions to their own minds and not to Nature. The rapid progress of science in recent times is due to our questioning Nature by means of experiment. This is the true foundation of science, as well expressed by Wordsworth:

... "to the solid ground  
Of Nature trusts the mind which builds for aye."

This need of experimental inquiry does not apply to mathematics, which was a product of the opening of Greek civiliza-

tion, and the achievements of the Greek geometers, Euclid, Archimedes, and Apollonius are still admirable at the present day.

If the untutored senses be sufficient to appreciate and understand what you see with your own eyes and hear with your own ears, it would not have required many thousand years for mankind to acquire our present imperfect knowledge about air and water. In explaining to our students the knowledge of to-day I think it would often be useful to show how it has been attained and how our crude faculties have become tutored faculties by close thinking, observation, and experiment upon the most familiar objects about us. Theories of the past have fallen as the leaves of trees fall, but while they existed they drew nutriment to the parent stem of knowledge. The theory of to-day is the error of to-morrow. Error in science is nothing but a shadow cast by the strong light of truth. Theories, as they arise, are an absolute necessity for the progress of science, because they collect in a common focus all the light which is shed upon a subject at a particular period. The descriptions of and arguments for the old theories I found very useful as ladders let down from the nineteenth century platform, which enabled my uneducated audience to mount to it by graduated steps, until they came to the same level of the science which I was trying to expound to them.

The world is still young and science is never old. It is sheer vanity for any generation to suppose that their state of knowledge represents the final triumph of truth. I think it is always useful in educating in modern science to show how much we owe to our ancestors by their laborious efforts to build it up. We have inherited so much from the past. Roger Bacon, writing so long ago as 1267, said: "The an-

cients have committed all the more errors just because they are ancients, for in matters of learning the youngest are in reality the oldest; modern generations ought to surpass their predecessors because they inherit their labors."

This thought, three centuries later, Francis Bacon put into his famous apothegm—*Antiquitas Seculi, Juventus Mundi*—antiquity in age is the youth of the world.

It is no small object in view that your purpose is to permeate the mass of people with the desire for knowledge. It is chiefly among them that great discoverers in science and great inventors in industry arise. I would refer you, as an illustration, to the past discoverers who have adoned the lecture table of the Royal Institution in Albermarle street. With scarcely an exception they have sprung directly from the people. The original founder was Benjamin Thompson, afterwards Count Rumford, a provisional schoolmaster from New England; and the institution has had as successive professors Sir Humphrey Davy, the son of a woodcarver; Young, illustrious in politics, the son, I think, of a yeoman; Faraday, a newsboy; and Tyndall, who was of humble origin.

All of these men sprang from the people. Among inventors this origin from the people is still more marked. Watt was an instrument-maker; Wheatstone, who invented our telegraphs, was a maker of musical instruments; and Bell, who added the telephone, was a teacher of deaf-mutes; Stephenson, the inventor of locomotives, an engine-tender at a colliery; Arkwright, who revolutionized the cotton industry, was a barber. These instances might be multiplied indefinitely both from modern and ancient history.

The great humanizing movements of the world have sprung from the people. The Founder of our religion did not disdain to be called the son of Joseph the carpenter, and he took

his disciples from among the working men around him. Paul the tentmaker and Peter the fisherman found time to earn their daily bread and diffuse the religion of Christ. The growth of philosophy in Greece depended upon men who were using one hand to win their daily bread and the other to mold humanity. Socrates was a sculptor; Plato and Zeno were actively engaged in commerce; Aristotle was the son of a physician. They founded schools of thought, but they themselves were the products of Athens and Corinth when they were active seats of industrial activity.

I hope I have made myself intelligible when I argue that the University Extension movement is doing work of its own kind most valuable, not as an education of the people but as a means of permeating the people with a desire to be educated, and by giving them methods and subjects which they can use in continuing their education. Your opponents still object to the need of doing this, because they quote cases, such as I have mentioned, like Faraday, Watt, and Stephenson, where men of the people even in the absence of schools, educated themselves without aid from others and became great discoverers; so they say it is much more easy now to do likewise, when technical schools are covering the country.

I have spent a large portion of my life in helping to found these technical schools and therefore I fully appreciate their importance, but they do not even touch the ground covered by your movement. Such schools look to the education of a man for his daily work and only give what the Germans call *Brodstudien*, while the University Extension movement professes to give mental culture or what the Germans might call *Verständnisstudien*. No doubt one of your triumphs will be that the University Extension scheme will tend largely to feed schools of science and technical schools with students incited

to learn through your permeating influence in creating a taste for knowledge. This is as it should be.

During my life I have enjoyed the friendship of many men who have risen by their own great talents, such as Dalton, Faraday, Stephenson, Wheatstone, and Livingstone. I knew the great African discoverer when he rested his book on a spinning-jenny, snatching sentence after sentence as he passed it at work; and I attended the evening classes with him in Glasgow and saw him pay the pennies he had saved during the day as a cotton-spinner.

As I am recalling old memories I may say that three companions studied together in those days. One was James Young, a carpenter; Livingstone, a cotton-spinner; and myself, the son of a physician. Young the carpenter established a new industry and became very rich. His purse was always open to Livingstone for his African explorations; and, although he would never acknowledge it, my election committees never lacked funds from some mysterious donor, who I always believed was my old friend, for the contributions ceased at his death.

Were my old friends now alive, I would call them all as witnesses as to how much trouble and suffering would have been saved to them had they been able when young to enjoy the advantage which you now offer to the youth of this century by giving them the materials and methods of education. It is quite true that men of genius will cut out steps for themselves in the toilsome ascent of knowledge. The mistake of the argument is obvious.

All the dwellers in a plain do not surmount the mountain which frowns upon them at the end of the valley. A few daring spirits may reach the summit unaided and pass into the world beyond, but the great mass of men remain in the low-

lands where they were born. We can induce many of these to make excursions which will brighten their existence, by making roads and showing them how to use the roads. Perchance in doing so we may come upon a genius and put him on his way, and wish him Godspeed! The case should not be argued by contrasting a heaven-born talent with ordinary ability. All systems of education try to draw out the mental abilities of the scholar, but they do not profess to give the gifts of God or to create special abilities in man. Such great men as I have mentioned are discoverers of new truths in science, and the bulk of mankind must be content to live on a lower plane, but their life is made the happier, more graceful, and dignified by helping them to acquire some of that knowledge which shows them how the world has advanced and how society has been improved by the advances made in science, literature, and philosophy.

In our own time science has been the great civilizing agency. Within my own memory I have seen the origin of five inventions which have had more profound effect than revolutions in altering the conditions of kingdoms and nations throughout the world. I allude to steam-locomotion, telegraphy, telephony, photography, electric lighting, and electric locomotion. The discoverers in science are the artisans of civilization, their laboratories and the workshops, and their instruments of precision and experiment are the tools with which they perform their world-labor. By the system which you pursue the people are made to take an intelligent interest in these modes of civilization. The most intelligent nation will in future be the greatest nation, and your work is to do your part in permeating the people with this general intelligence which is so necessary for their prosperity in the competition of the world.