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Iowa Plan for Atomic Energy Education

Department of Public Instruction, Iowa

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THE IOWA PLAN FOR ATOMIC ENERGY EDUCATION

PUBLISHED BY THE STATE OF IOWA

JULY - 1950

VOLUME I

Iowa
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STATE OF IOWA

1950

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Orientation to the Iowa Plan For Atomic Energy Education

VOLUME I

THE IOWA PLAN FOR ATOMIC ENERGY EDUCATION

ISSUED BY THE DEPARTMENT OF PUBLIC INSTRUCTION
JESSIE M. PARKER
SUPERINTENDENT
DES MOINES, IOWA

PUBLISHED BY THE STATE OF IOWA

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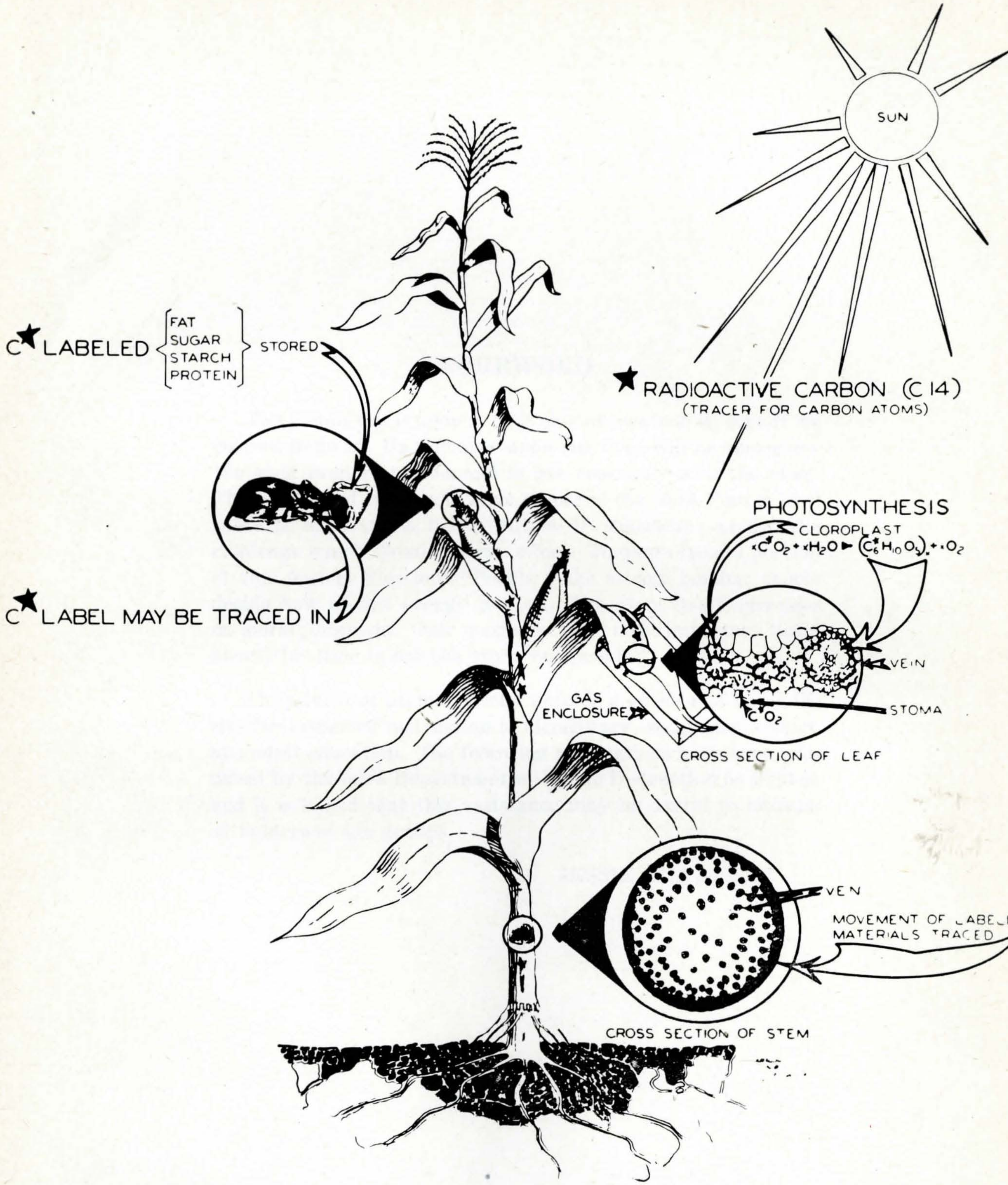
THE TALL CORN STATE

The accompanying illustration presents one picture of how atomic energy can be put to useful purpose.

Radioactive carbon (carbon 14) is widely used in research on plant and animal physiology. Here the radioactive carbon is incorporated into the carbon dioxide atmosphere in which the plant is growing. Through photosynthesis, the process by which plants convert carbon dioxide and water into food, the radioactive carbon takes the place of ordinary carbon in starches and sugars produced by the plant. When fed to animals, food labeled with radioactive carbon may be traced through the digestive process into the blood, muscle and bone. In this way scientists are able to analyze the most complicated organic processes.



RADIOACTIVE TRACER ILLUSTRATION

Courtesy of Atomic Energy Commission

FOREWORD

The atomic era is upon us! We cannot overlook it, even if we desired to do so. Its influence upon our lives will be enormous. We must prepare to live, and to live peaceably with the atom. The position of those who have prepared the Iowa Plan is that there is hope and a bright future if Americans accept the challenge which atomic energy offers. To quote from a portion of this first publication: "People make atomic bombs: people decide how atomic energy is used. The atom itself exercises no moral judgment. Only people do. The most important thing about the atom is not the atom, but people!"

The advent of atomic energy unfolds a number of possibilities for expanded instruction in elementary, secondary, college and adult education. The following publications have been produced by the Iowa Department of Public Instruction as guides, and it is hoped that this assistance may be useful to citizens of numerous age groups.

JESSIE M. PARKER

TABLE OF CONTENTS

INTRODUCTION

Atomic energy is here to stay. In fact atomic energy development in the United States is now more than ten years old. It was in the last week of January, 1939, that the phenomenon of nuclear fission was first confirmed in the United States. The release of atomic energy poses a number of problems, both physical and political. The physical and political problems are inseparable. What we do in one direction determines largely what **must** be done in the other. The American citizen does not approve of being stampeded into action through an "or else" attitude. He chooses instead to accept a sane and rational position and to work toward more lasting results than those achieved by fear-driven impulses. This opens all avenues for education. The American people need atomic literacy quickly. They need to know about the price which might be paid if they make wrong choices. They must be aware of the fact that it is up to them as to whether atomic energy will make their lives better or destroy them. Our democracy exists upon a sound judgment of its constituency. Education commands a high position in the survival of a race living within the atomic age. The facts of atomic energy can be grasped by most people. The Atomic Energy Commission branded the practice of keeping the public in the dark about atomic energy as "plain nonsense and dangerous nonsense, dangerous to cherished American institutions and for that reason dangerous to genuine national security."

The Department of Public Instruction, through the early encouragement of Mr. Robert Blakely, now of the St. Louis Star Telegram, has attempted to spearhead educational activity about atomic energy from a state level. Four committees have been organized to evaluate existing materials and to prepare additional materials, on various levels, from elementary through adult education. The final approval of their work has been left in the hands of a central planning committee. The names of all committee members appear elsewhere in this first publication.

This "Iowa Plan for Atomic Energy Education" is presented to teachers, future teachers, college students, high school and elementary students, and the lay public of Iowa with a most sincere desire that it may help remove fears and may assist in pointing the way toward a sensible and sane consideration of what American citizens can and should know and do about atomic energy.

The Department of Public Instruction is indebted to the many committee members listed elsewhere in this bulletin for their efforts and to others who served on our original planning committees.

G. E. HOLMES, General Chairman

BASIC ASSUMPTIONS IN THINKING AND PLANNING IN AN ATOMIC AGE

We now live in the atomic age. Adjustments are necessary. The following assumptions are basic to our thinking and planning for the future.

The advent of atomic energy is sure to influence our lives from now on.

People make atomic bombs; people decide how atomic energy is used. The atom itself exercises no moral judgment. Only people do. The most important thing about the atom is not the atom, but people!

Atomic energy has been used as a weapon of war, but it also holds promise of great benefits to mankind. In other words it is neither good nor bad.

The tasks in atomic energy will involve more than our own generation.

Peace in the atomic age is a scientific necessity, not just a human desire.

Our democracy is founded upon a belief that, when people are honestly and clearly informed, their conscience and common sense will carry them safely through.

The elementary facts of atomic energy can be grasped by most people.

The scientific method is not a mystery, but simply a way of thinking about things around us.

Today we need raw materials of atomic energy education. The basic information needed is neither secret nor difficult to secure.

A general understanding of the physical aspects of atomic energy will assist us in projecting our social and political plans.

Physical science and social science must move hand in hand in solving our world problems from now on.

Any effort to establish atomic energy education in school must include a total program. All pupils must know about the phenomenon as soon as they are old enough to grasp the facts, and must continue to keep informed on the subject.

HISTORICAL DEVELOPMENT OF ATOMIC SCIENCE

To those who are interested in the historical development of atomic science the following data are presented. Effort has been made to give a brief chronology herein with a view toward introducing historically the discoveries in atomic science leading to our present day.

From the date of the earliest recorded ideas of science until the last quarter of the eighteenth century matter was little understood. Its nature and even its mass were supposedly subject to large changes without any explanation.

The discovery of oxygen by Priestley in 1774 and the publication of Lavoisier's theory of combustion in 1777 laid the foundations for modern chemistry.

In 1808 Dalton published his atomic theory based on experimental evidence. This crystallized speculations which had been made by several philosophers at intervals during the centuries which had elapsed since 400 B. C. when an atomic theory was promulgated by Democritus. Light and heat were classed as elements by Lavoisier.

About 1860 Cannizzaro's restatement of Avogadro's hypothesis at Karlsruhe led to final clarification of the ideas, denoted by molecule, atom and equivalent.

In 1871 Mendeleeff published a periodic table of the elements containing 63 of the elements now recognized though some were not arranged in the correct order. This table was arranged according to atomic weights and presupposed indestructible atoms whose most characteristic property was the same weight for all atoms of the same element. (Men 100 years old now, could have been college graduates in 1871).

From 1895 to 1912 J. J. Thomson, R. A. Millikan and others showed that negative electricity was composed of unit charges (electrons).

From 1902 to 1913 the idea that the atom of each element consisted of a small dense nucleus surrounded by electrons revolving as planets was proposed and established by Lewis, Rutherford, Bohr, and others.

The chemical properties of the atoms are determined by the number and arrangement of the planetary electrons.

Between 1896 (the discovery of radioactivity by Becquerel and the Curies) and 1920, it was shown that many atomic nuclei were breaking into pieces, and that the pieces were common to all elements and few in number.

Three series (headed by Uranium, Actinium, and Thorium) spontaneously produce more than forty kinds of atoms belonging to twelve different elements.

Since alpha particles (nuclei of helium atoms) and beta particles (electrons) are the material particles given off by natural radioactivity, these particles were first supposed to be the building material for nuclei.

By 1932 protons (mass about one unit bearing a unit positive charge) and neutrons (mass about one unit with no charge) were considered the principal fundamental particles in a nucleus.

The number of protons in a nucleus determines the number of planetary electrons, therefore the chemical properties and element to which it is assigned.

The number of neutrons associated with the protons in a nucleus determines the stability against radioactivity, and helps in determining the atomic weight.

Since different numbers of neutrons can be present in nuclei containing the same number of protons, atoms of different weights and stabilities can belong to the same element (isotopes).

Between 1919 and 1934 it was shown that a high fraction of the supposedly stable atomic nuclei could be either broken into pieces or caused to become radioactive and decompose later by subjecting them to high concentrations of energy, such as rapidly moving particles or extremely short X-rays.

In 1934 Fermi found that slowly moving neutrons could enter the nuclei of many atoms and cause them to disintegrate often with the evolution of much energy.

In 1906 Einstein had suggested that matter and energy could be converted into each other and that the equation $E = mc^2$ expressed the relationship between matter and energy. E is energy in ergs, m the mass in grams and c the velocity of light in centimeters per second or 3×10^{10}.

Careful determinations of the energies evolved, and of the masses of the original nuclei and of the resultant nuclei showed that Einstein's equation is true. Mass disappeared when energy appeared and in the estimated amounts.

It was well known that atoms of intermediate atomic numbers and weights weighed less for each proton and neutron than the elements of large atomic numbers and weights.

If heavy atoms like uranium (atomic number 92, atomic weight 235) decompose by fission to form krypton (atomic number 36, atomic weight 84) and barium (atomic number 56, atomic weight 138), the two new atomic numbers require all of the 92 protons found in uranium nuclei; but the sum of the atomic weights is 222 which is 13 less than the original weight, 235. One might expect to find 13 free neutrons but other changes use a large fraction of the neutrons. The exact number of free neutrons is not published but is near 3.

SALIENT SCIENTIFIC FACTS ABOUT ATOMIC ENERGY

In the following pages an attempt has been made to unfold some of the basic facts of atomic science step by step. This collection of scientific facts should help to answer some of the most common questions about atomic energy.

All elements are composed of tiny pieces called atoms.

Each atom is like a small solar system and can be divided into smaller pieces.

An electron is a unit charge of negative electricity. In atoms, electrons travel around the positively charged nucleus at relatively great distances and move at high speeds.

Protons and neutrons make up the nucleus of an atom.

Ninety-two elements occur naturally in the earth. A few additional ones have been artifically made. These elements differ only in the way their atoms are put together—not in the basic particles of which the atoms are composed.

Atomic number refers to the number of electrons or protons each atom possesses.

Atomic weight is the ratio (approximately) of the weight of one of the element's atoms to the weight of the hydrogen atom. Hydrogen is our lightest element. Its atoms each have one proton and one electron, but no neutrons.

The nucleus of each atom has the same number of protons within it as there are electrons outside of it. This keeps the atom in electrical balance.

It is a neutron bullet from the outside which causes the nucleus to disrupt or fission. The neutron has a mass of 1 and carries no charge and, thus, can readily penetrate the positively charged atomic core.

Atoms having in their nuclei the same number of protons, but with a slight difference in the number of neutrons, are called isotopes. That is, atoms of a given element which differ in weight are called isotopes.

The word "isotopes" means "same place" in the periodic table of the chemical elements. Isotopes of an element have the same chemical properties.

In nature certain kinds of atoms, for example, those of radium, uranium and thorium, are breaking up naturally. This disintegration is called radioactivity.

Uranium 235 and plutonium atoms, when bombarded by neutrons, will split into approximately equal fragments. This is called nuclear fission.

This splitting or fission releases vast amounts of energy. If fission can be made self-sustaining, as in a "chain reaction," it is possible to obtain usable energy.

The key to the self-sustaining release of energy is the neutron. The normal uranium nucleus contains 92 protons and 146 neutrons. $92 + 146 = 238$. Uranium 238 is the most common uranium isotope. Two other uranium isotopes are U-235 (92 protons and 143 neutrons) and U-234 (92 protons and 142 neutrons).

Uranium 238 does not split. It captures neutrons and becomes uranium 239.

High speed neutrons are released when the atoms of uranium 235 split in two—about one to three neutrons to each split atom.

This process of fission in uranium 235 can, under proper conditions, set up a chain reaction.

A chain reaction is not possible in a small amount of uranium. The critical mass is the amount of uranium large enough to keep the chain reaction going.

The multiplication factor is the average number of neutrons released from a fissioning atom which are effective in blasting new atoms. For instance, if for every atom which is blasted apart, one of the released neutrons blasts another atom apart, the multiplication factor is one.

The size or mass of fissionable material which gives a multiplication factor of 1.00 is called the critical mass. A multiplication factor of 1.00 or better is needed to sustain a chain reaction.

An atomic explosion involves the sudden bringing together of separate chunks of fissionable material, thus exceeding the critical mass and inducing a chain reaction.

The "secret" about an atom bomb is not a scientific secret. It is a technical or engineering secret. It involves processes, not principles.

Other countries can make bombs.

An atomic pile reactor is simply enough uranium or plutonium arranged with purified carbon to reach the critical size or mass. The carbon is put into the pile to slow down the neutrons. Control rods of neutron-absorbing material are used to regulate the speed of the chain reaction occurring in the pile.

Slow neutrons are more effective in producing fission than speedy ones.

An atomic pile consisting of uranium 238 mixed with uranium 235 can be used to produce plutonium.

Plutonium, atomic #94, mass 239, is fissionable like uranium 235.

Most uranium is the non-fissionable 238 instead of 235, but uranium 238 can be changed into plutonium, which is fissionable.

When uranium 238 is converted into plutonium, the radioactivity and heat are tremendous. Large plants have to be located in fairly isolated places for the sake of safety, also where enough running water can assist in cooling the pile.

Deuterium or hydrogen bombs recently discussed have no critical mass. In theory they can be any size whatever.

Einstein's theory states that the amount of energy produced when any material is converted into its energy form is equal to the mass of that material times the square of the speed of light. The formula is $E=mc^2$.

In any atomic fission process, there is a loss of mass. This mass is changed into energy.

The peaceful uses we may expect from atomic energy are in two fields. One is power; the other involves the use of radioactive isotopes. These isotopes are made in the atomic pile.

SOCIAL ASPECTS OF ATOMIC ENERGY: PROBLEMS TO THINK ABOUT

The rapid development of science and technology in the past has always created social problems. With the advent of atomic energy and the atomic bomb many of these social problems have been intensified and new critical ones have been created. Below are presented some social and political problems to think about:

The discovery of atomic energy led to the enactment of the Atomic Energy Act of 1946, the provisions of which are truly an experiment in government.

It also led to the establishment of the United Nations Atomic Energy Commission, seeking a world plan for the control of atomic energy.

The Baruch proposals for the international control of atomic energy and the Soviet counter proposals should be of interest and should be studied by all Americans.

In 1948 the negotiations to control atomic energy on an international scale virtually collapsed. Will they be resumed?

The prediction by the A. E. C. that industrial power from atomic energy is a possibility in 10-20 years means that our ways of living will be changed.

The uses of radioactive substances in the study and treatment of diseases increase.

The employment of radioactive tracers in the understanding of the life processes of plants and animals promises a brighter future for us.

The use of radioactive isotopes in industry and research is resulting in new and better products.

The problem of the redistribution of our population and industry resulting from the possible use of the atomic bomb poses a problem never before experienced.

The threat of war will affect city planning.

Will there be a realignment of international powers? And what about the relation of small powers to big powers?

Military and civilian defense measures against the atomic bomb under threat of war become a real need.

The problem of **One World** looms larger than ever before.

The relation of national sovereignty to a possible international authority must be seriously considered.

The problem of public vs. private control of atomic energy for industrial purposes presents itself.

The problem of civilian vs. military control of atomic energy, especially as related to atomic weapons, is still with us.

The role of the small entrepreneur in relation to big industry in the industrial use of atomic energy warrants close study.

The impact of an atomic world on our basic socio-ethical values commands attention.

Secrecy in atomic science, affecting as it does our democratic tradition of free discussion and exchange of information, will continue to be a major problem.

SOME EDUCATIONAL IMPLICATIONS

In a democracy the important public decisions cannot be left to any one man or to a handful of men. They must be the decisions of the public at large. That is why education is so important and why we must have faith in the judgment of the people as a whole. In reaching decisions about atomic energy, the American people has at stake its whole future and the future prospects of many peoples in many lands.

This committee has from the beginning based its work on the assumption that a program of sound education on atomic energy must rest on a calm and objective consideration of atomic energy as a permanent and important part of our life and that this program of education can be most successfully carried out through the existing educational agencies. On this basis the committee has provided a program for all ages and levels of maturity. Following sections are, therefore, devoted to the information that will be understood by pupils in the elementary and secondary schools, by college students and by the adult population.

The average citizen has an obligation to understand this newly discovered force, but the obligation for its understanding rests even more heavily upon the teachers in our schools. In the final analysis, it is these teachers, to a great extent, who interpret our civilization to succeeding generations and who are in the best position to make all of the people understand the implications of this new found force. Despite the fact that there may be some aspects of the subject that he does not understand, the teacher must **not** take the attitude that this new force is so difficult that it would be futile for him to strive for comprehension. Neither can the teacher afford to consider this matter as one of the numerous demands made upon his class time. The teacher must constantly reach decisions about what can be omitted in order to make room for more significant subject matter and certainly the teacher will need to make such decisions with respect to the curriculum in order to include material on atomic energy.

To aid the teacher in promoting this education, the administrator needs to be constantly alert to providing materials for instruction so that the teacher will not need to spend time which might otherwise be devoted to instruction in finding suitable materials or information from which suitable materials can be devised. Most colleges will have an adequate supply of materials in their libraries, but in the public schools particularly, it is important that principals and superintendents see that such materials are on hand.

Certainly atomic energy is here to stay and as David Lilienthal has said, "Nobody can take it out of your life. Like the sun or the tides or the law of gravity, it is there and it affects you. The discovery of the release of nuclear energy is so important, so fundamental that the country will be wary of those who seek to treat it as just another weapon, just another invention. Here is a process that affects everything that we as human beings are concerned with: education, health, agriculture, industry, war—and peace."

WHAT IS THE IOWA ELEMENTARY SCHOOL PROGRAM IN ATOMIC ENERGY?

The Elementary School Production Committee has prepared a **Source Book** for use by teachers in the elementary and junior high school. The use of this **Source Book** will depend upon a number of factors: the local curriculum, the preparation and interest of teachers at various grade levels, the philosophy of the school, the ability of the pupils, and the extent to which the administration believes in an in-service education program.

The elementary committee has chosen to emphasize the preparation needed by children for successful living in the atomic age. For this reason, they title their publication **Preparing Elementary Pupils for the Era of Atomic Energy.** Although realizing the difficulty of doing much with the scientific aspects of atomic energy, the committee has included suggested ideas and instructional materials that can be adapted to local situations. Major attention, however, has been given to the building of social understandings and personal traits which seem to be especially important in today's world.

Some parts of this Iowa plan have already been tried out in classroom situations. The plan in its entirety, however, makes no effort to present a grade-by-grade or day-by-day program of instruction.

Schools giving emphasis to current events as part of their social studies program will soon find it relatively easy to carry out many of the suggestions presented in this handbook. In schools which have strong science programs, the children may welcome an opportunity to study atomic science and the problems which center in and grow out of it.

The publication is organized by chapters. Attention is directed especially to Chapter I, where the basic assumptions which guided the committee in their work are presented. Chief among these basic assumptions is the one which states: "**Maturity is not acquired suddenly in adult life.** Concepts, attitudes, habits, and skills are learned step by step throughout our childhood and youth. A good educational program will discover as clearly as possible the first age at which children should have certain experiences. Those experiences will serve as foundations for continuing the development of related experiences. There are certain concepts, attitudes, habits, and skills, which, if developed at the elementary level, will not only be valuable in themselves and thus make a wise use of the children's time—they will also serve as necessary foundation experiences for atomic energy learning at the high school level."

Chapter II presents the point of view of approximately 30 elementary science and elementary school specialists regarding the teaching of atomic energy to grade-school children.

In Chapter III, the elementary science curriculum is analyzed, indicating ways in which the normal science program will contribute foundation experiences for the understanding of atomic energy.

An interesting point of view regarding the **Social Studies Program and Atomic Energy** is presented in Chapter IV. **The Language Arts and Atomic Energy** is the subject discussed in Chapter V.

To furnish a convenient classification of activities, under such headings as (1) Bulletin board activities, (2) Experiments, and (3) Intergroup activities, is the function of Chapter VI.

Chapter VII will be published separately (as well as being part of the teachers' handbook) and thus made available for direct use by children. This chapter presents a story entitled **Barbara and Howard Discover Atomic Energy.** The story is illustrated with drawings and photographs.

In order to obtain some first-hand information regarding children's interests and reactions to the study of atomic energy an experimental unit was taught in a fifth grade class in the Campus School, Iowa State Teachers College, Cedar Falls. A diary report of this unit was recorded and is presented in Chapter VIII. An evaluation of this unit was made both by the children and a competent observer (another fifth-grade teacher).

Chapter IX presents a brief but informative discussion (at the adult level) of the **science of the atom.** At the close of the chapter suggestions are made as to **What the Future May Hold for Mankind.**

The capstone of this publication, Chapter X, presents a number of citizenship traits which appear to be of high importance in today's world. Suggestions are made for helping the pupils acquire these citizenship qualities.

There are three appendices: (1) Annotated lists of student and teacher materials, (2) Glossary of technical terms (these terms are explained in the words of fifth grade children as well as being given a more technical definition), (3) A description of atomic energy as it has been taught in about 10 elementary school systems in the United States.

The committee members who prepared this publication at first felt that they were exploring in a "desert" of content and instructional materials. Recognizing the importance of the problem, however, they set out to discover what could be done with atomic science and its related problems at the elementary level. While they have not found an "oasis" of materials they have explored far enough to uncover and compile a number of useful ideas and suggestions.

As a **source book**, this publication should serve a useful purpose. Through its use, elementary teachers should be better able to help their pupils to develop an awareness of the significant things that are going on in this era of atomic energy. It is fully expected that this fast-moving age will quickly reveal many ways in which the publication can be improved. The worth of the source book will be attested by the constructive experiences which its use may bring to the elementary classrooms of the state.

WHAT IS THE IOWA SECONDARY SCHOOL PROGRAM IN ATOMIC ENERGY?

It is apparent from the preceding section dealing with the elementary school that there is much valuable background material and many worthwhile activities which can introduce the pupil to an understanding of atomic energy. Since an organized and systematic study of the scientific fundamentals and the social implications requires greater intellectual maturity, the senior high school has been selected as a fitting place to introduce a study of THE ATOM AND YOU.

The deep significance of the atomic era makes it imperative that all students in Iowa high school should achieve some understanding of atomic energy. Knowledge of the basic scientific principles of matter and energy is so fundamental to developing insight into the social implications of atomic energy that the teachers of science and the social studies should join together in a cooperative teaching effort. The fundamental concepts concerning atomic energy which high school boys and girls (and alert citizens generally) should know are sufficiently simple and clear. Teachers willing to invest a little time and effort need have no fear of their ability to teach effectively about atomic energy.

The urgency of teaching about atomic energy is such that every possible encouragement should be given to teachers and administrators to introduce the subject as quickly as possible into Iowa schools. It is with this in mind that a teaching unit entitled THE ATOM AND YOU has been prepared as one part of the Iowa Plan for Atomic Energy Education. The unit is designed to be taught for three weeks in the eleventh grade as a part of the required course in American History, though it can be equally effective as a part of the problems course or the American government course in grade twelve. Under ideal conditions, the physics and the history teacher will jointly develop the unit. The materials are drawn up in such a way, however, that neither one need hesitate to teach the unit alone.

The unit manual contains a teacher lesson plan and a student assignment sheet for each day, supplementary and follow-up activity suggestions, an annotated list of audio-visual teaching aids, a modest list of the most useful materials to be acquired by the school library, and some suggested evaluation techniques and multiple-choice test items over the unit. The appendices contain useful summaries of content materials for the use of the teacher and students. The teacher lesson plans contain a statement of the problem for the day, a brief content outline with keyed references, suggested activities and teaching procedures, and the student assignment for the following day. The student assignment sheets, which can be reproduced and distributed to the students, state the problem to be considered, give the assignment with reading references, and list study and discussion guide questions.

A unique and useful feature of the plan is designed to save busy teachers time in gathering together the materials needed to carry on the unit. The Iowa State Department of Public Instruction has stocked all the basic references included in the lesson plans, and is making them available in convenient kits or packets at minimum cost. A single order on the form provided in the manual is all that is required.

The specific nature of the unit may give the mistaken impression that the plan is rigid and inflexible. This is certainly not the intention of the manual. Rather, the unit is conceived as a "critical mass" necessary to initiate a "chain reaction" on the part of students and teachers in finding better ways to learn and teach about atomic energy. It should be adapted to the local school situation and used flexibly to fit the individual teacher. Obviously, constant revision will be necessary as new developments occur and better teaching materials become available.

One thing is certain. No matter where the implications of atomic energy are taught, or by whom, or by what methods, the real measure of effectiveness will be seen when and if Iowa high school students develop a feeling of personal responsibility in understanding atomic energy and are willing to "do something about it" in their own communities. It is to this kind of "understanding with action" that the unit THE ATOM AND YOU is dedicated.

WHAT IS THE IOWA COLLEGE PROGRAM IN ATOMIC ENERGY?

The awesome destruction possible with atomic energy in the form of bombs gives a first impression that atomic energy is a detriment to total mankind. There are, however, with the advent of atomic energy, many signs looming on the horizon that point to extensive beneficial effects. These benefits could far outweigh any destruction but intelligent actions are necessary to direct properly the course of world-wide utilization of atomic energy.

Since a large proportion of the leaders in our society get some college training, it is exceedingly important that an adequate perspective of both the physical science and the social science relative to atomic energy be made available in connection with college work. It is hoped, that by proper training, the college graduate, whatever his specialization, will be sufficiently familiar with the physical and social aspects of atomic energy to think intelligently on problems involving atomic energy as they come within the realm of his activity.

It is quite obvious that society as a complex of social relationships never stands still; it is in a perennial state of activity. The constant alterations in the nature, content, and structure of groups and institutions, and in the relationships among men, groups, and their institutions are undeniable facts of modern life. Social life today is different from that of yesterday; social change is a reality.

Many factors contrive to make for social change. In the last decades the role of technological innovation as a source for social transformations has become increasingly significant. Atomic energy, as one of the most recent major technological-scientific inventions, portends many major social consequences. These social implications of atomic energy may be viewed within two frameworks; within a framework of the threat of war and within a framework of peace.

The college syllabus on the social implications of atomic energy seeks to view society in the atomic age with and without the threat of war. By first understanding the principles governing the relations of technology and social change it should be possible to place the problem of the social aspects of atomic energy within a basic pattern of orientation. Starting, therefore, with the existing theories and principles of social change, the syllabus, proceeds to the problem of technology and social change, and then to the possible social effects of atomic energy. Problems relating to the international control of atomic energy, possible peaceful uses of atomic energy, and an objective analysis of socio-economic aspects of these uses are noted. Alternative plans for the inclusion of atomic energy materials and information in college curricula are suggested.

The destruction of a large part of Hiroshima by the explosion of one bomb may seem to be a totally unheralded innovation. The general public may feel that the making of such a bomb was a fortunate (or perhaps unfortunate) accident. Comparatively few people know the long series of discoveries and the slow sure building of a foundation of fundamental scientific principles on which the preparation of that bomb was based. No one person, not even the combined wisdom of all the experts, completely comprehends all of the causes and effects of this most spectacular of the recent revelations of physical science. But those who have been following the developments in our knowledge of the structure of matter can trace the steps which foretold the possibility and finally before 1940 the probability that energy could be released rapidly in enormous amounts and tremendous concentrations. The making of the atomic bomb, like all other scientific achievements, was the result of establishing of facts and gradual organization of knowledge.

Some basic ideas of physical science connected with atomic energy and a rather general discussion of what atomic energy is, how it operates and some of its possibilities are presented in the material for education on the college level. A number of possible means for including education in the physical science of atomic energy in the college curricula are suggested.

WHAT IS THE IOWA PLAN FOR ADULT EDUCATION IN ATOMIC ENERGY?

The Importance of Clear Premises.

A practical people, Iowans are as a rule more concerned with getting things done than with making philosophies. However, research into atomic energy education for adults undertaken at the State University of Iowa [1] has already revealed that amongst leaders of American research and opinion there is considerable confusion concerning what adults should know, and that, at least partially as the result of lack of clarity in direction, there is a semi-paralysis in systematic adult education other than that specifically designed for school teachers.[2] What has been achieved and what it is hoped to achieve in Iowa spring from a philosophy of adult education for the atomic age which was wrought out by a group of men and women of various professions and differing localities, many of whom never met the others and most of whom, like other Americans, started with an undefined feeling that "something should be done." Because it was possible in Iowa to articulate this feeling and to arrive at a functional philosophy unanimously subscribed to by workers in the field, a brief section of the adult education bulletin "Iowa Citizens Investigate Atomic Energy" is descriptive of how a set of clear working premises were achieved.

The premises on which adult education in Iowa now rests are quite simple and may be briefly expressed thus:

Because the future of democracy itself is inherent in the way problems arising from the impact of atomic technology on society are solved, the primary aim of adult education in atomic energy is spreading awareness and understanding of the social issues, encouraging their discussion and attempted solution, among a significant proportion of local citizens.

Because the social problems are intrinsic in atomic science as applied to contemporary living in and among the national states, a sufficient knowledge of atomic science and its applications is indispensable for the understanding of the social problems.

Because scientific developments are the context of social issues, including secrecy and therefore security, adult education logically proceeds from science to social issue.

And because the scientists and social thinkers of tomorrow grow in the adult atmosphere of today, atomic energy is a proper part of general adult education.

Premises, Facts and Concepts.

This type of thinking about atomic energy education does not mean that there has been in Iowa a neglect of consideration of what facts adults should know. Rather it conditions the presentation of facts so that they may be immediately useable in adult thinking. Rote knowledge of the Atomic Energy Act means little to adults. The revolutionary decisions it represents are meaningful only in the context of the circumstances in which it was planned, and these circumstances arose out of atomic technology and are contextual in it. The whole is a single concept.

It is idle to discuss policy for the export of radioactive isotopes if the discussants do not know what radioactive isotopes are and how and where they may be manufactured in this world. Isotope and policy are again a single concept. At the highest level of social thinking in the atomic era, the nature of atomic energy and its international control are a single concept. Unless the contextual relationship is understood, adults may well not realize that the choice between forms of control of atomic energy is compulsive and radically different from choices between forms of religious worship or practices in constitutional government.

Thinking conceptually is therefore necessary to the maintenance of democratic procedures. Such thinking leads automatically to confidence in open discussion, relegates fear to its rightful place as one of the stimuli to action. Because fear is detrimental to understanding, its alleviation is a conscious aim of the Iowa program. A second section of the adult bulletin is devoted to typical facts and their arrangement in useable concepts.

The Approach to Adults.

Normal channels of adult educational activity—reading, seeing films, listening to lectures, staging public demonstrations, attending classes and workshops—are recommended in Iowa. The more normal, the less melodramatic the channel of communication, the more likely is the subject matter to become permanently a part of local thinking.[3] In Iowa much thought was given to adapting material to local interests in such a way that the subject would not appear as merely academic.

The final section of the bulletin is descriptive of projects recommended for Iowa and based, where possible, on what has been experimentally developed under local conditions. The public demonstration, for example, is based on the Burlington Atomic Energy Week, the adult lecture series on the Marengo Experiment, the special interest group work on an Iowa City Project.[4]

Special techniques developed during the course of experimental work are also described. They include club quizzes for motivation, means of adjusting national films to local environments, means of testing and evaluating films informally to distinguish the effective from the merely pretentious, ways of involving people and organizations from the morning milkman to the Sunday sermon, "group memory" note preparation, question recording as an index of existing interests, the use of individual interests in reading, and others. These techniques are adjustable to any situation on an inter-state basis. Much of the information on resources remains local.

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[1] "A Study of Atomic Energy Education for Adults" by Emil C. Miller, incomplete at the time this bulletin went to press.

[2] Inasmuch as school teachers are preparing for classroom expression or are under compulsions not bearing on other adults, teacher-training workshops are not characteristic adult education.

[3] The Iowa editor, W. W. Waymack, when a member of the Atomic Energy Commission, stressed constantly the importance of designing atomic energy education in the locale in which it was to be used.

[4] Burlington, Iowa; pop. 26,000, industrial city.
Marengo, Iowa; pop. 2,100, agricultural county seat
Iowa City, Iowa; pop. 27,000, university town

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