SCIENCE READINGS for Students of English as a Second Language

With Exercises for Vocabulary Development

Edited by
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Georgetown University
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Preface

This book provides reading and vocabulary study for students whose proficiency in English has reached an intermediate level and whose major interest is in the biological, physical, or applied sciences. It has been found that students of English as a second language who are scientists or expect to be scientists wish to build up a working science vocabulary in English as soon as they possibly can. *Science Readings for Students of English as a Second Language* was designed for this purpose.

The text is a general science reader with special attention given to the development of vocabulary. The reading selections, dealing with science education, biology, chemistry, earth sciences, engineering, mathematics, medicine, meteorology, oceanography, physics, and space exploration, have been adapted for intermediate students of English. Through adaptation, the selections have been shortened and divided into convenient parts.

Vocabulary control has also been applied, so the student will not be faced with a large number of "new" words at one time. For this purpose two vocabulary lists have been used: *A General Service List of English Words* edited by Michael West, including the 425-word "Supplementary Scientific and Technical Vocabulary" by Flood and West, and the Thorndike 3,000-word list from *The Teacher's Word Book of 30,000 Words* by Edward L. Thorndike and Irving Lorge. To these a few words from the Thorndike 4,000 list have also been added, namely, words that experience has shown to be within the English vocabulary of intermediate-level students. Thus, the assumed vocabulary runs to about 3,500 words.

About 700 additional vocabulary items are introduced in the readings and exercises. Where "new" vocabulary appears in the reading selections, footnote explanations and, in some instances, pictured illustrations are given. For convenient reference, new words and expressions are also listed in the glossary at the back of the book.

Exercises follow each reading selection. Some test the student's understanding of what he has read and his understanding of the words and idioms introduced in the lesson. Others are devoted to systematic word building and vocabulary review. "General purpose" vocabulary has been given the same careful treatment as "scientific or technical" terms. Most patterns of word formation seem to apply equally to both kinds of vocabulary.

As far as we are aware, this book is the first of its type to be published commercially in the United States. Comments and suggestions from teachers who use it will be welcome.

Washington, D. C.
December, 1965

KENNETH CROFT
BILLYE WALKER BROWN

The two articles which follow reflect the concern for better science education during the past decade and the efforts that have been made to improve the situation.

Contents

Science Education for a New Age

THE very great advances in science just before and after the midpoint of the twentieth century have caused educators in the United States to realize that science teaching in the future must differ from science teaching in the past. During the past twenty years science has played an important part in shaping the character of our civilization. The welfare,[1] stability, and security of our nation and the continuation of a free society are closely related to the discoveries of science and the applications of these discoveries. The scientific revolution which we are beginning to experience, together with the trend [2] toward world industrialization, demands a program of science education with new emphasis,[3] purpose, and content. Simply knowing about the existence of the scientific enterprise [4] is not enough for effective citizenship.

Need for Good Science Teaching

Governors, lawyers, and business leaders have to deal with scientists; and every educated person finds his views influenced by

[1] *welfare*, the condition of health, happiness, and prosperity
[2] *trend*, general tendency or direction
[3] *emphasis*, special attention or importance
[4] *(scientific) enterprise*, the development and use of (scientific) knowledge

ADAPTED from "Science Education for Changing Times," by Paul DeH. Hurd, which appeared in the 59th Yearbook of the National Society for the Study of Education, 1960, Part 1, entitled Rethinking Science Education. *Used with the permission of the author.*

science. Yet our science teaching of nonscientists, in school and college, has built up mistaken ideas, dislikes, and the common boast, "I never did understand science." Even those students who arrive at college with plans to become scientists usually bring a mistaken picture of science: some have *a collection of unorganized facts* about science, and some regard the study of science as a game which involves *getting the right answer*.

The first of these attitudes seems to come from a kind of course which provides bits of miscellaneous[5] information; the second, from a training course on how to pass examinations that do not ask about the student's understanding but simply require him to put the numbers in the right formulas. Neither type of course (in school or college) seems to give students an understanding of science as we find it among scientists. Neither shows students how real scientists work and think, how the facts are gathered, how discoveries are made, and what they mean.

Young people need good teaching of science; not so much a great wealth of knowledge as *a healthy understanding of the nature of science*. They need an understanding of knowledge leading to a sympathy with science and a keen awareness of the way scientists work. Given these, it is easy to encourage later reading and learning.

Balance in Education

If it were only necessary to decide whether to teach elementary science to everyone on a mass basis or to find the gifted[6] few and take them as far as they can go, our task would be fairly simple. The public school system, however, has no such choice, for the two jobs must be carried on at the same time. Because we depend so heavily upon science and technology[7] for our existence and progress, we must produce specialists[8] in many fields. Because we live in a democratic nation, whose citizens make the policies for the nation, large numbers of us must be educated to understand, to support, and, when necessary, to judge the work of experts. The public school must educate both producers and users of scientific services.

[5] *miscellaneous*, consisting of various kinds

[6] *gifted*, having natural ability which is greater than usual

[7] *technology*, applied science (cf. *technical*—having to do with the practical, industrial, or mechanical arts or the applied sciences)

[8] *specialist*, a person who follows a special branch of work, study, or other activity

In education there should be a good balance among the branches of knowledge that contribute to effective thinking and wise judgment. Such balance is defeated by too much emphasis on any one field. This question of balance involves not only the relation of the natural sciences, the humanities,[9] and the arts but also relative emphases among the natural sciences themselves.

Similarly, we must have a balance between the current and classical [10] knowledge. The attention of the public is continually drawn to new possibilities in scientific fields and the discovery of new knowledge; these should not be allowed to turn our attention away from the sound, established materials that form the basis of courses for beginners.

Knowledge and Enterprise

Science teaching must deal with the knowledge and methods of science; both are necessary. From science courses students should acquire a useful command of science concepts [11] and principles. Science is more than a collection of unrelated facts; to be meaningful and valuable, they must be arranged to show generalized concepts. A student should learn something about the character of scientific knowledge, how it has been developed, and how it is used. He must see that knowledge is subject to growth and change and that it is likely to shift in meaning and status [12] with time.

At each grade level in school the student needs to increase his knowledge in an organized way, to acquire sufficient vocabulary in science for effective communication,[13] and to learn some facts because they are important in everyday living, such as knowledge that is useful for his health, for his safety, and for an understanding of his surroundings.

Science and Society

Young people need to understand how our society depends upon scientific and technological advancement and to realize that science is a basic part of modern living. The scientific process

[9] *the humanities,* literature, philosophy, etc.
[10] *classical,* accepted as being standard; traditional; not new and experimental
[11] *concept,* idea; general notion
[12] *status,* rank or position
[13] *communication,* the giving or exchanging of information, ideas, etc. by speech or writing

and the knowledge produced cannot be considered to be ends [14] in themselves, except for the classical scientist. A student should understand the relation of basic research to applied research, and the connection between technological developments and human affairs. More of technology than science will be involved in social decisions, but both are important in public policy.

The knowledge and methods of science are of little importance if there is no inclination to use them properly. An open mind, a desire for accurate knowledge, confidence in the procedures for seeking knowledge, and the expectation that the solution of problems will come from the use of tested and proven knowledge—these are among the "scientific attitudes."

Science instruction should acquaint students with career possibilities in technical fields and in science teaching. A continuous effort should be made to identify [15] and encourage those who develop special interests. They should be given opportunities for some direct experience of a professional nature; they should also learn about the extent of the various science fields and how these fields are related to each other. But it is even more important for young people to acquire those skills and abilities that will enable them to take the responsibilities for expanding [16] their own learning.

[14] *end*, aim; purpose
[15] *identify*, recognize as belonging to a particular group; discover
[16] *expand*, make or become larger; increase in size

Exercises

A. Put a check mark (√) in front of the sentences below that are recommendations made by the author of this reading selection for programs in science education.

___ 1. The public school must educate both producers and users of scientific services.

___ 2. Science instruction should acquaint students with career possibilities in technical fields and in science teaching.

___ 3. Classical knowledge is no longer important in science education; attention should only be given to current knowledge.

___ 4. The student must see that knowledge is subject to growth and change.

___ 5. Students of science should devote relatively little time to the study of the humanities and the arts.

___ 6. Young people should learn that basic research is more important than applied research.

___ 7. Scientific facts must be arranged to show generalized concepts.

___ 8. In science courses, students should acquire a good deal of general vocabulary as well as vocabulary in science.

___ 9. A student needs to learn some scientific facts because they are important in everyday living.

___10. All students should take science courses for at least three years.

B. Fill the blank in each of the sentences below with the word from the list which correctly completes the meaning. There are more words on the list than you will need.

communication	identify	status	expanding	technology
miscellaneous	welfare	trend	accurate	enterprise
specialist	gifted	ends	concepts	classical

1. From science courses students should acquire a useful command of science ___________ and principles.

2. A continuous effort should be made to ___________ and encourage students who develop special interests.

3. The scientific process and the knowledge produced cannot be considered to be ___________ in themselves, except for the classical scientist.

4. The development and use of scientific knowledge is called scientific ___________.

5. One of the "scientific attitudes" is a desire for ___________ information.

6. Students in our schools need to acquire sufficient vocabulary in science for effective ___________.

7. A ___________ student is one that has natural ability which is greater than usual.

8. Unfortunately, some present-day science courses provide only bits of ___________ information.

9. A program of science education with new emphasis, purpose, and content is demanded by the scientific revolution and the ____________ toward world industrialization.

10. It is important for young people to acquire those skills and abilities that will enable them to take responsibilities for ____________ their own learning.

C. Fill the blank beside each noun below with a related verb and the blank beside each verb with a related noun. Use a dictionary if you wish. Here are some examples: arrangement, *arrange;* proceed, *procedure.*

development	____________	collect	____________
emphasis	____________	govern	____________
communication	____________	contribute	____________
knowledge	____________	begin	____________
discovery	____________	arrive	____________
increase	____________	answer	____________
application	____________	require	____________
understanding	____________	grow	____________
judgment	____________	expand	____________
surroundings	____________	exist	____________

Recent Developments in Science Education*

SERIOUS examination of the extent and quality of pre-college science teaching in U. S. schools, beginning about a decade ago, has led to programs of reform and improvement that already have had profound impact on all aspects of elementary and secondary science education. Major changes have been effected in the content of specific science courses; in the planning of coordinated, sequential programs, or curricula, in science from kindergarten and early grades through high school; and in programs for updating knowledge of science among teachers. A parallel development of great significance and effectiveness has been a vast expansion in the number of science supervisors, coordinators, and helping-teachers at state and local levels. Also, there has been a concerted effort to modernize and increase space, facilities, equipment, and supporting materials used in science teaching.

These lines of development have established patterns and trends of such strength that they will continue for many years to come. Moreover, the tide of reform is now engulfing both college science programs and college programs for preparing teachers to handle science in secondary and elementary schools. Professional scientists and their societies, supported by the National Science Foundation, have established Commissions in all the basic scientific disciplines—biology, chemistry, physics, and geology. Their counterparts in mathematics and engineering have done likewise. These groups are working to modernize and reorganize content, approach, and instructional techniques at the college level. The National Science Teachers Association has a Commission on the Education of Teachers of Science to study, in particular, the special methods courses and the student teaching experience of future teachers. As these groups grow in strength, activities, and coordination, the prospect of vastly improved science teacher education, liberal education in science for nonscientists, and the production of future scientists and engineers is exciting to contemplate.

The movement to revise high school level science courses began in earnest with the funding of the Physical Science Study Committee by

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** "Recent Developments in Science Education" by Robert H. Carleton, Executive Secretary of the National Science Teachers Association, was written to accompany "Science Education for a New Age" by Paul DeH. Hurd. It is presented here for reading practice without adaptation and without footnote definitions of vocabulary. However, most of the "new" words appear in the glossary at the end of the book, and a dictionary may be used for other unfamiliar vocabulary.*

the National Science Foundation. The result was "PSSC Physics." This total program consisted of a textbook, laboratory exercises, especially designed laboratory equipment, films, and a series of supplemental paperback books. With the pattern set, there soon followed three versions of biology from the Biological Sciences Curriculum Study, and two approaches to chemistry—the Chemical Bond Approach and Chemical Educational Material Study. Presently nearing completion are several other NSF-funded course development projects for elementary and junior high school levels, including the Earth Science Curriculum Project, the Introductory Physical Science project, and the Science As Process project.

School systems by the hundreds have science curriculum committees hard at work preparing course outlines and curriculum guides in the modern mode. Also, private authors, editors, and publishers are working feverishly on revised and new textbooks that truly incorporate the spirit and substance of "the new science."

And what, we might ask, are the distinguishing qualities that mark the current reform movement in science education? First is the determination that science in the classroom shall be reasonably up to date and in tune with science as thought of, accepted, and practiced by scientists. What is taught in science education can no longer lag 20 to 30 years or more behind the revised theories and models, new knowledge, and currently accepted concepts. However, what is taught should place emphasis first on principles and major concepts of science rather than overstress the applications and technological extensions of scientific knowledge. Also, the reformers are determined that laboratory activities shall be revised, restored, or introduced in a manner to emphasize science as process—to reveal through practice that science involves inquiry, discovery, and experimentation.

Scientists have taken increasing responsibility for telling us what to teach. They have given untold time and effort to teaching thousands of teachers what this content is. Science educators, educational psychologists, and scientists, too, have labored hard on developing improved methods of *how* to teach. Designers, builders, and purveyors of materials for teaching have met the challenge of change by providing new and improved equipment, audiovisual devices, and learning systems. In summation, these and still other contributory factors have significantly reshaped the content and methods of science education in American schools. To be sure, not all students, teachers, and schools have yet been reached; but it is only a matter of time until they are. And now with the advent of new opportunities and challenges under the 1965 Elementary and Secondary Education Act, one can truthfully say that the future of American science education promises to be limited only by sheer manpower and the genetic distribution of creativity and ability among this population.

Distribution of Nutrients[1] in Plants

THE green appearance of the water in ditches and lakes is caused by tiny, microscopic green plants called *algae*. These plants each consist of a single cell. Transport[2] of nutrients in these plants is not much of a problem. The sugars and other products of photosynthesis[3] are used in the very cell in which they are produced. So food products do not have far to go.

In higher plants, which are very complex,[4] the cell is usually more specialized. Many cells are so specialized that they cannot produce their own food by photosynthesis. Ordinarily, root cells are colorless and must obtain their sugar from the green leaves of the plant. A considerable distance is often involved, so an efficient transport system is necessary. It is rare that one finds plants with green roots capable of photosynthesis. One of these is a *Hydrocharis*, a pretty floating water plant of the ponds and ditches of Holland.

It is generally believed by scientists that millions of years ago

1 *nutrient*, anything that supports growth and repairs tissues
2 *transport*, distribution
3 *photosynthesis*, the formation of sugars and starches from carbon dioxide and water. This takes place in the green cells of plants using energy from sunlight.
4 *complex*, consisting of many parts; not simple

ADAPTED from "Transport," chapter 4 of The Lore of Living Plants, *by Johannes van Overbeek. Produced by the National Science Teachers Association in cooperation with the U. S. Department of Agriculture. McGraw-Hill Book Co., 1964. Used with the permission of NSTA.*

plant life originated in the water, and that gradually new forms of plant life evolved[5] that could live on land. This would not have been possible if an effective transport system had not evolved inside the plant to distribute food, water, and minerals. The development of such a transport system was, indeed, the key to the great development of land plants. The giant *sequoia* tree, in California, sends down to the ends of its roots sugars that are made in the leaves hundreds of feet up in the air. And the ends of the roots may be a hundred feet away from the base of the tree.

Plants have three systems that make possible a rapid interchange[6] of substances among various parts of the plant body. Although all three systems involve different tissues, they do interconnect[7] so that material may go from one system to the other. In addition to the *food transport system*, there is a *water transport system* and an *air transport system*.

Food Transport System

The food transport system is the most delicate of the three. It is easily damaged because it is alive; that is, the cells through which the food is transported are biochemically active.[8] Wounds, heat, and exposure of the plant to toxic[9] chemicals all damage the system that transports food. If you cut a branch and put it in water, it may seem alive for many days or even weeks; yet the food transport system stops functioning soon after the branch is cut from the tree.

Water Transport System

The water transport system is much less delicate than the food transport system. Water transport in stems takes place in long strong capillaries.[10] These are dead cells. During the last century, a German scientist cut down a tree and then placed the base in a tub containing picric acid.[11] The yellow, poisonous acid moved up to the top of the tree. There it killed the leaves, but the water transport system itself was not affected by the poison.

[5] *evolve*, develop gradually
[6] *interchange*, change from one to another of various parts
[7] *interconnect*, connect with each other
[8] *biochemically active*, active in that chemical changes take place in the cells (cf. *biochemistry*, the study of chemical changes that take place in organisms)
[9] *toxic*, poisonous (Noun form: *toxicity*)
[10] *capillaries*, very small (hairlike) tubes
[11] *picric acid*, $C_6H_2(NO_2)_3OH$