PRELIMINARY WORK
IN SCIENCE
IN THE JUNIOR SCHOOL

Preliminary Work in Science
in the Junior School.

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C O N T E N T S

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CHAPTER 1.

The Necessity for Elementary Science Training

Modern life is so closely bound up with the progress of science, that there is scarcely a field of human activity now untouched by its influence. Our present health, home, city, national and even international life, alike depend on the material advances made in science during the last century. Thus, we can live in large numbers in cities only because of the advances in medical and sanitary sciences. The cities themselves, with homes comfortable and convenient beyond the dreams of our grandfathers, depend, in the main, on discoveries in the physical sciences and their application by the Applied Sciences. Their industries have been enlarged in scope and efficiency by the application of scientific principles. The trains, street-cars, automobiles, all made possible by the initial discoveries of a small number of physicists and engineers, carry millions of people to their homes everyday. In a like manner, trains, steamers, aeroplanes, telephone, telegraph and radio services have made international communication possible. Thus, science has made the world one, in a sense never before comprehended by man. We are only now beginning to realize what tremendous, political, economic, yes, even ethical questions this involves.

This latter discussion reminds us that the changes brought about by Science are not confined to the material world alone; the changes it has wrought in the world of thought are also far-reaching. Thus, Science has freed civilized man of the terrible fears and superstitions, which have haunted man from prehistoric times. Again, it has spread hope where before was despair - as in the case of numerous diseases. For instance, thirty years ago most people who contracted tuberculoses died from sheer hopelessness; now, through a complete change of view-point due to the advances in medicine, in many cases people recover because they believe they can recover. Furthermore, Science has created an idea of continued progress, and its implications in the social world are amazing.

"The idea of progress, the idea that civilization is moving forward to better and better states is taken for granted to-day. It is part of the web of modern thought. It has reformed the ethical code recognized in the western world by the admission of a new principle of far-reaching importance, namely, the inclusion of the unborn generations of the future in the responsibilities of the present. The principle of duty to posterity is quite a new idea and is a direct corollary of the idea of progress, and it has given a dignity and purpose to the conduct of life which before was wholly lacking. I repeat that in spite of the fact that we can hardly imagine any other view, the idea that civilization is moving and will move in a desirable direction is quite modern, and historians agree that it began in the seventeenth century and is a product of the growth of natural knowledge".[I]

Moreover, man no longer tolerates ills or inconveniences simply because they have always been, but attempts by systematic social or scientific research to remedy or remove them. Thus, man now sets out to control his environment in a way never before attempted, scarcely even conceived, in the history of the world.

From these considerations, it would seem that our present mode of life, and to a lesser extent perhaps, our ideas also, are greatly influenced by the advances made in Science, and the changes these bring in everyday life.

If, then, science is of such great importance in modern life, how is it to be regarded? We can either ignore it or, by a more general appreciation of its method, make it a force for the betterment of society. For science is at best an instrument - a method of attack - neither good nor evil of itself. It is for man to use either to his advantage or disadvantage. But to control an instrument, we must understand it. Consequently we must seek to educate the rising generations to understand science and its method of working, in order that

I. Growther, J.G. (Editor) "The Place of Biology in ~~National~~ Education". p.17

it may be used effectively for man's betterment and not his destruction.

This is no easy task to accomplish. The work of the scientist is highly specialized; he may spend a whole life-time on research in a seemingly insignificant part of one branch of science. How then are ordinary people, who make no pretense of special abilities in this direction, to understand the workings and applications of science, and experience the wonders and delight it reveals?

This problem, a relatively new one, has only been tackled within the last thirty years[I]. Previous to that, individual sciences (mostly chemistry and physics) were taught in schools, but there was no real attempt to give this broader cultural view of the whole, we now deem necessary.

Thus, the aims of science teaching have had to be enlarged. The old narrow treatment of the individual science, from the point of view of method and data only, is being superceded by a wider vision. With the growth of civilization certain great and noble avenues of human thought and expression have become apparent. Science, like history, is undoubtedly one of these. Thus, Science sets out to explain the phenomena of the physical world by means of observation, experimentation and finally reflection on this

I. This is true as far as the schools are concerned. I believe, however, that men like Davy, Faraday, and Huxley had this wider view, as shown by their popular lectures at the Royal Institution considerably more than half a century ago.

data; history attempts to chronical events, reveal the workings of cause and effect within these, and show the development of customs and relations in human society.

"The first point to be seized is that a subject justly claims a place in the school only in so far as it represents a movement of primary importance in the evolution of the human spirit....... Equally with literature and art, science is one of the grand historic expressions of the human spirit; it is entitled, therefore, to an equally honorable and spacious position in the curriculum"[I].

Hence, to deprive an individual of some knowledge of Science is to render his equipment for life the poorer. With this in view then, it becomes important that each child, whether he leave school early or late - at 14 or at 18 - should have some science training, no matter how elementary.

We must now return to the question of how such science training is to be accomplished. I shall now proceed to discuss the aims, method and content of science courses with particular regard to the work of the Junior School.

I. Nunn, Sir T. Percy - "Science" - "The New Teaching" edited by John Adams.
He also expresses the same idea, in slightly different terms in the report on "The Eastbourne Conference on Examinations" edited by Paul Munroe. p.55.

How Shall a Broad Cultural Education in Science be Achieved?

CHAPTER 11.

General Aims and Methods

Science, as has already been intimated, has acquired a unique importance in modern culture. Hence, of necessity, science education has become increasingly important in the modern school, But, heretofore, the efforts of the science teacher have been concentrated largely on the method and specific material of the science or sciences taught; while Science in its broader, human aspect has been entirely disregarded; but if we are attempting to give a modern, cultural education, this last must, it seems to me, be our cardinal aim. Thus, the science teacher must no longer concern himself solely with the mere facts and methods of science, valuable as they may be; it is quite as important that he attempt to set forth the aim, the spirit, the service of Science.

"We are, however, confident that the teaching of Science must be vivified by a development of its human interest side by side with its material and mechanical aspects and that while it should be valued as the bringer of prosperity and power to the individual or the nation, it must never be divorced from those literary and historical studies which touch most naturally the heart and hopes of mankind"[I].

I. Report of the Committee on the Position of Natural Science in the Educational System of Great Britain. - 1918. p.5.

If this be the case, we must develop something more than a slight knowledge of chemistry or physics or, perhaps, biology. The science teacher must set out to cultivate a knowledge of Science, illuminated at every turn by reference to familiar everyday things and also to human affairs. Thus, to teach one branch of science, however well, will not be enough. The great facts and generalizations of the physical and biological Sciences must be presented, and their inter-dependence shown. It will be impossible to do this without showing in part the historical development of Science, and introducing some of those great personalities which have so greatly influenced that development. Then Science will be presented as a living, creative force - not to be confined within the covers of a text-book, and science teaching will illuminate everyday happenings and phenomena.

With this larger purpose always in mind, the science teacher must aim to develop the power of observation by means of practical work, and must strive to inculcate habits of careful, precise recording of such work. Then, by his own example, he must aid the student in reasoning from observed facts and in making careful generalizations. These are specific powers that science teaching, by its very nature is suited to develop, though I do not imply that they can be attained only through science teaching.

"A knowledge of the methods of observation and experiment in the different branches of science helps to develop a logical mind, a critical judgment and a capacity for methodical organization; while a knowledge of the great questions with which science as a whole is concerned fosters the broad outlook which is essential for the successful solution of the problems of life"[I].

Science training must begin in early childhood by the observation of common plants, trees, birds and insects etc. Great care should be taken that the child's natural wonder and appreciation of the things he observes should increase, and not diminish, as his knowledge of the universe grows. Then later, he will slowly perceive the relation of cause and effect, the rule of natural law. Finally he will reach a stage of mental development, when his knowledge, gradually accumulated, can be arranged systematically in the form of the sciences. Throughout the whole of his development, and particularly in this last stage, he should gain some acquaintance with the method of science - its formulated laws, its tentative hypotheses, discarded when they cease to stand the test of fact, its rigidly tested theories. He should grasp to a certain degree, the aim of the scientist - simply to increase knowledge, with no ulterior motive of personal credit or gain.

"To smite all humbugs however big. To give a nobler tone to Science. To set an example of abstinence from petty personal controversies and of everything but lying. To

I. Westaway - "Science Teaching". p.10.
The same idea is also expressed in "Natural Science in Education", p. 58.

be indifferent whether the work is recognized as mine or not, so long as it is done"[I].

Then, finally, he should begin to appreciate the fact that Science is always changing, and, therefore, never adheres dogmatically to one point of view. It is built up fact by fact, hypothesis by hypothesis. When one of the latter fails to interpret new facts it is discarded; thus, hypotheses are merely the tools by which Science progresses.

But above all in this teaching, I would wish that the childlike wonder of the universe should be preserved and deepened. Once really awakened, I do not think it can be killed, but it is often dimmed by poor teaching and processions of half-assimilated spectacles. Wonder should grow with knowledge, for it is intensified by love and understanding.

"The most obvious and fundamental characteristics of the scientific life are a love for "nature" and a disinterested desire to understand her ways. There are two things here, love and understanding, which God has joined together and man cannot hope to sunder without grievous loss to both"[2].

Thus, even one view through a microscope opens up possibilities of a world more beautiful, more intricate than we had dared even to imagine. Consequently, while the rational, methodical powers of the pupil should doubtlessly be

I. From Huxley's "Journal".

2. Nunn, Sir T. Percy, the article "Science" - "The New Teaching" p.160. Edited by John Adams.

developed by science teaching, this must not be allowed to obscure the spirit of wonder and awe of the universe - the true spring of religious feeling and genuine love of nature.

"......those vulgar heads that rudely stare about, and with a gross rusticity admire his works, ... those highly magnify him whose judicious enquiry into his acts and deliberate research into his creatures return the duty of a devout and learned admiration"[I].

There is one precaution we must observe. We are not trying to make every school-child a scientist; such would be impossible. Neither do we wish that each be a naturalist; naturalists are born rather than made. Our real aim is simply that each child in his years at school should begin to realize the aim and spirit of Science, its place as an indispensable part of modern culture, and in the meantime develop his own understanding and appreciation of the universe.

To achieve this object we must try to create for science a wide, cultural background similar to that aimed at in the teaching of literature. To do this, we must widen educational opportunities, particularly in the early, less formal stages of science teaching. In the selection and presentation of material for study, we should aim so to challenge the individual child that, before he leave school, each shall find some particular interest which compels him to further reading, observation, study or the like.

[I] Browne, Sir Thomas - "Religio Medici", as quoted "Biology in ~~National~~ Education". p.131.

No side of school training can be more fertile than the science work for stimulating such interests, not simply because of the universal range of natural phenomena, but also because of a child's inherent curiosity with regard to them. Thus, one child may be disposed to observe birds, another insects, a third may possibly be interested in collecting pebbles or shells, while a fourth may delight in making scientific playthings. Teaching which tends to awaken or create such interests may possibly form the basis of life-long hobbies or pursuits of inestimable value to the individual.

The importance of this phase of education would seem to be enhanced when one considers that, in the future, it is highly probable that many adults will have an increasing amount of leisure which they, unaided, will be unable to fill adequately. Such hobbies and interests, created early in life, may possibly be valuable as a pleasant and intelligent use of leisure time. This is not of itself sufficient justification for the inclusion of science teaching but it is, nevertheless, one which merits attention in modern education. Also, this increase of leisure will probably enable many to escape more frequently from cities, where they must earn their living, to the country for rest and refreshment. Here, again, Nature Study teaching should aid the individual, in developing outdoor interests, and also the ability to observe. For nothing, it seems to me, can be more pitiable than people with leisure to spend in the country, or even city-parks, and yet no interest in the out-of-doors - no desire to observe, study or even enjoy the myriads of things in common view! Moreover, there is real danger that the population of large cities will actually lose by disuse, this power of observing and enjoying natural rather than created pleasures.

Possibly, these aims, which have already been discussed may be criticized as those of a complete scientist. I do not expect ~~these~~ pupils leaving school to realize them fully. They are to be considered as ends and not expected at the beginning of science work. The aim, the method, the philosophy of Science can be realized only after years of study and preoccupation on scientific problems. The fact remains however, that even children at school, if taught with these aims in mind, can at least gain an inkling of their meaning. We can only hope that this may be deepened by future reading and study. Moreover, if science is to aid the modern state in its fullest capacity, the rank and file of people must have some understanding of its method, and the schools are the main agent in establishing this.

The need that scientific knowledge and method be more widely dissemihated, urges on us a further caution. It will not be enough to introduce science teaching into the primary school, but the substance and method must be specially adapted to its peculiar needs. Thus, it must be an end in itself, and no mere preparation for the science work of the secondary school. It is for this reason I urge that the time spent in science teaching should be divided between chemistry, physics and biology etc., in order that the pupil may obtain a well-rounded picture of science as a whole. This will, of course, involve a very careful selection of material, but the final result should prove infinitely superior to that obtained if all the time were devoted to one science only. Consequently, each stage of science training must be considered as an end in itself, and its aims, content, and methods must be determined with this in mind.

In view of the above, there are two further considerations which merit attention here. First, in the development of the child there are definite stages of psychological development, each with its own particular needs. Science courses must be planned with these in view. These stages will be discussed in detail in Chapter 4.

Secondly, it is universal experience that there are certain well-defined periods before the completion of the whole secondary education when children tend, for one reason or another, to leave school. The ages at which these occur, are, roughly, about 14 and again about 16. I cannot attempt to discuss all the reasons for this phenomenon, which is so closely bound up with the present economic and social structure of our society. For our purpose, however, this fact must be recognized and education organized to meet the needs of these two groups. The first of these are the children who leave school at the end of the primary schoolcourse, the second, those who leave after one or two years of secondary education. If primary education is considered an end in itself, and treated accordingly, the first group will, at least, leave school with their education a complete thing as far as it has developed. The second group however, leave in the very middle of their secondary education - in a betwixt-and-between stage with each subject in a raw, unfinished state. Their education can in no sense be regarded as a well-balanced complete whole (even when its stage of development be considered) but is rather to be compared to an unfinished garment with many rough ends and seams.

To meet the needs of this latter group special schools have sprung up in various countries. Apart from technical and trade schools, the Junior High School J.H.S. on this continent the Central or Modern School in England, the Mittelschule in Germany and l'ecole primaire superieure in France, all have arisen to fill this need. The curriculum is a shorter but complete, and balanced type of secondary education.

We must, therefore, recognize this type of school as a definite stage in education. The science course planned with this in view, must be shorter than that customarily given in a secondary school, but well-balanced and complete in itself. Its aim, stated simply will be to develop an understanding and sympathy with nature, and some little acquaintance with the fields of knowledge and invention needed for an intelligent outlook on modern life.

In general, the method employed in science teaching, whether it be in the primary school, the Junior High School or the High School ~~are~~ is essentially the same. It is rather in the <u>degree</u> than in the method wherein the difference lies. The basis of all science teaching is observation - <u>observation of things</u>, and this is true whether a plant or an animal, or a carefully regulated chemical or physical experiment be under consideration. Naturally enough, we would not ask a little child to observe minute objects or changes, nor would we expect him to use precision instruments to aid him in his work; but the essential fact of observation is the same in each case. Also, the child in his nature study lesson will reason from his observations in quite as real a sense as will the boy who has completed his observations in a chemistry laboratory - again a difference in degree only. The essential difference in the various stages, is I think, in the degree to which experimentation is employed. Experimentation will begin early in the primary school, with simple, every-day apparatus, and will continue, always increasing in difficulty and range to the end of school life. In the early stage, experiments will be largely suggestive; in the later stage, they will be used not only as a means of accumulating data, but also as a means of testing the truth of conclusions - i.e. as a check on reasoning powers.

Much has been written regarding various methods employed in science teaching, for example, the Concentric method, the Heuristic method, the Historical method, the Project method, and so on. They are all built, it seems to me, on the same fallacy, namely, the magnification of one sound aspect into the whole of method.

Thus, the "concentric" method begins with the simpler aspects of a subject - say, heat - and comes back and back to it at various times in the physics course each time developing some aspect of the subject in greater detail. But this is a very ordinary device of an experienced teacher, - to postpone the treatment of certain aspects of a subject until his pupils' grasp of facts, or, perhaps, their ability to handle these same facts has increased. In other words this so called "method" is merely a way of organizing the subject matter concerned.

The Heuristic Method, much in vogue 30 or 40 years ago, consisted largely of laboratory training. Pupils were set to work in the laboratory with the very minimum of instructions and told to "discover" certain facts, or laws, etc., for themselves. Naturally enough, they made frequent mistakes, drew many faulty conclusions and learned a little in a very long time. In all probability the teacher did most of the real work, for it is rare that, unaided, a pupil can see beyond the particular experiment in hand to some hitherto unknown phenomenon or generalization. Moreover, the very assumption that a boy in his inexperience can "discover" facts or generalizations which a scientist, possibly a number of scientists, had spent long years in developing, seems entirely unwarranted . Let us speak by all means of "search" and "inquiry" but the term "discover" in this connection is misleading, to say the least. Undoubtedly, a gifted teacher who knew just when to give or withhold information, could obtain good results by this method, if he had only a small group with which to work, but even then his work would necessarily be limited in outlook and accomplishment.

The Historical Method, though undoubtedly useful at times, is limited very seriously for the purposes of science teaching. Frequently, it may seem desirable to develop a subject - for instance in chemistry - by reproducing the original experiments of the investigators. This is, however, usually impossible due to the nature of the apparatus used and the time required for the experiments. As a general rule, historical facts will be introduced as parts of the lesson; occasionally they may be used as a background in order to understand some development in Science. Pupils should undoubtedly know something of the historical development of the science or sciences they are studying, also of the lives and work of famous scientific investigators. There is a danger, however, that the science teacher in his own interest in this aspect of science, may possibly obscure the development of his main subject by too many details concerning the lives and work of investigators. Whatever use is made of the historical, either as a method of approach of development of a subject, the history of Science should not be neglected. This would for many reasons be placed towards the end of the science course.

Much has been written on this continent concerning the Project or Topic Method, which is said to be very widely applicable to science teaching. A subject of wide interest is chosen by teacher and class, and after discussion certain things already known are sorted out, and other aspects which need further discussion and investigation set aside to be treated in turn. It is claimed that, because the "project" has in a sense been chosen by the pupils, the subsequent work is more real and consequently of greater interest to them. There are, however, inherent dangers, sometimes, triviality, often lack of logical development and frequently a neglect of the "tool subjects" of education. Moreover, it is really only a method of approach rather than a method in itself, and as such is used very frequently in teaching. Capably used, however, this so-called "Project Method" should stimulate individual work in class-room, laboratory, library and even out of school - which is highly desirable.

But whatever the method employed, science teaching must begin with facts, facts of everyday experience added to by those obtained from experiments. Principles and chains of reasoning come later, the facts are the foundation. In other words, science teaching must be largely inductive in method.

I have discussed in general the aims and methods in Science Teaching. I shall now consider the types of science courses suited to the various parts of the school with the more particular aims and methods concerned in each case.

CHAPTER III.

A Consideration of the Aims and Methods in the Several Stages of Science Teaching

The work in Science in the School falls very naturally into three divisions:-

A. The "Nature Study" of the Junior School.

B. The "General Science" of the Junior High School.

C. The Physics, Chemistry, and Biology of the High School.

A. Nature Study

Nature Study, in its broadest sense, seems peculiarly well adapted to the educational needs of the Primary School. Assuming that this is the school of the pre-adolescent period, the large number of its pupils will be between the ages of 5 and 11 plus (i.e. from the Kindergarten to, and including Grade VI in the Quebec System). Now the main characteristics of children at this period are their tremendous bodily activity, and their great curiosity. Consequently they are ceaselessly, tirelessly investigating all manner of things around them, driven by an instinctive urge to learn more concerning their environment. But, this is Nature Study in its simplest form - the observation of things which come to hand, and which have aroused natural curiosity.

Nature Study in the Public Schools - Macdonald Institute 1904

"Nature Study aims to encourage the childish spirit of inquiry and of activity by appealing to things rather than to books. It calls for seeing and thinking rather than mastering what others have seen and thought. Nature Study is the method of the schools to continue nature's method....."

Thus, the fundamental purpose of Nature Study is to develop in the child the power to observe, to appreciate and finally to understand nature in its more significant aspects. Sir Percy Nunn terms this the "intellectual love of Nature"[I]. But this must be no far-away objective; the child must first see and appreciate familiar things about him before he is introduced to less familiar ones. Thus each stage must be sufficient unto itself; his joy and appreciation must be here and now, not in some nebulous future.

The basic need in such teaching is that the child shall <u>see</u> things for himself - only then will he know their characteristics and differences. It is impossible to obtain lasting appreciation of natural objects except by familiarity born of careful observation combined with the assurance that such observation is worth-while. A few seconds with a magnifying glass will engender far greater appreciation of, say, a tiny flower than hours of talk.

We must remember also that there are many things which can be appreciated at sight. Thus, it were better for the teacher to stand in silence with her pupils watching the sunset,

[I]Preface - "<u>The Teaching of Nature Study</u>" - C.Von Wyss.

than to talk enthusiastically about it. There are many things that must be seen and felt, but about which the teacher should talk little; otherwise, she is likely to overshadow by her own the child's vivid enthusiasm, which she is in reality trying to foster. I do not mean to imply that Nature Study should in any way dull enjoyment or appreciation; on the contrary, to know, for example, that the sunset is caused largely by dust in the earth's atmosphere, serves rather to increase than to diminish the awe and wonder with which one regards it! The real danger is that the adult substitute his own, for the child's feelings, or that the latter may become verbal rather than real feeling.

When confronted with unfamiliar things the child acts, as a rule, instinctively. Thus, the young child will hide under the bedclothes during a thunderstorm, or, the boy will pull his new mechanical toy to pieces, he knows not why! He is guided not by reason, but rather by curiosity. Moreover, this curiosity is more often emotional than purely rational. This, again, is particularly noticeable in the reaction of small children to anything unfamiliar. "What will it do to me?" "Will it hurt me?" , are frequent questions. Nature Study must start with these emotional and instinctive reactions; as later they give place to rational conduct, so will Nature Study give way to science. cp. "Teaching of Nature Study" - C. Von Wyss. p.4. "Nature Study is characterized by a predominance of instinctive reactions, which gradually give way to the function of reasoning, preparing the way for science."

But the observation of things, the collecting of facts is but the beginning of Nature Study; it will be useless if it stop there. Isolated facts of themselves are merely deadly encumbrances - they cannot even be remembered if left disconnected. It is facts in their relation to ideas which are important. "Facts in association with ideas may determine to a great extent the interests and quality of a child's later years"[1]. Thus, it is relatively useless to observe the rose-tree with the aphides and ants upon its stem, if we do not ultimately recognize the connection between these three things. The inter-relatedness of all things in Nature is one of the extremely valuable ideas with which the child should become acquainted in Nature Study. Moreover, this idea of relations should be presented in such a way that the child will thrill to the wonder of it. I am certain that children are at times capable of appreciating the beauty of these inter-relations, just in the same way as a mathematician experiences a thrill of pleasure on observing some hitherto unperceived relationship in his problem.

"We cannot fathom the mystery of a single flower nor is it intended that we should, but that the pursuit of science should constantly be stayed by the love of beauty, and the accuracy of knowledge by the tenderness of emotion"[2].

1. Stevens, Bertha - "Child and the Universe". p.10.
Note:- Rousseau expresses the same idea in "The Emile" (W.H. Payne translation - p.153).

2. As quoted in "Outline of Science" - Sir J.A. Thomson p.1084 from "Modern Painters" - John Ruskin.

I do not mean to imply that the relationship with other things must be recognized immediately a fact or phenomenon is observed for the first time. There must be reflection on the original facts before such relationships are perceived. The teacher is often inclined to hurry this process too much. There is an obvious danger here. The child will neither grasp to the full, nor appreciate in the sense just discussed, such relationships if he is hurried. Thus, the teacher, by undue haste would be defeating his own aims. "Go slowly. Let children live with an idea. Progress in understanding will come not from accumulation of ideas, but through their gradual unfolding. Wonder, happiness and steady absorbed interest are legitimate factors of children's experience, but stimulation, thrills and peaks of interest transiently occupied are not"[I]. By the time a child leaves the Primary School most of the facts he has accumulated should become related in this tangled "web of Nature". It would seem unwise to include in elementary science work many facts and phenomena that cannot readily be fitted into this order of things, otherwise, memory will be taxed at the expense of reason.

The examination and study of things little or big, in field or wood, class-room or laboratory, should help to develop careful habits of observation. The solution of problems encountered in the above, and from time to time in the course of lessons, should develop the capacity to search

I. Stevens, Bertha - "Child and the Universe" . p.23.

for and handle facts, and then to reason from the data thus accumulated. "If there is any good at all in science education it is that men should be trained, as I said before, to know things for themselves at first hand, and that they should understand every step of the reason of that which they do"[I]. This process of mental development is the more likely to take place in Nature Study because the problems chosen or encountered are intimately connected with the child's own life and environment - ones in which he has an <u>active</u> interest. Thus, Nature Study should not only widen the child's knowledge of everyday phenomena, but contribute also to the training of eye and mind.

In the course of Nature Study from time to time some simple apparatus may become necessary:- e.g. small boxes for seed-planting, a bird house, a stand for the aquarium etc. These, I think, the children should be encouraged to make for themselves. This may be done at home, or, possibly, at school if the help of the handwork teacher be enlisted. Drawing, too, will frequently be used in the Nature Study lesson. Thus, a certain manual dexterity should develop, directly or indirectly, as a practical concomitant of the work in Nature Study.

Consequently, the aim of Nature Study is virtually three-fold. It should maintain a proper balance between the development of practical, mental and aesthetic values. These different avenues, "head, heart and hand", are alike essential; each should receive due attention, if we are to develop the qualities we have already discussed. The teacher must continually bear this in mind, or one or other of these values will be developed at the expense of the others.

I. Huxley, Thomas in his essay on "<u>Science and Art in Relation to Education</u>".

Thus, the values to be obtained from Nature Study are many. The chief of these is, I think, the development of rational wonder and a glimpse of the intrinsic beauty of the Universe. I do not hesitate to put this first, for no other teaching in the school has quite this aim. Science teaching will later foster the methodical side of the study, but Nature Study must initiate this emotional beginning.

Dr. J. Rennie in "Nature Study" p.X11, says:- "Speaking of values, however, I confess to the heresy that one of the functions of science in schools is recreative in the true sense.......

(p.X1V)"Just as we must not peer into play too much, inspecting and criticizing, so we must not codify, rationalize and examinify Nature Study too much. Grammar badly taught is very bad, but it does not spoil a life, whereas harshly taught Nature Study may dim the eyes for life.

"Never let premature scientific study blast the buds of wonder........ Perhaps the "via media" is most likely to be found if we bear in mind that we wish not information but inquisitiveness, not learning about things, but thinking about things in the presence of things, not to teach scientific principles (an understanding of which comes later, if ever) but to develop the scientific mood, which is as natural as breathing".

This appreciative,understanding love of Nature should foster a love of out-of-door pursuits to the benefit of the child's health. Moreover, when this sort of love of the out-of-doors has developed, the child will become our most powerful ally in protecting and conserving natural beauties and curiosities - a very necessary thing when we consider the encroachments of civilization on the beauty and diversity of our flora and fauna. Then, again, his work with seeds and flowers, in class-room, field and garden will encourage him to grow things himself and possibly beautify his immediate surroundings - an obvious advantage both to the individual and the community. Besides these undoubted values, Nature Study should discipline hand, eye and mind.

Miss Von Wyss in "The Teaching of Nature Study" p.7, states the values as follows:- " The joyousness of observation and discovery, the discerning of beauty and fitness, and the health-giving open air activity that Nature Study brings with it, make of it not only a brain-stretching pursuit and fundamental discipline, but contributes much to the culture of the senses and the development of the artistic emotions."

In the previous chapter I discussed in general terms the method of science teaching; this applies also to Nature Study.

The method of Nature Study, is to start from things - whether they be the seeds or twigs in the class-room, or the various plants, insects, etc., collected during a Nature Study ramble. Thus, Nature Study must be direct and

and concrete; the teacher must proceed from objects to ideas never from abstract ideas to things. This is, perhaps, the fundamental method of Nature Study.

Like the Science teacher, the Nature Study teacher, to do good work, must have at her disposal not only a class-room but a laboratory - but the latter need not be elaborate. The fields and woods, the garden, even the parks and vacant lots may be the laboratory of the Nature Study teacher. However, where possible a separate room for Nature Study is desirable. This should be an airy, sunny room fitted not only with ordinary desks but also a demonstration table. If, instead of desks some long tables, at which the children may work, can be provided, this will make the room even more useful. It is desirable, but not essential, that such tables be fitted with water and gas. This room may also be used for the manual training classes. In it should be kept the plants and seeds under observation, also the aquarium, terrarium, the charts, calendars and diaries made by the children, and other things needed for Nature Study. I think, however, that the old stuffed animals and birds appearing in such places can well be done without.

It is almost impossible to describe the method of teaching Nature Study. The chief requisite is a teacher, an enthusiastic nature lover herself, who is eager that the children should share her knowledge and enthusiasm for the innumerable beautiful and interesting things to be found everywhere. She will need to have something of the artist's perception to convey to the children this beauty and wonder, without talking too much. Moreover, a knowledge over a wide range of science is necessary if such aims, as have already been discussed, are to be developed. Nor will a mere passive knowledge of science be enough, an active knowledge of scientific method is essential; likewise some knowledge of scientific literature, for the searching questions of the children will frequently send the teacher, in the attitude of a student, to reference books. Nor need she be ashamed to do so, for no person, however well versed in Science, could pretend to answer immediately the varied questions of even young children. Thus, the Nature Study teacher must needs be a Nature lover, a science student and a teacher-artist all rolled into one! It is because of these very special qualifications, that it is advisable whenever possible to have a specialist to conduct this work, for few teachers other than a specialist could possibly have such love of the subject as to give freely of their time and energy to collect and prepare the necessary materials. However, I am far from discounting the excellent work some class-teachers do in Nature Study, but it would seem that these are almost without exception enthusiastic Nature lovers, and students by attitude if not by training. I am almost tempted to say that the successful Nature Study teacher is born rather than made.

"Temperaments and interests among teachers vary so widely that to expect any members of the staff of an elementary school or of the junior department of a secondary school to go out into the country and bring home creatures and flowers for the pupils, is both unreasonable and unprofitable. It is only one to whom the process is a delight and recreation who would not find this duty a burden. It cannot be too strongly urged that this work, so special in its outlook and in its practical needs, should be in charge of a naturalist born and trained"[I].

It must be acknowledged, however, that there are serious practical difficulties in the way of the city teacher; the supply of suitable material is a problem, difficult, but not impossible to solve. Thus, either on the school grounds or in adjacent vacant lots, seedlings, trees and weeds can always be found - sometimes even between the paving stones and in the dust in corners of buildings. These will serve quite as well for some purposes as more pretentious specimens. Then again, a tiny garden of common hardy flowers and ferns, in the corner of the school yard can furnish specimens for lessons. Also, co-operation between teachers and park authorities should be established, thus simplifying the obtaining of supplies of leaves, twigs, possibly even of cultivated plants. As both the parks and the schools are in existence for the benefit of the public, there is no reason why there should not be mutual co-operation. It has also been suggested that exchanges of materials could be effected between country and city schools; both would benefit if the country schools sent natural specimens, and the city schools, in exchange, interesting manufactured samples, etc.

[I] Von Wyss, C. - "The Teaching of Nature Study". p.19

The greatest difficulty of the Nature Study teacher is the choice and organization of material. The field is so vast, how are the most significant things to be selected? Then again, is it to be the child's choice, or the teacher's choice, or a course of study determined from the outside? Moreover, there is the question of organization - how are the various subjects to be treated?- merely as disconnected units or in some methodical order? I think we must admit, that however stultifying pre-determined Nature Study courses may be, nevertheless there must be some central idea, some logical connection running through the work, if it is to be of any value whatsoever. The severest criticism of Nature Study has arisen because of its seeming purposelessness - its lack of a continuous purpose. The basis of organization will receive more complete treatment in the following chapter.

Despite the necessity for continuity of theme throughout the work of the class, and even of the whole primary school, the Nature Study teacher must be quick to take advantage of any special circumstances which may arise, or of any special material which comes her way - in other words, she must be an opportunist. Thus, the best time to talk of snow, particularly to a junior class, is at the first snowfall, when the reality of snow and its present beauty sends a thrill of only partly sup-~~ex~~pressed excitement through the class. Or again, should the injured bird which has been brought into school die, possibly the teacher will use it to show how the wings are adapted for flight; perhaps, on the other hand, she may, in an effort to ease the obvious concern of some children, tell what happens to dead things, and how Nature uses their remains to bring forth fresh beauty in the form of plant or tree. At such times as these, it seems to me, the best and most permanent teaching can be accomplished, for the children are "keyed-up" to the situation. In other words, no artificial motivation is necessary; the "growing point" is already there waiting to be seized and used.

The above forms an excellent example of the difference in method between Nature Study and Science. The province of Nature Study is one with that of Science - the whole realm of Nature. The aim of Nature Study, however, differs from that of Science in that it sets out to develop a familiarity, an understanding and appreciation of common objects and phenomena, in contrast to the formal comparison and classification of these same things into a body of related phenomena. Thus, it may be said that Nature Study is "child-centred" as it sets out to develop his powers of wonder, appreciation, observation etc., - aesthetic as well as intellectual. Science, on the other hand, having in mind the development of a body of principles based on observation, sets out to observe, compare and finally to build up systematically a body of data - a science. Thus, Nature Study and Science deal fundamentally with the same phenomena; it is only the organization and possibly the motive behind this which constitutes the difference between them. Moreover, the spirit of enquiry is the same in each case, but in Nature Study the <u>order</u> in which phenomena are studied is determined by chance (as has been shown in the preceding paragraph) or necessity, while in Science there is a logical sequence from one to related phenomena.

Just as observations had to proceed for thousands of years before any science was possible, so the process of accumulating facts in childhood, makes possible the teaching of science later. The same process of accumulating facts is present in both cases; the main difference lies in the fact that the modern child can accumulate more diverse observations in a year or so than the ancient "natural philosophers" could in centuries. From an historical point of view then, the study of Nature precedes Science. It is still a necessary and indispensable stage in the approach to Science, for the latter cannot proceed adequately unless a familiarity with simple physical and biological phenomena has already been established. The neglect of this stage is, I believe, the reason why much of our school science fails to achieve the results we expect. Hence, the Report of the Committee on "The Position of Natural Science in the Educational System of Great Britain" (1918)p.60. states emphatically:- "There is general agreement among science teachers that the best preparation for the study of science at Secondary schools is a course of Nature Study up to the age of 12".

B. The General Science of the Junior High School

The conditions which have in many places prompted the establishment of the Junior High School have already been discussed in Chapter II. The Junior High School is the school of early adolescence, and this fact determines its main characteristics.

Adolescence marks a new stage in the development of the individual. Bodily changes and rapid growth cause to some extent increased self-consciousness and instability of temperament. This is intensified also by psychological changes which must naturally puzzle the child. There is a new capacity to handle pure ideas, a new urge to explore both the self and the environment, possibly in an attempt to find some harmony, some validity, by which to evaluate and understand these inward changes. Moreover, the range of ability of the pupils becomes decidedly more marked than in the Junior School.

The Junior High School therefore is to be considered as a period of exploration, not simply of the physical environment (as in the case of the Kindergarten and early Primary years) but also of the world of ideas. There must be great diversity of educational opportunity to aid in this exploration, and also to provide adequately for the different types of pupils. Also, it is imperative that more careful grading according to ability be undertaken, than was necessary in the Junior School. In these ways it is hoped that pupils of different capabilities and interests may each be stimulated to his utmost.

Due to the increasing complexity of modern life and the consequent need of greater initial preparation, there is a marked tendency in many countries to raise the age at which compulsory education ceases. Consequently, it is probable that eventually the greater part of the adolescent population will attend some type of Junior High School. Thus, the Junior High School must provide for two distinct types of pupils:-

I. Those who will leave school when they attain the age limit of compulsory education, somewhere about 14 or 15 years.

2. Those who will proceed to further secondary education.

For both of these groups, the first year of the Junior High School will probably serve as an exploratory period to find what type of studies best fits the abilities and interests of the individual pupils.

In addition, for the first of these groups, this school must attempt to develop a well-balanced, modern education, as complete as exigencies of time and mental development will permit. It must be recognized that, in all probability most of these children when they once leave school, will never again be connected with an educational institution. Consequently, it is imperative that they be acquainted with the large and vital interest of modern life.- e.g. the question of the individual and public health.

For the second of these groups, the Junior High School will provide a preliminary secondary course which will be broadened and intensified by further work in the High School. There are several distinct advantages to be gained by their attendance in a Junior High School. First, the diversity of curricular activities affords opportunities to discover latent abilities and interests, with the view to their greatest development. This is more likely to happen in the Junior High School in that the classes will be smaller than in the Junior School, and, consequently the teacher will be able to devote more attention to the individual. Then again, the Junior High School will bridge the gap between the Junior School and the High School. This function, it seems to me, is very important. In the Junior School the class teacher is in such intimate contact with her class, that she knows when any pupil is falling behind and needs special help and encouragement. This, however, is not so simple in the High School where a number of specialist teachers come and go between classes, the pupils of which they scarcely know by name. Thus, unless some special organization is evolved to take care of this supervisory function, the High School pupil is thrown very largely upon his own resources. The Junior High School, with a method of treatment somewhere between these two extremes will, therefore, be of great benefit to the adolescent pupil. Also, the type of general cultural education followed in the Junior High School will lessen the possibility of premature specialization, for, even if a student specialize in one or more particular branches of science in the High School he will at least have an elementary knowledge of other branches of knowledge, and will be less likely to become a narrow specialist.

As the Junior High School movement is comparatively recent, researches as to curricula are still in progress. However, practice, so far, seems to indicate that a broad, humanistic education is preferable to a technical one at this period. Thus, the Consultative Committee on "The Education of the Adolescent"(p.84) declares: "It is essential, of course, that nothing should be done to prejudice the continuance of the general education of the pupils, or to cramp their mental development for the sake of demanding some form of specialized proficiency.......

"A humane or liberal education is not one given through books alone, but one which brings the children into contact with the larger interests of mankind".

The above seems to suggest that the programme of the Junior High School be a broad, cultural one. Its activities would be organized, in the main, about four elements: Language, science, social studies and mathematics. Music and Art as other great avenues of human experience would also be included. Of these, we are here only interested in Science.

Science in the Junior High School sets out to build, on the foundation of Nature Study which has already been established, a wider understanding and appreciation of the world of Nature, of mechanical invention and scientific progress. We must now consider how this is to be accomplished, In the past, there have been numerous experiments to ascertain the type of science instruction best suited for early adolescence. Elementary physics, mechanics, chemistry, biology, physiography, physical geography, all have been tried with varying success. The reason for these failures and partial successes involves some consideration of common mistakes in science teaching.

Quite frequently, the student who commenced the study of one of the special sciences on entering the High School, was immediately involved in abstract considerations and complicated mathematical treatments.

Thus, the study of physics was frequently commenced by a mathematical treatment of mechanics. This must have deadened the interest and enthusiasm of most twelve or thirteen year old boys. The study of Chemistry not infrequently opened with a consideration of molecular and atomic hypotheses, or, perhaps, of the theoretical differences between elements, compounds and mixtures. These topics are decidedly too abstract for the beginner in science; thus, the school-boy came to the conclusion (and who can blame him?) that physics and chemistry were "difficult" and "dry" subjects of no interest to him.

"Our efforts at teaching science up to this time have been disappointing for reasons which the above outline avoids; the elementary work has been too incidental; the advanced work has been prematurely abstract; besides, general conditions have been unfavorable. The High School boy who begins a systematic course of physics and chemistry without the previous training above described (a broad Nature Study course similar to that I suggest) lacks the bases in experience which is needed to make systematic science genuinely real to him. The usual text-book in physics or chemistry plunges him at once into a world of symbols and definitions as abstract as algebra. Had an adequate realistic treatment preceded, the symbols, when he finally reached them, would be realities. The abyss between sense training and intellectual training would thus be bridged."[I]

The great mistake in such teaching was the presentation of abstractions instead realities. Science cannot be taught by expounding theories etc., from a text-book nor will any training in the method of Science be achieved by doing this. Such theoretical considerations must be postponed until sufficient knowledge of facts has been accumulated to make generalizations intelligible. This mistake undoubtedly arose partly because those who taught science had, themselves, received only a superficial training in science, and, consequently, did not understand the working of the scientific method.

As one reads the lectures delivered many years ago by scientists such as Huxley and Faraday to child audiences at the Royal Institution, one is impressed by the fact that their method of approach is identical with that of the trained teacher of to-day - namely, to start with the familiar facts of the environment, to extend this knowledge by means of experiment, and then, only after much data had been presented, to evolve theoretical considerations and generalizations and finally to test these. This is the

I. Flexner, Abraham - "A Modern School", p.7

procedure of the inductive method, as compared with the former deductive procedure. The latter started from the law, hypothesis or theory, then worked to the applications of this; these scientists and teachers began with the everyday instances and applications, searched in these for a binding or common principle (a natural law), then proceeded to suggest explanations (hypotheses) for this mode of behaviour, and finally to test these explanations with the view of finding one which would fit all known cases. This inductive method is characteristic not only of science but of all purposeful thinking and problem solving.

Still another mistake in science teaching has been caused by the assumption that the powers of logical organization possessed by the adolescent are identical with those of the adult. The organization of the individual science is the finished product of adult logic, achieved by reflection <u>after</u> the problems have been solved. But, the adolescent has not yet achieved this power, and to assume that he has is only to confuse the end of the study with the process of arriving at that end.

cp. "<u>The New Teaching</u>" - John Adams, editor "<u>Science</u>" - Sir Percy Nunn - p.163.

"The teacher who is tempted to adopt this attitude (that science is a question of precision in definition rigorous testing of hypotheses and caution in generalization) should reflect that he is expecting his pupils to start from a point he himself reached only slowly........

"Habits of exact thought and interest in scientific theory must be regarded as the goals marking the end of a course, not the entrance gate into it".

The order to be followed in dealing with the adolescent would seem to be the psychological one - that of the mind in proceeding from one idea to the next in sequence, as in the solution of a problem. Moreover, if any real thinking is to be done, the problem or subject to be studied must be one which challenges the pupil to mental effort; this presupposes that it is one in which he is vitally interested, - one closely connected with his everyday experiences. Thus, the chief mistakes made in science teaching have been:-

1. Premature abstraction and mathematical analysis.
2. Use of deductive, rather than inductive method.
3. Use of the logical instead of the psychological basis of method.
4. Lack of motivating power to do real thinking, because of the unreality of the problems.

During the last twenty years many attempts have been made to obviate these mistakes and to create a type of science course specially suited to the needs of the adolescent in the Junior High School. Such courses are usually designated by the term "General Science".

General Science, may be regarded as an introduction to the field of Science. It is based, I think, on two assumptions:-

1. That the adolescent is interested in his environment in a very real sense, and consequently wishes to understand why certain things are done, how others work and so on; that is, he still retains his earlier curiosity.

2. That the adolescent has not arrived at the state of maturity where he totally abstracts a thing from its environment. The problems of the adolescent then, unlike those of the scientist, are not entirely abstracted from their natural setting. Consequently, the science work of the Junior High School differs from that of the High School in that it cannot be resolved into a treatment of the special sciences, but because of this special feature, rather partakes of the field of several sciences. It is, therefore, general and introductory in scope and tends to break down the artificial barriers between the several branches of Science.

In the past in many secondary schools some work in science, very elementary in character, was given to the ten or eleven year olds. This was accompanied by demonstrations on the part of the teacher and sometimes by practical work for the pupils. This work, too, was considered an introduction to science and a means of acquiring elementary laboratory technique. General Science, however, must not be considered introductory in this sense. The former was merely a preliminary treatment, to be amplified and deepened by future work in the various branches of Science. The latter is to be considered as a general introduction to Science as an end in itself, with no supposition that the children will receive further science-training, for it must be remembered that many children do not proceed to the full secondary education. Thus, it attempts to provide a science course for all adolescents, not merely those who will proceed to the High School.

The task of General Science, then, is a difficult one; it is to give as complete a preparation for life as is possible within the limits imposed by time and the mental development of the Junior High School pupil. Thus, the most important tasks of the General Science course are three in number. First, our life in a modern community demands that not only the individual, but the community at large must know something of the principles of biology and their application to the questions of health. Only by definite educational work can a well-advised public opinion be created, and this is essential to the community whether it be large or small. Secondly, as we live in an age when machines have become of paramount importance both in the home and in industry, it is essential that all should have some understanding of the physical principles upon which these appliances are based. Thus, the vacuum cleaner, electricity, refrigeration, automobiles, motors, dynamos, telephones, radios, sewing machines, hot-water systems and dozens of other things have become common part of everyday life, and to use them intelligently requires some knowledge of the principles which they embody. Thirdly, in so far as the school is committed to prepare the child to live the fullest life possible for him it is necessary that, before he leave school, he be taught at least the elemental facts and principles which will enable him to build up for himself an interpretation of Nature. It matters not whether he has the capacity of a student of Nature, or simply of one who can delight in her ways, it is the duty of the school to bring these interests and delights within his reach, so that he may grasp them, if he so desire.

"Knowledge of some of the secrets and processes of Nature creates an intellectual interest in various directions. The world of flowers, of animals, and of rocks is a book which if only partially opened at school may prove of absorbing interest in later life"[I].

I am tempted to add a fourth to the above list - some training in the scientific method, as a way of thinking. There is doubt whether this is inculcated in many cases even after advanced work in Science at the university, for it requires an intellectual honesty and self-criticism which, it seems to me, is comparatively rare. Nevertheless, the need of clear, critical and unbiassed thinking is a very serious one in a world of dogma and propaganda of various sorts, but largely in the political and advertising world - in fact, I think this type of critical thinking is necessary to the very life of a democracy. At this stage of science teaching most assuredly it is impossible to inculcate this method either by preaching or by practical work; rather its efficacy should be shown by the teacher as a common sense way of

I. From "Science in Senior Schools" - Board of Education(England) Educational Pamphlet No.89 - p.13 et seq.

tackling ordinary problems; in fact, all work done in the science lesson should be an embodiment of this way of thinking. The science teacher will also use stories of the work of great scientists, and also accounts of modern research work to further the consciousness of scientific method.

Thus, the aims of the teaching of General Science may be summarized as follows :-

1. To provide additional biological education, and as an outcome of this, to foster an intelligent individual and community consciousness on public health.
2. To develop some understanding of common appliances and the principles they involve.
3. To continue the work of the Junior School in arousing interest and appreciation of Nature i.e. in teaching children to read "the book of Nature".
4. To provide some training in the scientific method of solving problems.

The approach to General Science like that of Nature Study is made through the knowledge the child has already acquired concerning his environment. To proceed from the known to the unknown is the only sane way, as Huxley remarks in the Preface to his lectures on "Physiography" p. i .

"It appeared to me to be plainly dictated by common sense, that the teacher, who wishes to lead his pupil to form a clear mental picture of the order which pervades the multiform and endless phenomena of nature, should commence with the familiar facts of the scholar's daily experience; and then, from the firm ground of such experience, he should lead the beginner step by step, to remoter objects and to less readily comprehensible relations of things. In short, that the knowledge of the child should, of set purpose, be made to grow, in the same manner as that of the human race has spontaneously grown".

The General Science course, in its first stage, differs little in method from the final years of Nature Study in the Junior School. There is, however, a difference in arrangement. It has already been pointed out that, in the early years of adolescence, the ability develops to handle ideas as well as the simple facts of the physical world. The Nature Study of the Junior School is arranged very closely about seasonal activities and changes; the General Science of the Junior High School, however, because of this new ability, may now be arranged about some topic or problem of major interest in understanding the physical environment and its relation to man. This is the first step towards the abstraction of science, but the problem still remains in its natural setting, and, consequently, not divorced entirely from everyday considerations as much work in school science formerly was.

The choice of these topics and problems is of great importance. They must never be trivial, neither must they become abstract or unreal. If scientific thinking is to be done they must be problems in which the child is interested, for there can never be any desire to observe, experiment, discover or reason unless a real problem is present to challenge the individual and the class as a whole. It was here that the "Heuristic Method" frequently failed - in providing for the activity, without the prior and essential motivation, for the desire to gain further knowledge and to make careful observations and experiments only occurs in a mind already partly interested and partially informed.

Happily, for the science teacher, there are many such questions, continually being asked by the child who is eager to understand everyday occurrences, "Why does electricity light our houses"? "Why must we be so careful about the water we drink"? "What is air"? These, and many similar questions open up great possibilities for the General Science teacher. The work in General Science must, therefore, be built up systematically around such considerations, while the teacher must steer a course midway between the superficiality of the popular science lecture and the difficulty of many science courses which would confuse and mystify the pupils.

This is frequently termed the "project method"; more accurately, however, it is the treatment of a large topic, which is made up of numbers of sub-topics and problems - all closely related to the main theme. According to Kilpatrick ("The Project Method" Teachers' College Record XIX. p.320) "a project is a whole-hearted, purposeful activity proceeding in a social atmosphere". It would seem, therefore, that this name cannot correctly be applied to the main topic, but rather pertains to these sub-divisions, when they are motivated to the extent of becoming not simply an interesting problem, but our problem to the children concerned. Thus, the "so-called" "Project Method" cannot be regarded (as so many writers in General Science seem to regard it) as the only method for use in the General Science course, rather it is only one aspect of method, to be used with others, in this type of science teaching. It is clear, however, that the problem is of importance as an "organizing factor" in the General Science Course.

The method of procedure in the individual lesson, will differ little from that of a properly arranged lesson in any subject. The main difference will be the use of experiment. The first stage is a collecting of data - the recalling of previous experience, relevant to the subject, and the supplementing of this by means of experiment. The second stage is a clear formulation of the problem, with a view to its solution. This may result in a new formulation - as a main problem, with a number of subsidiary ones, each requiring its own solution. Thirdly, after this discussion and analysis, various hypotheses may be suggested, which in turn must be critically examined and tested. The next step will be a final summary of the problem, and the solution so far arrived at. The final stage will be to apply the hypothesis, which has survived the testing stage, in a wider field to see if it still holds true, possibly also to find if it can explain or simplify some knowledge which has previously been acquired.

It will be noticed in the above, that this rational attempt to solve a problem, follows the line of the "scientific method" - showing that the latter is merely a common sense way of tackling a problem, and is, therefore, applicable in a wide range of subjects.

The method of approach to the lesson will vary from time to time according to the nature of the problem. Thus, in some cases the approach may be made through a demonstration on the teacher's part; at other times it may be approached through discussion; occasionally even through experimental work on the part of a class; and possibly even a story told by the teacher of the history of some great discovery or invention or of the person connected with this. The possibilities are many, but the object in all cases will be to collect relevant material, and to present the problem in such a fashion that the class will be interested in its solution.

The final stage of the process also permits a variety of treatment. This may consist of the discussion of appliances in common use - possibly a demonstration on the part of an able pupil; it may consist of an excursion to the fields or woods, or perhaps to a factory or power-house - depending on the nature of the problem; perhaps of short "lectures" by one or more pupils who are particularly interested in the subject (akin to the "Littleman Lectures" of Caldwell Cook's "The Play Way"); or possibly the report of some work done in the library. But no matter how this part of a problem be worked out, the aim is largely the same - namely, to connect the work done in the science class with the everyday interests of the pupil, in order to extend and enrich, to strengthen and increase these as systematically as possible. Thus, the science classes should serve to draw the school and the outside world together. This happens most completely when - as Sanderson of Oundle never tired of preaching - the school undertakes some community service, such as, for instance, the testing of seeds, soils, or fertilizers for the farmers around. Then the work of the school becomes no mere experiment but "service" definitely scientific both in method and object.

The General Science course must be thoroughly inductive in method, the Junior High School is no place for a deductive treatment - in fact this is inexcusable in any type of science teaching whatsoever. If a text-book is to be used in the General Science course, great care must be exercised in its choice, for many such books are wholly deductive in method - and, consequently, are useless from our point of view. Moreover, the individual topics should not be organized on the lines of the special sciences - e.g. one in physics, one in chemistry, and so on. It is preferable, as has already been indicated, that for the present purpose, Science be considered as a whole. The large topics will, therefore, transgress the boundaries of the special sciences, for these boundaries are largely a matter of convenience. It is also essential that these topics be wide in scope and few in number, rather than small and numerous, for in the latter case it will be more difficult to give really scientific training and also to foster an appreciation of the inter-relations between the topics studied and between the various fields of Science. Another mistake in organizing the work in General Science is that of organization about a generalization or abstract principle; then, principles are put before facts and applications - another form of the deductive method. Thus, it would seem that the best organization of the General Science course is about a large topic of interest and significance to the children; the method followed will be inductive, and the subject -matter quite irrespective of the separate fields of the special sciences.

Before leaving the question of method and organization of the General Science course, it may be well to consider shortly the function of experimentation. The uses of experimentation are mainly two:-

1. Collection of information on the problem.
2. Testing of hypothesis or generalization.

The former, as has already been suggested would occur at the beginning of the work on a problem, and quite frequently in the first stage of the science lesson. Its function in these two instances is the discovery of new facts to supplement those which are already familiar. The second use pertains, as we have seen, to the fourth stage of the science lesson, or of the solution to a problem, and consists in the critical testing of the solution or generalization not by one experiment, but by as many as possible. This is a point in science teaching which is frequently weak; it is so easy for the busy science teacher to slur over this stage with as little testing as possible - but this is bad when one considers how necessary it is to inculcate the idea of unrelenting testing and self-criticism on the pupil's part. Pasteur continually referred to this necessity; - in his speech at the opening of the "Pasteur Institute" he said:-

"Keep your early enthusiasm, dear collaborators, but let it ever be regulated by rigorous examinations and tests. Never advance anything which cannot be proved in a simple and decisive fashion" .

"Worship the spirit of criticism. If reduced to itself, it is not an awakener of ideas or a stimulant to great things, but without it everything is fallible; it always has the last word"[I].

A third possible use for experiments is, it seems to me, in the review lesson. A decisive, new experiment would do much to aid in the review of theoretical considerations, by focussing the attention of the pupils, recapturing the problem situation, and applying the principles in yet another case, as an aid to "fixing" them in the memory.

In the teaching of General Science there is, it seems to me, too great a reliance on text-books. This is particularly true in America; in England there seems to be a more general realization that it is impossible to teach General Science from text-books or at any rate from one text-book - the "general formula" has been abandoned. In the first place, the good General Science course, like that in Nature Study, cannot be "made to measure"; it is a product of the reaction of the school on the environment, and the environment on the school. Thus, it is an individual thing, and will differ slightly from

[I] Vallery-Radot, Réné - "<u>The Life of Pasteur</u>" . p.219.

school to school, due to the dominant interests of the children, as determined by the type of home they come from, and the sort of industries etc., carried on in the immediate neighbourhood. For this reason the interests of a child living in an agricultural district will not be quite the same as those of a child living say, in a sea-port (I am not losing sight for a moment of the large central core of interests common to both which will form the "backbone" of the course). The training and dominant interests of the teacher or teachers will also be reflected in the course - it would be absurd to expect that a biologist would give exactly the same course as a teacher whose training had been largely in physics and chemistry. Consequently, schools in different districts will each have a course similar in general outline, but different in local "bias".

There is another aspect of the "text-book" method of teaching General Science, which seems largely to have escaped notice. In a number of text-books, it is suggested that the child answer preliminary exercises and read the story or introduction to a topic before this has been presented in class. This presentation consists in some cases not only of introductory matter, but also of a discussion of the principles which, evidently, are to be derived by experiment in the Science class. But surely, this is the very antithesis of approved methods in science teaching. In other words, these writers under the guise of "motivation" are authorizing the reading beforehand of much of the theoretical work which should be derived by the inductive, experimental method in class-room and laboratory - a dubious practice!

The main function of the text-book in General Science teaching is as a reference book, and possibly for review work. It may, in some cases, also be used as a laboratory manual and a source of additional problems and exercises. In any case, the teacher will be ill-advised to stick closely to one book, for due to the breadth of the field, there are usually some topics or chapters quite weak in treatment. There are extremely few people - and those apparently not given to writing General Science books - who are equally at home in the fields of Chemistry, Physics, Biology, Astronomy and Geology!

Two props of the traditional science course - the rigid course of study and the text-book - have at least been partially removed; there remains only one - the teacher. There is no doubt that the success of the General Science Course depends very largely on the teacher. It seems, therefore, fitting to discuss the qualities necessary for a good teacher of General Science.

The first and foremost qualification is wide knowledge of Science, possibly a more specialized and thorough-going knowledge in one special science. This is of tremendous importance, for no teacher of General Science can possibly be successful if he has not some grasp of the field as a whole. More specialized knowledge in one field will make the teacher more useful to the school, but will also have personal usefulness - a more rigorous training in scientific method, a greater grasp of the aim and spirit of Science, and the stimulation of having felt the "mysteries" on the outer, still somewhat hazy boundaries where research is feeling its way. Unless the teacher is at least partly sure of himself, he will be unable to stimulate his pupils to the utmost, and then, as a sort of self-protection will tend to stifle rather than encourage the more venturesome and enquiring pupils.

This stifling process is bad at any time, but is particularly deplorable where adolescents are concerned, because of their peculiar sensitiveness and frequent tendency towards introspection. The teacher, therefore, must have a sympathy and understanding of the adolescent, of his capacities, his needs, and the limits of his powers. The teacher must also have an interest in, and understanding of the environment, in order to appreciate its resources and limitations, and also the needs and interests of the children.

With these qualifications, the teacher must also be resourceful. The responsibility for the organization of the General Science course will largely fall upon him, if it is, as has been suggested to be specially adapted to the peculiar needs of the school. Thus, he must not be tied down too closely by traditional types of science teaching, but ready to adopt the most suitable material from the wide field of Science for his purposes. This resourcefulness will be taxed to the utmost in providing suitable experiments, for many of the stock experiments of the several sciences will be unsuitable at this stage; also, his ingenuity will be greatly needed in adapting the apparatus he has to a wide variety of purposes, and possible devising other necessary apparatus. Although the pupils in the Junior High School should themselves make much of the apparatus needed, yet it will be of great advantage if the teacher has some skill with glass and metal. Numerous small things are continually being needed or having to be renewed in a laboratory which the teacher can then make himself.

The General Science teacher must recognize and seize all opportunities of giving systematic training in scientific method. He must, therefore, steer a course midway between the superficiality of the popular science lecture, which yields no training in Scientific Method, and the deep delving into a subject which would be beyond the comprehension of his pupils. By means of the lecture-table and the laboratory the pupils should become familiar with elementary laboratory technique - though too much emphasis must not be placed on this, for it may mean that the whole class will be sacrificed for the few who will proceed to further work in science.

In all probability, the Science teacher will find it necessary at this stage to give definite training in description and recording of experiments etc, in clear, concise English. It is amazing how much time and energy the High School teacher uses at present, in fostering this skill, which, it seems to me, should be acquired long before Grade X or XI. Assistance should also be given in the matter of notes, and this will be of considerably greater importance if a text-book is not used rigidly. The ability to handle reference material in the library is one of the skills the General Science teacher must help to foster. It may be objected that these latter skills are somewhat outside the teaching of science, but the function of the science teacher, like that of all teachers, is not to teach a subject but to teach children, who will find these skills useful not only in the present, but in after-life. Thus, the teaching of such skills is quite within the province of the General Science teacher, particularly when it is considered that numbers of Junior High School pupils will receive no further science teaching after they leave this school.

It will be evident from the above that the General Science teacher needs not only a thorough science training, but also a careful professional training. Moreover, if General Science were to be accepted more generally in the schools (and this is to be regarded as inevitable, with the spreading of the Junior High School idea) provision will have to be made for the training of such teachers. Under present regulations in the Universities, students wishing to pursue a science course of anything like the breadth described above, are hampered very seriously, if not prevented entirely from accomplishing their end. Moreover, their very qualifications in science frequently make them ineligible for a teaching diploma. Consequently, if General Science is to be any more adequate than the old Nature Study, Physiography and the like, the schools must look to the supply of teachers for this purpose.

C. The Science of the High School

A full discussion of the science of the High School is beyond the scope of the present subject. It will suffice to show how the science in the High School is the culmination of the earlier type of science teaching already discussed.

The aims of science teaching have been set forth in the preceding pages, and apply equally well to the science of the High School. The function of this will be to broaden, deepen and integrate more fully all the science work of the Junior School, the Junior High School and the High School itself. It is particularly necessary that by the time a boy or girl leave school this knowledge shall have become a whole. This will be impossible if the special sciences are narrowly conceived and taught. The broad, human values of science are, in the end, likely to be of greater value to the majority than the purely disciplinary values; and these former are most frequently neglected.

The science of the High School will consist largely of chemistry, physics, and biology. Each will now receive its special treatment, so that the particular discipline and methods of each may be tackled more thoroughly and comprehensively than in Nature Study and General Science. In this separate treatment, however, it is highly necessary that the connecting links between the sciences be emphasized so that the pervading impression is of a large field of knowledge permeated by the same method and spirit throughout. This should be done despite college entrance requirements, where these would seem to narrow the scope of science teaching unduly; for the school would be conceiving its task too narrowly should it allow such requirements to prevent it from accomplishing what it considers to be its whole duty towards its students. It is most certainly a narrow sense of duty which would lead all High School students to be sacrificed to the few who proceed to the University!

It is particularly necessary that both the physical and biological sciences be represented in the High School programme - the latter is most eminently essential as a basis for intelligent living and good citizenship, and biology cannot possibly be taught well without some knowledge of Chemistry and Physics. Moreover, these two sciences are essential of themselves in that the knowledge and training they afford are necessary to an intelligent interpretation of the modern world.

I think the necessity for the inclusion of these three sciences is quite generally appreciated now, the main difficulty in the way of including all three is the lack of time - the over-crowding of the High School programme. There are no doubt numerous ways in which time could be saved if we were eager to find them. There is little doubt, however, that much time now spent on obsolete and unnecessary mathematics could be used more profitably in other ways. If an extended treatment of arithmetic were eliminated after the Primary school, the methods of Algebra, Geometry and trigonometry could be introduced much earlier (and perhaps less formally) than at present. This would not only save much time, but also simplify the work of the science teacher greatly, for many of the difficulties in physics and the mathematical side of chemistry are due largely to insufficient knowledge of purely mathematical processes. Moreover, mathematics should take over the treatment of quantity - by weighing and measurement. This would relieve the physics and chemistry courses, somewhat, and allow more time for biology.

Time could also be saved in the science courses themselves, by excluding topics of purely academic interest. Much tedious work in weighing and measuring might also be eliminated without loss; likewise experiments purporting to "prove" laws etc, and still others, the refinement of which is quite beyond the range of school apparatus. At the same time, that dubious practice of "cooking" experiments would, I believe, be almost entirely eliminated; students do such things mainly because they feel that their own powers are unequal to the tasks set them. Such practices could be eliminated entirely by focussing attention on the importance of careful, individual observation - "a research attitude" towards experiments intrinsically interesting, and of course, treated inductively.

The end of High School science like all other forms of science teaching should be :-

1. To acquire some knowledge and understanding of the broad outline of great scientific principles of how these are exemplified in everyday natural phenomena, and applied in divers ways to meet

the needs and increase the powers of man.

2. To promote an increased understanding and appreciation of Nature in its varied manifestations.

3. To provide an atmosphere for the growth of scientific habits of thought and appreciation of the aim and spirit of science in its relation to modern life.

Although training in the method of Science is undoubtedly valuable, the greater stress should, it seems to me, be placed on the human side of the values of science. The work in science should be connected in every way possible with human activities. Thus, in the matter of illustration, examples might well be taken from common industrial processes where possible, or appliances frequently used in the home or work-shop rather than those merely of interest to the scientist.

"....the science course to be taught in our schools should not be that which is suitable for the future expert science specialist, and which can be of value to only the small minority of pupils, but rather a good general science course on broad humanistic lives which will be of value to all our pupils as a part of a sound liberal education"[I].

Science teaching in the High School at present is seriously limited by the lack of good science training in the junior classes. Such training has been so scarce and unsystematic that many pupils, when they commence the study

I. Brown, John - "The Tearching of Science in Schools". p.10.

of chemistry, physics or biology have little knowledge on which to build. This undoubtedly makes the work on the part of both pupil and teacher more difficult. Much general knowledge of great use in the High School can be acquired much earlier in the school life.

I do not wish to suggest that the earlier work in science should be chosen with this end, only, in view; that would be as ridiculous as to suggest that the science work in Grade X and XI should fit all pupils for specialized work at a university. It has already been shown that the work in science in the Junior School sets out, in the main, to develop powers of observation, and appreciation of Nature in its varied aspects. This must be an end in itself - quite untrammelled by High School and College requirements. The greatest possible contribution that the Junior and Junior High Schools can make to the work of the senior classes in science is just this training in habits of careful observation, and the accumulation of funds of knowledge of common phenomena and processes in Nature. This, then, will serve as a foundation to be incorporated, amplified and rendered more systematic by later work in the High School

If at each stage of the child's development, his interests be considered as paramount, there will be no talk of making the work of the Junior School subserve that of the Senior School - in science or anything else.

Each, then, must be considered as a stage complete and necessary in itself. Thus, the developments of the child and the unfolding of his interests and powers are the criteria to be considered, not the development of any abstract science or the pursuit of an academic course of study.

The method of science teaching has already been discussed in general, and in the case of General Science. It seems sufficient, therefore, to indicate here the slightly different method of treatment in the individual sciences. The method should of course be largely inductive, and carried out through work in the class-room by demonstrations on the teacher's and laboratory work on the pupil's part.

It was pointed out in the section on General Science that the psychological rather than the logical order should be followed. In teaching the individual sciences, this will still be true, though more difficult to carry out. If the teacher break away very far from the logical order of the science, he will soon run into difficulties. The more difficult parts of any subject can however, be postponed for further treatment later, rather than tackling them all at once, and thereby tending to confuse the pupil. Thus, in Chemistry, after considering chlorine and hydrochloric acid it would be unwise with High School students to proceed directly to a study of the other acids, real or hypothetical, containing chlorine for the latter is very much more difficult than the initial study.

It would seem, then that the psychological should be the logical order, where possible, and that difficult subjects should be excluded from a first treatment, either to be postponed or omitted entirely.

It is a debatable point whether in High School science, more advanced considerations, occupying the attention of scientists of the present day, should be mentioned - e.g. the theory of relativity, the latest theories with regard to the structure of matter, etc,.If it is at all possible to present them in a way in which the pupils are likely to understand, I think it is well to mention them at least. Much criticism has been levelled at History and English teaching for confining their work to the past to the total exclusion of present happenings and work; the same might also be said of science if the teacher excluded entirely these "growing points" in modern thought and investigation. They should not, of course, be considered for examination purposes, but merely to broaden the general treatment, in the hope that the students will thus be enabled to take an intelligent interest in hearing or reading discussions on these topics, treatment of which from time to time filters even into ordinary newspapers and periodicals.

No opportunity should be lost of making science <u>real</u> to the High School pupil. The general treatment of the lessons, the fostering of individual investigations as hobbies, visits to factories, laboratories and museums, all will aid in making science no mere school subject. A school science club, occasional lectures by people from outside the school, readings in the history of science, all should help to de-formalize the teaching and make the subject of more lively interest to the students. It is the connection of their science studies with things outside of the school, which will affect the largest number of the students, when once they leave, for relatively few, it seems,will continue to work on these lines , or even pursue work in science as a hobby.

Wherever the size of the school permits there should be two science courses:-

1. For boys who are pursuing scientific and mathematical studies in the main.
2. For others who are devoting most of their time to English, History or languages.

This division is necessary for the good of both groups, for it permits a larger amount of work for the science division, yet will not consume relatively too much of the time of this second group. The treatment of the latter group may be either an extension of the General Science course of the Junior High School or a shorter treatment of the science courses;in the latter, the method should be none the less scientific, but the treatment of some topics will necessarily be shorter, and others of still less importance will be omitted. On the whole, I think the second type of course would prove more satisfactory at the High School stage than a continuation of General Science. Moreover, where such a division of courses is made, care must be taken to prevent undue specialization which is undesirable at the High School level.

Thus, the science work of the school falls into three distinct states, Nature Study, General Science, and the special sciences of the High School. Each has its specific function within the whole; each contributes in its own special way to the development of special abilities, of knowledge and appreciation of the world of Nature and modern invention.

But science has not yet, as Sanderson reminds us had a chance to come into schools in its large creative way. "Science to be effective, so that it impresses its genious on the minds and souls of boys must come in with all the majesty and the beauty of abundance. Its demands are great. Science is ~~a~~ creative, and changes the value of the things of life. It means change, growth, development, discovery, unrest. It stirs man's thought to new ideals, to high efforts and sets before us new aims. Its demands are great, nor need we be surprised. As we look over the things of life, when we consider what scientific discovery and the great scientific pioneers and workers have done for the redemption of man, when we read the epic story of their lives, we know that no small claim will bring the spirit of science into the schools"[I].

This, then, is the Science which we would have - the great creative Science which will permeate and change the aim, the method, the whole teaching of our schools.

I. "Sanderson of Oundle" - p.270

CHAPTER IV

The Content of the Nature Study Course

When any part of the school curriculum is being planned, three different aspects of the problem claim~~s~~ attention. These are - the aim, the method, the content of the course of ~~the~~ study under consideration. The first, is the finger-post pointing to the goal to be achieved; the second, is the technique of teaching by which this may be achieved; the third, the material or subject-matter to be used in achieving the required goal. Thus, these three are equally necessary and equally important aspects of the problem. The aim and method of Nature Study have already been treated at some length; we must now consider the choice of material to form the course.

The selection of suitable material is, however, a difficult problem. The scope of Nature Study is boundless; its material is as wide as Nature itself. The very abundance of the material makes the choice bewildering. The only limit is the present capacity of the child to understand - and this is much greater than most people imagine. Upon what criteria then, is the choice to be based?

The chief is, I think, that the subjects chosen should be close to the child's interests - vital subjects, intimately connected with his environment. Thus, we must start with everyday things, and common phenomena; we must learn a little about our "parish", before we attempt to understand the Universe. These interests will gradually widen, just as the ripple does on the pond, until, in the words of Thomas Huxley "......the conviction dawns upon the learner that, to attain even an elementary conception of what goes in his parish, he must know something about the Universe"[I].

Then, again, the "illuminating power" of the subject must be kept in mind. It is useless to study one thing after another if the knowledge gained cannot be fitted together somehow, to become part of some general principle or large idea by which it may be remembered.

"I have already said that purely speculative knowledge is hardly adapted to children, even when they have approached adolescence; but, without carrying them very far into systematic physics, proceed in such a way that all their experiments may be connected through some sort of deduction, so that by the aid of this chain they may place them in order in their mind, and recall them as occasion requires; for it is very difficult to hold isolated facts, or even trains of reasoning, for a very long time in the memory when we have no hold by which to recall them"[2].

The teacher must, therefore, have the aims of Nature Study in mind in selecting the material for study.

But the actual choice still remains.

I. Huxley, T.H. - "Physiography"; p.VI et seq.

2. Rousseau, J.J. - "The Emile" (W.H. Payne Translation) p.153.

Who is to make the selection? There are three possibilities: the child, the teacher, some authority other than the teacher.

In some modern educational circles there seems to be the impression that the child is capable of determining the materials to be used in his education. This is utter nonsense. It proceeds, I think, from a misinterpretation of Rousseau's doctrine of education. It is confusing two issues:- namely, the technique of teaching and the content of the course of study. Most assuredly the child's interests are to be observed, and used as a basis to awaken fresh interests and to enlarge those already formed, but this is quite a different matter from allowing the child to make the choice himself. If he were capable of making such a choice, then he were as wise as his educators, and consequently in no further need of them! As the aims of Nature Study which have already been presented are the ends of education; it is therefore impossible that the child can make an adequate choice of materials to accomplish these ends, which he cannot yet visualize as a whole.

Ideally, the teacher is the person to make this choice, as she is most familiar with the children and with the local environment. In practice, however, few teachers have a sufficiently wide knowledge of science - or even of everyday natural phenomena to make this choice adequately. While it is impossible that Nature Study should cover the whole field of natural knowledge, yet it is essential that some completeness of outlook be achieved. For if large fields of nature study be neglected entirely, then it is possible that material rich in teaching value may be disregarded, and still worse, opportunities lost of stimulating the widely varying interests of the children. For instance, if successive years in the Primary School were devoted to the consideration of plants, trees and birds, then the fascinating study of insects, life in stream and pond, weather studies, studies of local rocks etc., would be left out of consideration. This would be an immense loss to the children, particularly when it is remembered that some of them at least may have no further opportunity of directed work in Nature Study or science.

It must be remembered, however, that now a scientist is a specialist in a very particular field; the teacher, therefore, a specialist in education, cannot be expected to have a "complete" view of the whole field of science. Nevertheless, in a school of any size there will be teachers of widely differing interests, which, in a sense, may supplement one another. Consequently, while it may be a colossal task for one person to frame a Nature Study programme, yet the staff in consultation may be able to do this, Moreover, such a course of study, due to its common planning, would have the advantage of active co-operation between the various teachers and classes, and this is a great advantage to any study whatsoever.

The only adequate substitute for a Nature Study programme prepared by competent teachers is one prepared after careful work of some committee possibly appointed from an association of teachers, possibly appointed by the government or education authority. Examples of the first kind are the various reports prepared by the Science Masters' Association of England and similar associations in America; of the second, are reports of committees appointed by the Board of Education in England or the monographs of various American cities, states and Bureaux. Similar work was also done in 1932 by the British Social Hygiene Council, in their conference on "The Place of Biology in ~~National~~ Education".

There are both advantages and disadvantages in courses arising from such sources. The greatest advantage is, perhaps, that by this method the schools secure the advice of experts in their particular fields - sometimes scientists of first rank who have spent their whole life on teaching and research, When such people - aided from the practical side by experienced teachers - frame a course of study, we may be sure it will be excellent from the point of view of choice of material, method and aim. The greatest disadvantage is that these same people frequently know little of the child or of the modern school, its needs and methods. Then, courses of study will be evolved which are frequently too difficult or in some other way impossible to utilize in the school. The only way anything of real value will be done, is by collaboration between these able scientists and teachers who know the aims, needs and methods of the school. An excellent example of such work is the appendix to the report on "The Place of Biology in ~~National~~ Education" which contains suggestions for science courses in different types of schools.

But from whatever source these programmes may emanate, they must no longer be framed as instructions. If the teacher is to be considered as an expert in educational matters, then hard and fast instructions are out of place. Let there by all means be suggestions - like the German "Richtlinien" - to be used and adapted by the teacher in the way which will best suit her purpose and the needs of the local situation. Nature Study can be killed by stiff-set programmes. Its very life depends on its quality of spontaneity. It is only when the skilled teacher has power to adapt and amend a Nature Study programme framed by an outside authority, that the latter can, in practice, be of any real value.

But no matter from what source the Nature Study programme is derived, there are certain elements which must be treated. The fundamental is, perhaps, the study of the plant as a living thing with definite needs. This will eventually lead to a study of sun and rain etc., possibly also of soil. The fact that plants are adapted to their environment may also be treated in a simple way. Then there is the question of insects, birds and even animals, and how they aid plants. Then, as the final step in this synthesis of relationships, the fundamental importance of the plant kingdom must be shown in its relation to animal life. Practically all the work in Nature Study will fall somewhere within the above. All that is needed to complete the outline is to mention, perhaps, the study of weather, the effect of water on the earth, a study of brook, stream and river etc, a study of common rocks and fuels and a few common insect life-histories. All this - food for a life-time of nature study - is connected with natural life on the earth, the idea of the earth as part of the universe must also be presented to round out the whole study of man and his physical environment.

This, it will be seen, is vast in scope, but it is essential to a whole picture of man in his place on the earth, in the universe. I do not suggest for a moment that it can be done exhaustively - there are, on the contrary, the strongest reasons why it should not; rather it should be left like a seed in the mind, capable of further development. Nature Study can never be considered as complete or finished; Nature Study in school is only a beginning - an attempt to open the doors of eye, heart and mind - in the hope that such study will continue long to enrich the individual throughout life.

It is for this reason that I feel certain Nature Study is missing its function in education, if all the time be spent in careful examination and dissection of flowers, for example. Let us by all means give the children some glimpse of larger ideas! I have watched with surprise how even 8 or 9 year olds seemed to feel a peculiar glow of pleasure when they realized for the first time, these wonderful inter-relationships between plant and animal life. "There are few joys greater than the intellectual joy of suddenly seeing the correlation of things which before were detached. Flashes of glorious light come to the young as their items of knowledge merge into order. Once or twice to have seen this light, is to have our intellectual hunger aroused"[I], and I do not think

I. Mackinder, H.J. - "The Teaching of Geography and History"; p. 5.

that when once comprehended such ideas can ever be entirely forgotten. It is this almost emotional attitude towards relationships in Nature which account, at least in part I believe,for childrens' interest in cycles like that of the egg, the caterpillar and the butterfly, rain,evaporation and clouds, and so on. Bertha Stevens in "The Child and the Universe", p.30, observes the same:- "A guiding principle in teaching generally is to be found in childrens' mental liking for events told in sequence". But the course in Nature Study must not be a diluted orsimplified science course. There is a fundamental difference between the two, as has already been explained; Nature Study will defeat its purpose if it is made up merely of the simpler subjects in the various sciences. Its approach is from an entirely different standpoint, but it should be none the less accurate on that account. The teacher - and this is especially true of a specialist in the subject,- must think first of the child, then later of the subject, only then will Nature Study lead the child to an appreciation and understanding of Nature, by means of experimental approach and evidence.

Moreover, with this sort of approach, the child seems able to grasp the significance of things usually considered quite beyond his range. Thus, a Grade III class of my acquaintance, after they had pollinated their narcissi flowers in the school-room, and obtained seeds; and again, watched the poplar outside their window with the showers of catkins and pollen; then talked of bees and their work; inquired most insistently into the formation of seed-boxes on the begonia plant which was blooming in the class-room, curious apparently that such should form in a room where there were no insects or wind to act as fertilizing agents. They discovered quite easily themselves the special mechanism of the begonia to secure pollin~~iz~~ation.

In her science work with children, Bertha Stevens also observes:- "It seems to be true that when little children reach the point at which they ask for facts, they are able to grasp the ideas which these facts involve, even though the ideas may be of a type commonly associated with maturer years. Knowledge sought can be appropriated when perhaps knowledge imposed could not be".[I]

Thus, Nature Study concerns itself with natural phenomena, with the building up of an appreciative, inquisitive attitute towards these, and with the development of power to interpret them. But how are the multitudinous natural phenomena of interest to children to be presented to them? The teacher has a choice of two methods - either to allow the child to learn these things haphazardly, with no previous planning, or on the other hand, to plan carefully beforehand how and when to introduce certain things. The former method might be adequate for the child who in early days spent all of his time, sleeping or waking, out in the woods or open places, but even then, I imagine, his elders took some hand in bringing to his attention facts they deemed necessary for him to know. Thus, this method is impossible in modern education, for there would be no assurance that the objectives of the study would be achieved. The teacher

[I] loc. cit. p. 22.

then, is committed to the careful planning of the Nature Study course.

But on what basis is this organization to be made? How are these many things and processes in the physical world to be presented to the child in the most advantageous manner? In view of the previous discussions, it is useless to attempt to take the study of, say, birds one year, animals the next, flowers the next, and so on. Children's interests do not develop in such a departmental fashion; their interests in flowers, and birds, clouds, and dew-drops, thunder and lightening and hundreds of other things seem to evince themselves simultaneously. We cannot, therefore, defer the treatment of their insistent questions for months or years on end, without losing their present interest, deadening their curiosity and eventually leading them to think that "grown-ups" consider their questions a nuisance. Moreover, this interest -"quickened intellect" as Dr. Rennie describes it[I] - is the very foundation and life of work in Nature Study; consequently we cannot afford to disregard so powerful an ally.

Our real question is, therefore, how can we arrange the Nature Study course, in order to make the greatest possible use of the children's interest? And this interest, it must be remembered, is to be sustained, yes, even increased, from kindergarten age throughout the Primary School. Again

I. Rennie, Dr.J. - "Nature Study". p.14

there are two methods of tackling the problem: first, the psychologist's way of finding at what time definite interests appear, and arranging the course to coincide with the appearance of these interests. The second way, is to my mind, the simpler, and sounder in the long run. Human interests, and emotions aroused by natural phenomena are largely a product of the weather; the seasons seem to exert a subtle influence on man as well as the rest of animate nature. Consequently, the child seeing and feeling these natural changes, is stimulated to ask questions and investigate the objects and happenings which arrest his attention in this pageant of the seasons. Nature Study will be utilizing his present interest to the fullest extent, if the work is arranged in the closest possible relation to seasonal changes. Thus, the flowering bulb, the sprouting seeds, the unfolding buds will claim his attention as spring approaches, just as will the gaily coloured leaves, the glorious gold and red of apples, the winds and frosts of autumn in their turn. It follows, therefore, that Nature Study should follow the seasonal order, for that is the most natural,and harmonizes most closely with the life and interests of the child.

The seasonal treatment has other advantages which will recommend themselves strongly to the teacher. They are listed as follows in the Appendix to the Agenda of National Conference on "The Place of Biology in ~~National~~ Education":- Scheme III - prepared by Sir J. Arthur Thomson, p.22.

I. "It comes nearest to what pupils (especially in the country) are seeing and feeling at the time.

2. "By keeping to the seasons it is easier to get fresh or living material to study, and even in the crowded town some of the shop windows are seasonally variable.

3. "By following the course of the seasons, the school Nature Studies will keep in touch (in the country at least) with the human activities going on around. There will be great gain if the pupils are convinced of the interestingness of the most familiar things within their own experience and get a glimpse of the problems behind them all.

4. "The seasonal method is that best suited to take advantage of the cultural value of Biology and it is the method that best admits of, and suggests, correlation between science on the one hand, literature and art on the other.

5. "The course with the march of the seasons as connecting thread, may preserve a unity though the depth to which the studies go may vary greatly from school to school or from class to class; and without repetition a second year may deepen the experiences of the first and add more also"

These considerations touch the very core of the teaching technique behind the Nature Study programme. They show very simply that the work should be connected very closely with seasonal changes and the human activities attendant upon them. Paragraph 5 suggests the whole organization of Nature Study throughout the school, and I do not think the suggestion can be improved upon. It obviates useless repetition, while treating things as they occur seasonally, yet I doubt if any subject will receive the same treatment or emphasis in any two years throughout the school. Like Huxley's method in his famous lectures on "Physiography" it will start with the simplest and commonest things in the environment and proceed in ever widening circle, year by year, to enlarge this sphere of acquaintance.

I have only one suggestion to add to the method of organization presented in the above. Previously I mentioned the necessity for mutual planning and co-operation in Nature Study between the various teachers and classes throughout the school. This is highly necessary if the above method is to function to the best advantage. Each teacher must know in advance just what work has been done in previous years, as a basis upon which to build her own work, and to avoid undue repetition and over-lapping. There are two ways of increasing this co-operation, so necessary to the good Nature Study course. The first is by frequent discussions in staff-meetings; the second, the keeping of some sort of diary either by pupils or teacher (or both) in which will be kept a careful record of the lesson - topics, the purpose of the outdoor rambles; the material collected and the subsequent use of this; and exhibits and collections accumulated throughout the year. This "class-book" must not be confused with the individual Nature Study diaries in which the pupils record their own observations etc, but it will be a careful record, most probably made by the teacher, of all the work in Nature Study during the year. This can be passed on as the class progresses from teacher to teacher, so that there is a definite record of the class-work in Nature Study from year to year. This, it seems to me, should prove of immeasurable value, for under the present system of Nature Study in Quebec schools, the absence of some such record and the frequent lack of co-operation between teachers lessens very materially the efficiency of the teaching. In such cases repetition of the same very limited range of topics year in and year out, with little thought of previous treatment, bores the children to such an extent that they lose all interest in Nature Study - a truly appalling state of affairs!

It must be admitted, however, that wherever a Nature Study course is prescribed by some authority external to the school, there are bound to be difficulties. The presupposition in such cases is that schools are uniform in the type of their pupils, in the quality of their teachers, and that the local needs are the same in all cases. This may be well in theory, but is impossible in practice. If the prevalent type of pupil in Montreal proper be compared with that in any Montreal suburb as to his everyday experiences many differences will be apparent. There is little doubt that these differences will be still further accentuated if the pupils of a typical city school are compared with those of any country school. Thus, "ready-made" courses [I] created irrespective of the needs of city and country schools will never be successful, for they neglect the fact that dominant characteristics of the out-of-school environment determine very largely the interests of the child.

I do not suggest for a moment that there is no large community of interests between city and country children; undoubtedly there is. Children everywhere are interested in knowing more about plants and animals, the weather, the seasons and so on; for these are phenomena of such general interest that they touch both the city and country child. Even here however there are differences of <u>degree</u>; one cannot expect the child of a city slum, who sees only the sickly plants on the window-sill, to have the same vivid experience of the plant as a living thing, as the country child who roams about the woods picking trilliums and lady-slippers. But there are also <u>special</u> interests due to their particular environment, which differ in the city and country child. Thus, the city child may ask how the meter measures electricity, or where the milk he had for breakfast came from - questions which would not occur to the country child. On the other hand, the country child may ask why the violet lives in the woods and the

I. It is true that such courses have a significance as belonging to a pioneer-stage of education when things had to be prescribed to be done at all, but the conditions prompting them have now almost vanished.

black-eyed Susan in the fields and roadsides, or why his father does not put the same crop in a certain field year after year - questions which would not occur naturally to the city child. Such differences of interests due to environmental conditions must therefore be recognized in the planning of a Nature Study programme.

Modern writers in education frequently urge that the school be a "mirror" of the environment. This, of course, implies that the school should reflect in its activities and curriculum the dominant interests of the world outside. In a sense then, no two schools can be alike, if each attempts to utilize its environment to the full in order to use to the utmost the interests of its children, and also fit them as it conceives best for their life after school. We must now determine to what extent this principle is to be carried out.

I think it can best be appreciated by considering one or two striking examples. Let us take, say, a city whose staple industry is making cars. Is it to the best interests of the child as an individual, or to the community at large that he be educated solely to perpetuate this industry? Or, is the village school in a community where the men are all employed on, say, a large ranch to educate its children solely for that function?

On examination of these examples - extreme ones, it is true - it instantly becomes apparent that such a narrow interpretation of education is unthinkable. The school must frequently examine itself in relation to the world outside, in order that its activities may not become pedantic and obsolete; it is quite another thing to say, however, that the school must "mirror" outside conditions with a view to educating the children in a narrow sphere. We are led to the conclusion, therefore, that the school, while using the children's environmental interests as a <u>motivating</u> force, must not conceive its function too narrowly. Otherwise, education will become purely technical and a "liberal" education will become impossible.

Let us now apply these considerations to the Nature Study course of the country school. Frequently, we are warned that the education of the country child must be such that he will desire to remain in the country, not leave for the city, as has so often happened in the past - in fact the Nature Study Movement in the United States originated with this specific purpose[I]. But surely in view of the above considerations, the education of the country child must not be narrowly utilitarian; for example, the Nature Study of the country school should not become purely "Agriculture". Thus, the Nature Study of the country school, like that of the city, fails partly in its purpose, if it treats only of things in the vicinity and neglects the rest of the world. Consequently, while a common course in Nature Study for city and country may present certain difficulties there is a danger that separate courses for country and city may be conceived too narrowly.

I. Comstock, Anna B. - See Introduction of "<u>A Handbook of Nature Study</u>".

I think, on the whole, we are inclined to accentuate too much the differences between the city and country in the matter of Nature Study. After all, the work in Nature Study of the Primary School should concern itself with matters of such fundamental importance that it should be equally applicable anywhere. The difference lies, very largely in the use of illustration and the question of emphasis. Thus, a city teacher illustrating the question of defensive mechanism in animals might well use the cat; the country teacher, perhaps, would also include the hedgehog and the porcupine, if she considered the children were sufficiently familiar with these - and so on. Also a city teacher would place a different emphasis on certain topics than the country teacher. Thus, the former might spend more time on weather and star study; the latter more time on bird study, for example. It is simply a question of using familiar things first. Finally the city child should become familiar with the above animals just as the country child may have to be shown the use of an electric light bulb.

There are, therefore, a number of ways in which Nature Study programmes, prepared external to the school, can be arranged to fit the needs of city and country schools:-

1. Separate course may be planned for the city and for the country school. Care must then be taken that these courses are not conceived too narrowly.
2. A minimum course may be prescribed, with

additional topics from which the city and the country teacher may select the subjects best suited to her purpose.

3. A single prescribed course may be conceived in sufficiently general terms, that it would leave the city or country teacher scope to chose illustrative material most suitable to the environment,and power to emphasize certain topics which she considers to be of the greatest importance for her own pupils.

It matters little which type of organization be followed. The main factor in the success of the Nature Study is the teacher's use and adaption of the prescribed material and opportunity to teach the things she is most vitally interested in herself (if these be suitable for children). Thus, no matter from what angle the Nature Study course is viewed - from the point of view of aim, method or content - we are forced to the conclusion that its main success lies in the well-trained teacher possessed of wide knowledge and interests.

There is one further aspect of organization which is frequently overlooked - namely, that all topics are not of equal difficulty. The Nature Study course must be so arranged that its outlook is progressive but the most difficult subjects should be deferred as long as possible. This is really implied in the method of organizing the work seasonally in what might be termed concentric circles of ever increasing difficulty. Thus, as spring approaches, the child in the Kindergarten may be concerned chiefly with the beauty and colour of spring flowers grown in the class-room; the Grade V pupils, however, may set out to discover why certain flowers can bloom in early spring - a study of food-reserves in bulb, corm, tuber etc., and hence of much greater difficulty than the above.

The only adequate way of determining how subjects shall be arranged within the seasonal order yet, graduated with regard to difficulty, is to examine the problem in relation to the psychological development of the child. Three stages can be recognized within the Primary School.

1. Early childhood - exploratory stage.
2. The Junior Primary Grades - Wonder stage - What is it?
3. Senior Grades - Why? stage.

1. This exploratory stage starts at birth, and is very noticeable before the child reaches the age of a year. Even the baby looks at and touches things, and attempts to hold them. When the child begins to walk, his opportunities for investigating are very materially increased and his interest in all things around causes his parents many anxious moments. The young child is, however, somewhat cautious with unfamiliar things. He will watch for some time before he will venture to touch them. He asks, "What will it do to me"? "Will it hurt me"? This is, distinctly a subjective relationship - this new thing and what it may do to him personally seems uppermost in his thoughts; it is a cautious, yet curious attitude, with something of fear in it. When this

fear is allayed this attitude may be followed, perhaps, by expressions of curiosity, wonder, or delight as evinced by the child's many exclamations and the clapping of his hands, etc. This stage then is characterized by great interest in things, and a certain emotional attitude towards them - of wonder or fear, of curiosity or expectancy; attention to any one thing however, is of short duration.

The persistence of this exploratory stage after the child has entered school makes it of interest to the Nature Study teacher. She will utilize this curiosity and interest in all things around to extend the children's knowledge of the immediate environment; fear will recede as the child becomes more familiar with his surroundings and the sense of wonder should increase as the beauty of flowers, trees etc, is noticed. Psychological investigations seem to show that even if children see things many times a day, the name of the object does not conjure up a clear mental picture of this same object. It is essential then, at this stage, to use things (or pictures as a last resort) in order that the child may form a concrete picture of these.

"The fact that children see an object a hundred times a day without acquiring consciousness or it, suggests that the teacher needs to converse with children about the most obvious aspects of their day to day life before he proceeds to erect a superstructure of more intellectual knowledge"[I].

I. Hall, Stanley - "Aspects of Child Life and Education"p.1 et seq. p.907. Quoted p.41 of the Hadow report on "The Primary School"

This would suggest that the Nature Study of this period of child-life should be very informal. It will consist in the main of play with Nature Study materials - nuts and seeds, leaves and leaf-stalks, flowers, berries, pebbles, etc., and informal discussions between teacher and pupils. No explanations, except to direct questions, should be given at this stage, which will last to the age of about 8 plus - i.e. to the end of Grade II possibly into Grade III.

2. As the child's acquaintance with his environment increases, so his fear of things, in consequence diminishes. Thus, increasing confidence marks the beginning of a new stage of development. His most frequent question "What is it"? shows that his attitude to his surroundings has changed slightly. With confidence that he now knows how things will behave, he is now interested in their relations to other things. I do not think that this question implies any very great interest in the thing itself - the "why" and "wherefore" of its existence - but merely its connection with other things. Thus, the child at this stage is frequently satisfied, for the time being, when he is told only the name of the new thing. It is his first tool to cope with the situation.

This stage is marked by great activity. The wide interests of the children make it possible to acquaint them with many living things, which they will come to know and appreciate as they watch the march of the seasons. The children will not be content merely to watch. They will want to make collections of leaves, seeds, stones and pebbles, and in all this work there will be competition - for this is the age at which the competitive instinct is at its strongest. This urge to collect, then, must be treated with great care, in order that it may not become destructive.

Then, also, there seems to be a tremendous urge to make things. The children will want to do something with their leaves and seeds, and so forth. They will work busily at leaf or seed charts or books; they will delight to make boxes or cases for the various seeds or stones they collect on their rambles. Consequently, at this stage the children should be allowed, if at all possible, to make the materials necessary for their Nature Study work - cases for collections, boxes to hold seedlings, bird houses, leaf prints, and so on. It is now that a room becomes valuable where Nature Study and manual work can be done without interfering with the rest of the school programme.

But amid all this motor activity, a new quality of "mind" is discernible. Thus, when out on a ramble the children finding a grass-snake will remark "It is green like the grass". "It has brown markings the colour of the ground". They do not now see merely the thing; they notice its relations to its surroundings. Miss Von Wyss in "The Teaching of Nature Study" p.33, shows this beautifully in the following:-

"At the earlier stage note was taken of the fact that the frog was brownish-green and had darker spots; it will now be discovered that such colour matches the colour of the bank and the moss, making it quite difficult for us to see the little creature if it does not move. In this way the children note relationships and discern biological significance in individual and particular instances".

This perception of relationships is the first step in reasoning. The faculty of reasoning now comes into play, to a small extent. Reasoning, as we usually consider it, involves not only the perception of relationships, but also the rapid association of facts. It is because of this, I believe, that till very recently psychologists believed that reasoning powers only emerged about the time of adolescence. Consequently, it would seem that 9 or 10 year olds are capable of reasoning, but that increased power to do so develops with practice and, therefore, becomes more apparent at the age of 11 or 12 years.[I]

It would seem, however, that the perception of causal relationships comes somewhat later[2]. Thus, it is essential that the Nature Study teacher, on hearing such remarks as recorded above, should conquer the almost overpowering desire to ask "Why"? The child at this stage is so concerned with relationships that he is only distracted and perplexed by this question. Moreover, the teacher in asking it is forcing the perception of cause and effect for which the child is as yet unprepared. This enquiring attitude in such instances cannot be counted as scientific for it represents very probably an over-simplification of the problem. We cannot prove that the colour of the frog is purposely such as harmonizes with its surroundings! In other words, there is an unwarrented assumption that what may be merely concomitant factors are causally related.

I. 2. Report of the Consultative Committee on the Primary School Board of Education (England) I - p.42; 2 - p.43.

This stage of mental development occurs at the age of 10 and 11, possibly 9,10 and 11, Grade III of our schools would be somewhat of a transition between the first and second stages. Grade IV and V would, I think, be the real place for Nature Study, built always on a seasonal basis, on the above psychological factors. The work of these grades should afford great opportunity for a naturally, happy, appreciative relationship with plants, and animals. This will necessitate a good deal of work out-of-doors, which, in addition, will permit the bodily activity seemingly necessary at this time. Thus, the Nature Study of this period will not be merely of the class-room; the woods, and fields, as well as the work-shop will all play their parts.

3. As has already been intimated, the third stage in the psychological development of the child commences about the time of adolescence - 11 plus. Then, a development in reasoning power becomes evident which permits a different type of work in Nature Study as well as other school activities. The children are capable, for the first time, of handling abstract ideas. Consequently, for the first time, the Nature Study teacher can follow the method of science, abstracting certain topics for consideration, rather than dealing with the environment as a whole. The difference between these stages may be illustrated as follows. In the earlier stages of Nature Study the teacher may organize the work as a series of units arranged around a central theme - say a walk in the woods in Spring - and the birds, flowers, insects, trees seen

will all be dealt with in the course of the lessons. In the later stage, however, a theme such as "Life in Springtime" may be adopted, - one aspect of the world in Springtime being thus treated separately. Within this topic the re-wakening life of trees, plants, ponds and insects may be considered. Thus, the method of approach is fundamentally different - the first is the method of the whole, as compared with that of a part.

Observation of plants and animals will, of course, be continued, but the children should now experiment for themselves. The observation of plants from seed to fruiting should be observed, and the whole life history of the animal, in order that the idea of growth and change, and rhythm in Nature may become familiar. The behaviour of the organism as a whole should be considered, as well as its separate life functions. It is particularly necessary that some treatment of reproduction in plants be considered at this stage, in order to form some scientific bases for important work in hygiene. The inter-dependence of plant and animal life must also be treated. This cannot be shown without some work in elementary chemistry. Physics, also, will be called on to explain certain problems in relation to plant life, etc.

It is essential at this stage that the final step to show the connection between these studies and the life of man on the earth be made; for in the case of children leaving after the elementary school course, this vital idea of the inter-relatedness of everything in the Universe may never be presented again. It is equally essential that the work may have an experimental basis, as far as possible; else our attempt to inculcate the scientific method will be impossible.

Also, we must encourage the reading of books on scientific subjects; a good library is, therefore, necessary. It is useless to assume that the children will continue scientific studies out of school, if they are not encouraged to commence these while still at school. The children should also be encouraged to consult periodicals and reports of various kinds to obtain information relative to problems they may be engaged upon. A certain facility of interpretation of charts and graphs should also result from the above.

This brief study of the characteristics of childhood as related to psychological development, would lead us to conclude that:- the first stage of Nature Study (to the age of about 9 years) should consist largely of the observations of things - mostly animal and plant life - in the immediate environment; the second stage (9 - 11 years) would extend this observation, but with emphasis on the study of the relationships of things to their environment; the third stage (11 years on) would amplify still further this observation and study of relationships with emphasis placed on experimentation.

It must be remembered, however, that as human beings are not made on one set pattern, so these stages are not hard and fast. There is a certain amount of over-lapping or shading of one into another. Thus, Grade III and Grade IV are to be considered somewhat in the nature of transitional periods - the first between early childhood and childhood proper; the second between childhood and early adolescence. Mental development proceeds not by leaps and bounds, but by a process of gradual unfolding; nor does it proceed at a uniform rate in all children; indeed at adolescence boys are quite a year behind girls in point of mental age. Thus, the questions suggested as characteristic of these various periods will not necessarily be the <u>only</u> ones asked; they seem, however, to be the prevalent type of question asked by normal children at these various stages of development. For this reason, they are taken as the basis of organization in the Nature Study course which I am about to suggest. In this way I hope to make the best use of those characteristics of childhood predominating at certain periods in order to increase the children's interest in the work, and to simplify the problem of organizing within a seasonal order, topics suitable in range and difficulty.

Thus, the Nature Study course will consist of studies of plant and animal life and of common physical phenomena. Its arrangement will be based on the psychological characteristics of childhood, and will be seasonal in treatment. The ideal course is one framed by competent teachers for the special use of their school, or failing that, one made by scientists interested in school science and aided by school teachers, then still further adapted to meet the needs of the individual school.

CHAPTER V

A Suggested Scheme of Nature Study

The Kindergarten.

The work of the Kindergarten teacher is so highly specialized, that with no special knowledge of this department, I hesitate to specify any Nature Study programme. Moreover, the Kindergarten teacher is, as a rule, very specially trained for her work, so the choice and methods of presentation may safely be left in her hands. Also, I am strongly of the opinion that the Nature Study of the Kindergarten should be treated not as a separate subject, but rather permeate the whole of the work and play of the department.

The characteristics of Nature Study in the Kindergarten are:- its prevalence and its informal treatment. The Kindergarten concerns itself largely with the extension of the child's knowledge of his immediate environment; this is carried out in play, in walks out of doors, in discussion and story-periods. Consequently, the work in Nature Study pervades the whole programme of this department of the school.

Secondly, the character of this work will be very informal. No set lessons will be attempted, but frequent discussions of things will take place between the children and teacher. These will arise naturally from the weather, objects brought into the class-room, pets, things found or seen in walks and so on. Stories, too, will aid in the

Nature Study programme. The Kindergarten room should be a beautiful one, filled with things which will interest little people and appeal to their sense of beauty. The pictures, plants, flowers and other things will all assist the teacher in her attempt to make this world a more interesting and fascinating place to live in. This, no less, is the task of Nature Study at this stage.

Kindergarten and Grade I teachers agree that there is little difference between the Nature Study work of these two classes. No difficulty is experienced in repeating work in Grade I which had already been presented to those children who attended the Kindergarten, for the children seem actually eager to hear stories they already know and to see old friends of the world of Nature; in fact children at this stage seem to welcome repetition and re-acquaintance with things they have become familiar with, and already love and enjoy. Thus, the suggestions made for Grade I may also apply substantially to the Kindergarten.

GRADE I

The aim of Nature Study in Grade I is simply to enlarge the children's knowledge and appreciation of the world (mostly but not entirely, their own environment) and to increase their pleasure and appreciation of it. To this end, the teacher will attempt to bring to the children's notice many common things, which before they "saw" but did not see[I]. The Nature materials she will use, will in the main

I. "The Primary School" - Board of Education - England p.41

be the larger, more brightly coloured ones, for these attract small children more easily than tiny, insignificant specimens, however interesting the latter may be to the adult. Moreover, it is highly desirable that the teacher have the things she is speaking about in the class-room before the children, in order that they may see, visualize, and thus, connect them as an object with their name. The reason for this has already been pointed out. (p.86).

Perhaps the best time to start a course in Nature Study is in Spring, when the re-invigorating and re-peopling of the world readily creates interests and awakens a questioning, inquiring attitude. Because of the organization of the school year, however, the courses are arranged with their starting point in September.

1. The first subjects of discussion will in all probability be the Autumn flowers - the familiar, brightly coloured ones which the children like to bring to school - nasturtiums, asters, both wild and garden varieties, sunflowers, marigold, etc.

It has been found useful at this stage to provide the children with envelopes in which they can collect pieces of string, cloth, etc, of varied colours. These are used in the discussions of the colours of flowers, the shading of Autumn leaves, and so on.

The children should also be encouraged to collect seeds - particularly big ones which are easy to handle. Thus, maple and ash seeds, water-mellon seeds, nasturtium seeds, (three in one), acorns and other nuts, pretty beans such as scarlet runners, hips and haws, and perhaps the seed-pods of milk-weed will be collected and used for play-things - for making designs and threading like beads, after they have been soaked. The stems of the falling horse-chestnut leaves will also be found useful in such play.

3. The leaves will be turning red and gold. The children may bring them in to press and decorate the room. They will be particularly interested in the vivid colouring of the maple, virginia creeper, and raspberry, and the yellow beautifully-shaped leaves of the poplar.

4. By the end of October the changes out-of-doors will be very noticeable. The birds are flying or have already flown away; the days are shorter and becoming cooler; the crops have been gathered and put away; the trees and some animals are getting ready for their winter's sleep. These subjects will afford plenty of material for work well into November.

5. With the coming of longer nights, the children will be able to see the stars before going to bed. They should be encouraged to look at them, and talk about them - their brightness, how they seem to twinkle, their large number, colour, and so on.

6. The coming of snow will afford chances of play, the noting of the softness and whiteness, and the idea of snow as a blanket to keep the seeds and plants warm may be suggested. A discussion of the sheep who gives us wool for clothes will also help to bring out the point.

7. At the end of November or beginning of December

bulbs may be planted, and put away for a month or so. If each child plant one himself, great will be the interest shown!

8. Early in December the Christmas Tree will loom very important in the childrens' life. It will be talked about frequently, and stories about the tree may be told. The children will then busy themselves in making decorations for it.

9. During the early months of the year, when Nature materials are difficult to find out-of-doors, pets may be brought to the class-room, to be watched, fed, and discussed. The aquarium with gold-fish may be introduced and will prove a source of interest throughout the remainder of the school year.

If possible, a rabbit may be kept in school for a few days. The children will delight to feed and watch it.

A canary, too, will afford much interest, if it can be properly cared for in a warm, draughtless place. If this is impossible, the children can be encouraged to feed any winter birds, both at home and at school. Thus, a starling came regularly to one class-room window to be fed, to the great interest of the children.

Animal stories - such as the "Burgess Bedtime Stories" are also of great use in this Grade, and while of use throughout the year, can be used specially in these months.

10. The bulbs planted in December must be watched from time to time. Narcissi will flower, most probably

in January; hyacinths, tulips and daffodils will be at least a month later.

11. As March approaches the melting ice and snow, the wind and rain will be discussed. Towards the end of the month, buds and would-be pussy-willows can be brought into the class-room to expand in the warmth. The children cannot at this stage be expected to note the formation, arrangement, etc., of buds, but they should nevertheless, become conscious of the growing and expanding process.

About this time, seeds may be planted and the children will watch their appearance with interest. The object at this stage, is merely to establish the fact that seeds can grow - the mechanism, the parts, etc, should of course not be mentioned.

12. In April the children will watch the buds unfolding and will delight in the silkiness of some baby leaves. They may be encouraged to watch for the birds returning, and the robins, in particular, excite them.

13. In May, the rapid growth and change in grass, plants, and trees will occupy attention. The children should be taken out for short walks if possible, to observe these things themselves in their proper setting.

The Spring flowers, particularly the bright, showy ones, will occupy attention, likewise the wild ones, as they are brought to school. Dandelions and their seeds seem of special interest to the children.

14. Birds, the making of their nests, their eggs, and finally the baby birds all will be discussed. The

children should be encouraged to watch the birds around their homes and gardens, and to talk about them. As Easter approaches eggs and baby chicks will be of absorbing interest. A visit to see chicks should be arranged if possible.

15. Throughout the year, the weather, clouds, wind will be discussed in an informal way.

Discussion of Grade I Work

A. It will be noticed that everyday things, are used, no very strange ones are brought in.

B. There are no set lessons, but rather talks with the children about the various things, and almost invariably with the things discussed in common view.

C. Only the very noticeable aspects are touched on - not small details; neither are small or inconspicuous things chosen, rather the brighter flowers, the big, common seeds, and so on.

D. Few questions are asked and no explanations given - except to direct questions the children ask. This is an exploratory stage; the "whys" will come later. The teacher must be a sympathetic listener to the childrens' discoveries.

E. As in the Kindergarten, Nature Study will play a very large part in the work of Grade I. It will not be a set subject, it will be part and parcel of the whole - coming into all work done in school. Thus, for Grade I no definite time need be set apart for Nature Study, as it will be taken care of almost entirely in the informal, everyday discussions, of what is happening around. In fact, it would seem that everything but the mechanics of early writing, reading and number work, will in a sense be Nature Study - and even these will frequently use nature-materials, such as counting the seeds or baby chicks, etc.

Grade II

The aim of Nature Study in this Grade is to enlarge the child's acquaintance with objects and phenomena of the world of Nature, and to increase his appreciation of its beauty, etc., the work of Grade I being used as a foundation upon which to build.

I. The first weeks in September will be occupied with a consideration of Autumn flowers:- the nasturtium, aster, sunflower, marigold, cosmos in the garden, the asters and golden-rod of the fields and woods.

2. In the examination and discussion of these flowers, most probably the seed, or seedboxes will claim attention. This will open up a new study of seeds, wild and planted. From this the idea of fruitfulness may be brought out which, in turn, will pave the way for the subject of harvesting and preparation of winter.

If at all possible, the children should be taken to a farm, or market-place, to see the numerous different varieties of fruits and vegetables now available. In this way a definite impression of abundant fruitfulness can be created.

3. The question of getting ready for winter will now be considered in detail:-

a. The Birds :- flying south to spend winter.

b. Plants:- some die leaving seeds behind; others "sleep" till Spring.

c. Trees :- the falling of the leaves - work with leaves.

d. People:- How does the farmer get ready for Winter? How do we get ready for Winter? - bringing out the dependence of people on others who grow their food. Then will come the idea of Thanksgiving - which should be arranged to coincide with the holiday.

e. Animals:- The squirrel, bear, snail, etc

These studies will probably occupy most of November.

4. The shortening day, the cooler weather, the rain and finally snow, the clouds - in short, weather study - will in all probability occupy the attention for the remainder of Novermber.

5. With the lengthening evening and early darkness, the children should be encouraged to look at the stars. The Great Bear - always a prominent constellation, and an excellent starting point for star-study - should be made known to them, pointing to Polaris (the North Star). Orion so prominent in Autumn and Winter may also be introduced. In November it does not rise till late, but towards the end of December and the beginning of January it is a prominent constellation in the sky in the early evening. The children will wish to discuss the many stars, and how some are brighter than others. The teacher may introduce the idea of their distance - but merely to heighten their sense of wonder; catalogues of figures and distances are, of course, out of

place.

6. Bulbs will be planted early in December, and after the Christmas holidays these may be observed from time to time and their growth noted.

7. If there are evergreen trees in the neighbourhood, it may be noticed, when outside, that these have retained their leaves while all the rest of the trees are bare. This will lead up to the ever-popular theme of Christmas trees.

8. At times during the Winter, if it is all possible, the children should be taken out for walks to observe the trees, covered with snow, or perhaps, casting their shadow on the snow, the beautifully curved snow-banks, the ice on pond, stream or river etc.

9. In the New Year the study of bulbs, their need of water, their colour change when brought into light, should establish the fact that plants require water and light. The children should be encouraged to care for the plants in the class-room and perhaps at home also.

10. In this in-between stage, when any work outside is difficult, the question of pets may be raised with the object that the child should become interested in caring for his own pets properly. Questions of food, cleanliness, etc., will be discussed in this connection in the hope that the child will learn the needs of his pets and how to care for them intelligently.

11. Weather study should be continued. Possibly the children could make weather charts, - simply by showing the sort of day by blocks of colour - thus, yellow for sunny days, grey-black for dull days, and so on. The lengthening

of the day should also be observed.

12. There may also be time for treatment of where certain foods come from in Winter. Thus, our fresh vegetables, oranges, etc., may be discussed, and pictures found and stories told of the places where they grow.

13. In March the preparation for Spring will be observed. Some seeds may be planted and tended in the class-room. Towards the end of April the children may each plant a nasturtium seed, and care for it until it is transferred either to a window-box or garden. The children may even take them home and observe and care for them throughout the Summer.

14. With the coming of Spring, buds, pussy-willows, flowers of the garden, fields, and woods will be observed. Their names and colours should be known, but it is too early for anything but very incidental work on the various parts to be undertaken.

15. The babies of Springtime will be noticed, the seedlings, the nestlings, chickens and so forth. If tadpoles can be procured, the children may watch them in the aquarium and notice their various changes.

16. As the season progresses, they should be taken if possible into the woods (or park). A subject like "A Walk in the Woods" may be taken as the basis of organization for much of the subsequent Nature Study work. Thus, the flowers, plants, birds, insects, trees and so on, may be discussed in turn. The children should become familiar with several of the local wild-flowers - e.g. the spring-

beauty, the trillium and the violet as well as the names and appearance of two or three common birds.

17. The remainder of the school year will be occupied in watching the development of plants, trees, flowers which have already been studied, and of enlarging the circle of acquaintance.

Discussion of Grade II Work

It will be noted that the environment is widening - not only in the number of the things studied, but their scope is also wider. Thus, we talk of the farmer's work - how he grows and stores food; then again, possibly of food that comes from other countries, such as the fruit and vegetables we obtain in Winter-time.

Also, the method is developing. The children are required to observe for themselves and begin to record - in a crude form, of necessity, due to their inability to write very freely. Of course their records will be simple, but they will take account of the more prominent features of the situation - those in particular which interest the child at this stage. No very minute or careful work is to be expected or desired of 7 or 8 year olds. The main thing is that their knowledge of their environment is widening, and they have commenced to make individual observations and recordings.

I understand that now Geography teaching is being commenced in Grade I, not as previously in Grade III. This Geography will consist largely of :- 1. a study of the immediate environment, and 2. stories of other countries.

The closest correlation should be observed between the first of these and the work in Nature Study. The term "correlation" implies the bringing together of separate things; it would be even better could they be taken as one. This is really only a question of time adjustment within the class.

Grade III

The aim of Nature Study in Grade III is largely the same as that of Grade I and II. In addition, however, this Grade is somewhat in the nature of a transition between the first and second stages of Nature Study. Consequently, besides the attempt to explore the environment, there will also be an effort to discover relationships between the different things which are studied, and their relation to the environment as a whole,(cp. p.87 et seq.)

It must be remembered, however, that the children are not at the stage to appreciate the "why" and "wherefore" lying behind the facts they are accumulating. The teacher, therefore, should not force this stage by too much questioning; rather let the children do the questioning, when they are ready for it.

1. The work will commence as before with flowers appearing in the gardens, fields etc., at this time of the year. The children should now be able to recognize most of flowers commonly found in the neighbourhood;- e.g. the aster, dahlia, nasturtium, cosmos, gladiola, stock, petunia in the garden, the aster, golden-rod, thistle, sunflower, burdock etc., growing wild.

2. Towards the end of September a visit should be made to the woods and fields in order to collect the seeds of various sorts. These may be supplemented by others collected from plants in the garden. In the city, the teacher will find some material in the park, some in the vacant lot, and possibly some of the children will also be able to bring seeds from the small garden or window-boxes at home. When this collecting is complete, the teacher may suggest the making of a seed-chart or book, or a case to house the collection. In the course of this work, the children should be encouraged to classify them in a simple way. They will probably suggest three methods:- seeds that fly -e.g. maple, ash, dandelion, aster, golden-rod, milkweed and thistle; seeds that "steal a ride" - e.g. burrs and ticks, those which fall near the parent plant - e.g. pansies, violets, cosmos, nuts, etc. The children may also suggest that squirrels, birds and even people also help in the scattering of seed. These may be included, if suggested, but the classification should not be forced; rather it should evolve naturally.

3. During September and early October the children should be encouraged to collect and press leaves. They may then prepare individual leaf books or possibly, a group of children may construct a chart or frieze of the most beautiful leaves to decorate the class-room. For the latter purposes, it has been found that if the leaves are pressed, then rubbed carefully with linseed oil and ironed between newspapers, then pressed again, they keep their colour and remain unbroken for months. They will keep even better if the chart or frieze is covered with cellophane.

During the work with leaves, the children should learn to distinguish between the maple, poplar, horse-chestnut and birch leaves - if these are included in the collection. Opportunity should be made to see these trees, both before and after the leaves have fallen, and to note the general shape, type of leaf and bark both on trunk and branches. During the Winter they may be observed again silhouetted against the snow - perhaps the most striking time to see the shape of a tree.

"Oh thought I! What a beautiful thing God has made Winter to be, by stripping the trees and letting us see their shapes and forms. What a freedom does it seem to give to the storms"! Dorothy Wordsworth.

It will be understood that these trees have been chosen as interesting types, but on no account should any of these be mentioned (at this stage, at least) unless they are to be found within easy reach of the school.

4. While out in search of leaves and seeds, any caterpillars found may be taken to the class-room, there to be fed until they form the chrysalis. The children will be interested in this change of state, and this will later be seen as one way of living through the Winter.

5. From the middle of September on, the preparations of the birds for their departure will be noticed. If their going is actually observed, a record should be kept of the date, type of bird, and so on. The children will be interested to note how the birds mass to fly. Any actual cases should be recorded.

While these records should be kept in the school diary, the children should also be encouraged to keep their own nature-study diaries, with sketches of things that interest them. These will be very simple at first, but good work of this sort can be done by eight or nine year olds. During the course of Grade III, when bird-study will be continued throughout the year, they can be specially interested in the keeping of bird-records, and these, incidently, will prove of great use in the study.

During the course of this study, the children should learn to recognize the commonest birds of the neighbourhood - those which leave in the Autumn, and those which stay for the Winter. This study will, of course, be treated much more fully in a country than in a city school. However, even in the latter, sparrows and perhaps starlings will be seen, and can be fed throughout the Winter.

6. The above studies will probably afford a very full Nature Study programme for the pre-Christmas term. However, the weather-study, already started in Grade II should be continued. At the beginning of the school term, records of the length of day should be started and continued for the remainder of the school year. The children should be encouraged to observe for themselves the time of day light or dusk. Their own observations may be compared with the times given in some newspapers. This comparison is more easily made, at time of sun-rise and sun-set, as the children's judgment of lightness and darkness will vary a good deal. The

object of this study is to observe the gradual shortening then lengthening of the day from Autumn to Winter, from Winter to Spring and Summer. By the end of the year, they will have sufficient data to show this very plainly. It is unfortunate the records are broken by more than two months in the Summer, but the children by the age of 8 or 9 will have observed the long Summer nights when they had "to go to bed by day", and will at least be able to fill in the gap qualitatively.

7. Towards the end of November, bulbs may be planted. A special study should be made of narcissus, tulip and daffodil. Before the bulbs are planted, the children should be allowed to compare them, and note their relative size. They will probably be curious as to why these flowers need a big bulb to grow from, whereas many other plants grow from small seeds. Without going deeply into the question of food storage and its relation to the early appearance of these flowers, they may be shown the cross-section of a bulb with its prospective bud and leaves.

8. As Christmas approaches, the children may this year try to find out what food the birds like. They may then prepare a bird-christmas-tree with crumbs, suet, seeds, placed upon it. This should be set up in view from the windows if possible, or otherwise in a place in the school-yard where it is not likely to be disturbed. After the holidays, the children may construct a bird-table from which to feed and study first, the Winter birds, and later those returning in the Spring.

9. It is preferable that star-study should be made in the Autumn. However, due to the many fall activities this may have to be postponed till early in the New Year. The children should already know the "Great Bear"; now they should become acquainted with the "Little Bear". The North Star will also be indicated, as the children study the directions in Geography during the year. It will be observed that, as these are always in our skies, the postponement in this case does not matter. The Milky Way should also be introduced to the children - in a way to stimulate their sense of wonder at the hosts of stars forming these beautiful pathways of light. This is most striking in Summer.

10. The children should be encouraged to notice the shape of snow flakes throughout the Winter. Some day when the crystals are particularly beautiful, they may be taken out of doors to examine them. These will seem even more beautiful and fascinating if they are examined with a pocket lens. They may attempt to draw the shape of some of the flakes, or cut or tear them from white paper, which may then be mounted on a darker background in order to show the form.

11. The remainder of the Winter will be spent on the question of what insects, plants, trees, birds and animals do during the Winter. Their observation of caterpillars, and the disappearance of house-flies may be used from the insect point of view; their work with leaves and seeds will have supplied some information with regard to plants and trees; their observation of birds will have told them that

only few remain in Canada; and their present knowledge of animals may be supplemented by stories and discussion, as first hand information will be very much harder to procure. Even here, some of the children may know of pet frogs, toads, hedgehogs and tortoises which disappear during the Winter months, to reappear in the warm days of early Spring.

12. Some of the seeds which specially interested the children in their Autumn collecting may be planted, and their development watched. The idea of the seed as a baby plant asleep, but capable of growing under certain conditions should be definitely established.

13. In March the children should begin to watch the trees very closely - particularly those which they studied in the Autumn - namely, the maple, poplar, horse-chestnut and birch. Towards the end of April, twigs of these should be brought into the class-room, and the development of the buds and leaves watched closely. The children will be particularly interested by the catkins on the poplar, and the tassels of the birch.

14. Concurrently with the observation of trees, the return of the birds should be watched. The children may be aided in identifying these by pictures hung around the room, and by reference to picture bird-books. They may also make sketches or paste coloured "cut-outs" in their diaries or scrap-books or special "bird-books". These may also contain simple, brief descriptions. These, of course, will consist only of the local birds; there is no point in spending valuable time on birds which the child may never see - he

will learn of these himself if he is sufficiently interested in the subjects.

The construction of a bird-chart may also be attempted. This may contain the date when the bird was first seen,the name of the bird, and the name of the person who first saw it, and described it clearly; a sketch or a picture of the bird may also be included if desired.

The children should also be encouraged to set up bird-houses, bird-tables, and bird baths around their own houses and gardens. The possession of a bird-house containing a nesting bird will awake more enthusiasm in a small boy than weeks of talking!

Suggestions for the construction, and in some cases even plans for bird-houses can be obtained, I understand, from provincial bird or Audubon societies. These make special efforts to aid youthful enthusiasts.

Care must be taken during the study of birds, that the instinct to collect does not lead to the disturbance or even destruction of whole sittings of eggs. The children must be made to feel that in this, it is better to watch than to own; to protect than to destroy. Moreover, if it is suggested to them that if each took even one egg from, say, the orioles' nests of the neighbourhood, soon there would be no orioles at all, the children even at this age, are reasonable enough to see the truth of this. The same attitude must be adopted to the wholesale gathering of flowers and blossoms from thorn or tree, in order to check the thoughtlessly selfish attitude which would take all, without thought of others, or of the consequences of such action. One is frequently reminded of the "Punch" cartoon concerning the last spray of blossom on the tree hanging over a fence adjoining the highway!

The number of birds definitely studied will depend largely on the neighbourhood - in the city, I doubt, whether the list would be longer than the sparrow and the robin, possibly also the crow, "canary" and humming bird, and if near water, the gull. In a suburban area, the robin, the various sparrows, mainly the English and the song sparrow, the "canary" or goldfinch, the blackbird (the red-winged blackbird will only be seen near swamps), the crow, the wood-peckers and flickers are the most common. In many suburban and most country areas there may be another ten or fifteen fairly common birds, but the above are undoubtedly the most generally known, and hence, the best choice as far as Grade III is concerned. This list will be augmented in later years. Of the Winter birds, the most common are the starling and the chickadee; the grosbeaks and snowbuntings may occasionally be seen and even an occasional woodpecker.

15. As the snow melts in March, the little streamlets which cut their way through the ice, may be observed, also how these join to form larger ones. The fact that water tends to the lowest possible level also may be noticed. These observations can later be used on works concerning the stream, the river, etc.

16. The teacher should attempt to intensify the children's joy of the general "awakening" of Nature, as exhibited by plants, trees, animals, birds and insects.

17. They should be taken to the woods to observe not only the birds and trees, but also to find the first flowers: The hepatica, the spring-beauty, the dog-tooth violet, the various violets and trilliums.

I think it is rather early to talk much of the parts of the flower. The leaves, stem and petals may be observed, particularly with regard to their beauty of shape and colour. In the large flowers, the children will probably ask also about the stamens with their pollen.

18. If the school is fortunate enough to have a garden, Grade III should most certainly have some share in it. The children should also be encouraged to make a garden at home - however tiny it may be. There is little doubt that actual work in caring for growing things, particularly one's own growing things, is the surest way to establish a real and lasting fondness for Nature!

19. The pupae of the caterpillars collected in the Autumn should be watched carefully when the warmer weather arrives. Other caterpillars may also be found, placed in a simple cage with the proper food, and watched in their various stages. The object of this study will be to discover from observation, the life-cycle, caterpillar - pupa - butterfly. If the eggs can also be found and watched the

whole life cycle will then be established. The cabbage white - as perhaps the most easily obtained of caterpillars, may be used, but it does not matter at this stage what particular one is taken - as long as its special food is known. The recognition of various caterpillars and butterflies will come later, but this life cycle seems to interest children intensely; when this is established they can learn the other from observation themselves.

Discussion of Grade III Work

The most outstanding change in the work of this Grade as compared with the previous ones, is that much of the work is carried like a continuous thread throughout the year. This is possible because the children's span of attention has increased quite appreciably. This should not mean that the lessons are very much longer; I think Nature Study lessons should rarely exceed twenty minutes. It does mean, however, that the children do not tire of a subject so quickly and are ready, if not eager, to carry it on over a considerable period. Thus, weather study, bird-study, and tree study are carried on throughout the year. The second of these forms the very heart of the teaching throughout the year. Thus, the topics or- "projects" if you will - are more sustained in character.

An effort is made throughout the year to intensify the children's knowledge of the plant, the tree, the bird, the animal, the insect, as a living thing. This will become more vivid through subsequent work in the school.

After Grade II increasing care must be taken in the manner of approach to Nature Study. While the previous year's work will be incorporated into the whole body of Nature Study this should not be mere uninteresting repetition. Thus, a more thorough experimental basis, a wider range of knowledge, should contrive to make the old seem new and more wonderful at each turn.

It is utterly amazing what children of this age can understand, provided that it be something they can observe themselves, and feel vitally interested about. The secret of it seems to be that whatever they can grasp sufficiently to ask vital and curious questions about, that same can they comprehend, at least in part. Thus the approach is of very great importance.

Moreover, the teacher must observe great caution when these interests literally "flame" up, in order not to impart too much. The children's wish to know will in all probability be satiated long before, the teacher's knowledge should be exhausted. To tell too much before further questions are asked - which might require days or months - only serves to deaden rather than to increase these interests. The teacher must be skilful in her use of opportunities. For instance, the facts about the formation of snow will be eagerly received when the first snow falls; a little later, possibly, a storm of exceptionally large flakes may provoke the question as to why the flakes are so large; still later, they may be shown the individual flakes under a magnifying glass; but the process should not be unduly hurried. Wonder upon wonder soon palls; and many beautiful or interesting things seen at the same time invariably cause some to escape unnoticed.

Another point to be observed at this stage is the desire to collect which is beginning to manifest itself. At the slightest encouragement, the children will collect amazing numbers of leaves, seeds, etc. If one beautiful stone be pointed out in some excursion, soon quite a collection will appear in the class-room. It is well to keep these together in a box, which the children may make themselves. Such a collection may be handed on from teacher to teacher as the class proceeds through the school. Where such things are not perishable, they may be kept until the time when such a collection, made by the pupils themselves, will lend itself to the more complete handling of a subject. e.g. the rounded pebbles in the work on the stream and stones of various kinds in considering local geological features. The danger already mentioned with regard to collecting, must always, however, be borne in mind by the teacher; otherwise, interesting plants, trees, insects may disappear entirely from our country - literally collected out of existence.

In Grade III as in the previous grades, the closest connection between Nature Study and Geography teaching should be observed. In fact in some schools they are grouped as Elementary Science, and taught almost inseparably.

Grade IV

The work of Grade IV falls quite definitely into the second stage of Nature Study. This stage(discussed p.86 et seq.) has been called the Wonder Stage of Nature Study - but "wonder" should not be confined to this period only; it is essential to all progress in Nature Study and Science. The characteristic of this period is a desire to discover relationships as shown by the questions :- "What does it do"? "How does it act"? "What is it"? These questions are concerned not merely with the thing itself, but how it is related to,or harmonized with its surroundings, e.g. the chipping sparrow becomes not merely the bird who makes the "chipping" noise but also the little brown bird which is difficult to see against the brown ground under the hedge. Side by side with this reconsideration of previous experience in the light of new relationships, the exploratory character of the previous Nature Study must, of course, continue.

I. Autumn flowers will as before occupy attention during the first weeks of school. The previous list of flowers known may be extended by the addition of others frequently seen in the neighbouring gardens.

During the discussions and examination of various flowers, the leaves, stem, petals may be pointed out; the stamens and stigma and ovary (seed-box) may also be noticed in the larger flowers. The pollen always interest children and they will be pleased to notice how it adheres to the sticky stigma.

2. Attention may be drawn to the butterflies, moths

and other insects which are seen around the flowers. The nectar which exudes visibly in some flowers and which attracts these insects may also be indicated. On observing a bee in a flower it may be noticed how it disturbs the stamens, collects pollen on itself, and deposits some on the sticky stigma as it passes. The children may be told, should they question further, that the tiny pollen grains grow and touch the would-be seeds ovules in the seed-box below and cause them to develop into real seeds. This can be done quite simply without introducing botanical terms, and the children seem genuinely interested. Thus, the first link in the plant and insect economy may be formed.

3. The collecting and simple classification of seeds, begun in Grade III may be continued. Thus, as well as seeds that fly, seeds that "steal a ride", seeds that fall near the mother plant, those which explode (e.g. the touch-me-not, peas, wood-sorrel, etc.) and hurtle their seeds to a distance may be observed, also the sifter arrangement of the poppy. The squirrel carries and drops nuts, the birds eat fruit and drop the seeds, e.g. raspberries, cherries etc., people too by accident, drop the apple seeds, from the apple they have been eating, or cherry or plum stones. Thus, the many seeds of Nature's harvest are scattered, but as yet no mention of why this happens is made.

4. Tree study will also be continued. Besides the four trees already studied, the children may be taught to recognize the beech and the elm, with their distinctive shape, bark, etc. They may again make charts, books, and

decorations with the leaves. They may also make attractive leaf prints by spattering water colours over the leaf which is meanwhile held firmly on drawing paper. Thus, not only the leaf but its characteristic shape and indentations will be impressed on their memory.

The children may be told of the function of leaves as food factories and how their work is finished in Autumn, so they drop off. The children will see for themselves, if an early snow should happen to come before the leaves have fallen, how the weight of them, frozen and snow-covered will even break the branches. The falling leaves also form a blanket for the roots and finally form leaf-mould which aids other plants and trees to grow.

5. Weather observations may be continued and amplified by noting the condition of the sky (cloudy, clear etc.); the temperature, (hot, cold, warm, and so on), the strength and direction of the wind - all of which can be recorded compactly in chart form. A comparison of such records with those of previous years should prove interesting. The records attempted in Grade III were intended to show the variation in the duration of daylight throughout the year. This year stress may be laid on the connection between the length of the day and the temperature.

6. Again any caterpillars and pupae found may be collected, and placed in cages in the class-room, the former to be fed and observed until they pupate.

7. Records of the departure of birds may be made and

compared with the previous year.

8. Star Study should be continued; a. by a review of those previously studied, b. in addition, Cassiopeia and Cepheus, Orion (already familiar) and "The Great Dog", of which Sirius is the important star, c. legends and stories connected with the stars known should be told.

9. Bulbs may again be studied and planted. The narcissus, tulip, daffodil and hyacinth may be chosen - the first to be planted in stones, the last, to be grown both in soil or fibre and also over water in a hyacinth vase.

As an outcome and extension of the previous study of the parts of a flower, the stamens, pistil and seed-box may be studied carefully as the flowers develop. The flowers of the narcissi can be fertilized easily with the point of a pencil or pen-nib; fully developed seeds may be obtained if the bulbs are watered from time to time. Thus the whole process of growth, fertilization and fruition may be observed in the class-room. I have not attempted this with daffodils and tulips but hyacinth stems usually bend and die before the seeds are fully developed.

10. As Christmas approaches a comparison may be made between the shape of evergreen and deciduous trees and tree silhouettes may be worked into the Christmas decorations and art work. This will lead in all probability to the study of the Christmas Tree with its needles instead of leaves. Attention may be drawn to its smell, and also to the sticky sap or resin which exudes when a branch or twig is broken.

If holly is obtainable, an interesting lesson or two may be given, including stories, and customs connected with it.

11. In January work may begin on the water cycle, by which I mean, the continuous process of evaporation, condensation and precipitation. Some day, in the work on weather charts and the discussion of clouds, the question may be asked as to where the clouds come from. The work should proceed on a thoroughly experimental basis. The children may first watch a boiling kettle, and how the steam disappears. In order that the children may not think that vaporization occurs only when boiling water, a saucer or shallow dish may be placed in the class-room, and others outside, possibly one on the window-sill and another in a place on the school grounds where it will be protected from spilling and sheltered from rain or snow. The children will see that this process of evaporation occurs both indoors and out. They may be reminded of the way the wet roofs and sidewalks "steamed" after a Summer shower. Also, they may watch the "honey-combing" and consequent evaporation of the snow under the action of the sun in Winter. Thus, the fact will be established that water evaporates both in Winter and Summer.(It is unnecessary for the present purpose to point out the difference in the rate of evaporation depending on conditions of temperature and vapour content of air). The next step is to establish the fact that this vapour may be condensed. The boiling kettle and a cold tin on which drops of water form greatly interest the children. The condensation of vapour on a pitcher of cold or ice water

may also be observed. From these experiments the children may be lead to understand that the same sort of thing happens up where the clouds are formed - in fact the "steam" from the kettle is really a miniature cloud. They may then be told of how larger raindrops are formed by the air-currents (wind) also how snow and hail are formed. Then these becoming too heavy, fall to the earth, to water it or cover it with snow as the case may be, and finally to feed streams, rivers, lakes, and oceans. The children see readily that this process is repeated, and in fact is continuous. Thus, another cycle of Nature is established and the study of snow during the rest of the Winter, and the observation of clouds, etc., throughout the remainder of the year will be more interesting and instructive in consequence.

12. February may be devoted to a study of the aquarium. This will be no novelty to the children, but it may now be established that for a <u>balanced</u> aquarium not only fish but also plants are required. Two aquariums may be set up - one with no plants, in which the water has to be changed frequently; another containing water plants, in which it will be found the water does not need to be changed very often if there is sufficient plant-life to provide oxygen for the fish. Goldfish will probably be most convenient for the school aquarium; guppies and tropical fish require an even temperature of a least 70 which is, as a rule, not maintained during week-ends and holidays. Snails will add to the interest of the aquarium, besides acting as scavengers. Should the latter lay eggs, these will occasion

still further interest. (The ramshorns are egg-layers, the Japanese snails are live-bearers.)

The aquarium vessel need not be elaborate, but the larger the air surface the better; thus a relatively shallow vessel is preferable. Sand not to fine, nor yet too pebbly is placed on the bottom to the depth of an inch in the front and sloping to about two inches at the back. Plants are placed in this, with the closest grouping towards the back of the aquarium, and are anchored firmly in the sand. The water may be poured on brown paper cut to fit the aquarium, in order not to disarrange the plants. It is well to leave the aquarium for at least a week before putting in the animals. The children may do this work themselves - indeed, they will be infinitely more interested and pleased with the result if they do.

13. Most probably the bulbs, which have already been mentioned, will claim attention towards the end of February. (The narcissi will bloom in January). The study of hyacinth, tulip and daffodil may be continued as already suggested.

14. Following the observation of bulbs, seeds may be planted and their development watched. Different kinds of seeds may be taken from the children's collections made in the Autumn, both wild and cultivated plants being represented. These may be placed between blotting paper and the wall of a straight glass cylinder or lamp chimney - the seeds and blotting paper being kept in place by dampened sawdust, sand or moss. In this way the children will be able to watch the growth of the seeds.

In addition each child may plant a seed in soil in an eggshell - the bottom of which has been perforated for drainage. The children may write their name, the name of the seed, and the date when planted on the eggshell, and these may then be placed upright either in soil or sawdust in an ordinary shallow seed-box. In this way each child may have his own seed to tend, and yet the class-room will not be filled by pots or boxes.

The work with seeds should intensify the thought that the seed is really a baby plant waiting for the proper conditions before commencing to grow. The idea that the plant is a living thing requiring light, heat and moisture may also be shown by experimenting with sturdy seedlings. Pairs of similar seedlings should be used for these experiments - e.g. bean seedlings which have their first real leaves. It will be simpler to control the conditions if if these are planted in separate pots. Thus, of one pair, one may be given sufficient water, and the other left dry, with other conditions the same for both; of another pair, one may be placed on the window sill and the other in darkness, while conditions of moisture and heat are the same for both; of a third pair, one may be placed in a warm the other in a cool place, conditions of light and moisture being the same for both; similarly, growth in sawdust and soil may be compared. The experiments may be carried on for a number of days, until decisive differences in growth are seen between members of the various pairs. Thus, the following general ideas will be established:-

1. The seed is capable of developing into a plant.
2. The plant is a living thing.
3. It requires light and heat, usually supplied by the sun.
4. It requires water - usually supplied by rain..
5. It requires soil in which to grow.

15. As the snow melts in early March, the effects of water may be observed. Thus the erosive effect on ice may be seen on all sides, as water cuts channels for itself, while escaping to the lowest level. These observations will help greatly in understanding the action of the stream and river, which will be attempted after the snow disappears.

16. With the coming of Spring, trees will again occupy attention. The swelling of the buds which have been formed all Winter will again be noticed, and twigs will again be brought into the class-room for closer observation.

This year, as the children are becoming accustomed to observe more closely, their attention may be called to the flowers on the maple, and they may watch closely the development of the flowers on the various twigs in school. It will probably be found that for this purpose a new set of twigs will be needed, as the flowers usually die before they develop on those first brought into the class-room. I have found that a magnifying glass left, seemingly carelessly, by the vase containing twigs will occasion such interest in the beauty and the development of tree flowers, that set lessons on the subject are scarcely necessary. The children will find for themselves the clusters of reddish or green maple flowers also the two types of flowers which appear on the fully grown pussy-willows from separate trees, poplar catkins and so on. They are also greatly interested in the tremendous quantities of pollen formed. As most trees are wind-pollinated, they become familiar with a second type of pollination.

17. The observation of birds should be continued and several new ones should be added to the list of those with which the children are already familiar. The teacher is the best judge of which birds are best to introduce. After those mentioned in the Grade III list, the house-martins, bluebirds, night-hawk and humming birds are probably most common.

Where bird study is concerned, I do not think it is much good spending time on those which the children will never see either in their own neighbourhood or during country holidays. Thus, if the city teacher judges that the above are quite beyond the experience of her children, and there is no access to a Natural History Museum, she would be well advised to spend her time on some other aspect of the Nature Study programme. Of course, observation of the birds already known would recur from time to time, and the teacher may, by exhibits of pictures or by including bird books in the library, make certain that the children do know that other birds exist. Movies of bird-life can also be used to supplement the above methods for overcoming the deficiency in direct experience.

18. From the study and observation of birds, out-of-doors in field, wood and garden, the teacher can pass easily to the study of the brook, stream and river. Any water course may be observed, the size does not matter. Opportunities should be made of observing the plants, growing in and near the water, also the water life and the insect and bird life around it. In fact the brook could be made the focus of not months, but even years of Nature Study. The study of the brook, related closely to previous aquarium studies, should continue for the rest of the school year.

Possibly the best introduction to the subject will be a view of the turbulent, muddy water of the flooded brook in early Spring. The physical principles such as the carving or erosive effect of water may then be seen. The turns and twists, the worn rocks and rounded pebbles may be observed, but there is no need at this stage to go into the physical forces acting to cause these phenomena.

Later, when the water is more peaceful the study of the plant, animal and insect life may begin. A wide, slow-running part or even a pond will be best for this purpose. There the duck-weed and algae may be seen, and all manner of life will be discovered. Preserving jars of the water containing these small living things may be taken back to the class-room. The children should be led to see that, as the Spring wears on, the waters of pond and stream literally teem with life.

19. Frogs eggs obtained from the pond may be made the object of special study. They may be kept in a shallow bowl or pie-dish in which some pond weed is floating. The eggs should be watched carefully and records of their development kept. The tiny tadpoles after hatching will cling together on the weed. Later, when they begin to swim, they should be removed to a jar or aquarium containing pond water and weed. If some of the mud from the bottom of the pond is placed at the bottom, the tiny plants and animals in this will serve as food for the tadpoles. Later they may be given tiny pieces of bread or meat, but this should never be left in the water for any length of time. Still later the large tadpoles should be transferred to a shallow dish with weeds and stones. If the final stage is watched until the frog is formed, the latter should be taken back to the pond - for unnecessary confinement, possibly ending in death would be detrimental to the development in the children of a respect for life in its varied forms which Nature Study must foster.

20. Spring and early Summer flowers should also be observed. The children may make a flower calendar to show the succession of wild and garden flowers from the first hepaticas and spring beauties, to the roses, daisies, buttercups, vetch of June. The observation of the stamens, pistil etc., will continue, and the children should be encouraged to watch and discover for themselves what insects aid in pollination.

21. The collecting and feeding of caterpillars should continue. As the butterflies and moths emerge they should be freed before they damage their wings against the cage. They

can be studied quite easily during the hours in which they are stretching and drying their wings. Incidently, the insect is most perfect at this time. The pupae formed in Spring will most probably emerge as adults in July or August. These must either be placed outside in some suitable place or the children should care for them at home until the time comes to free them; they should not be left to die in the class-room.

Discussion of Grade IV Work

It will be noticed that the range of the Nature Study has increased very materially; studies of the weather, the water cycle, of insects, of plant, tree, flower and seed, the brook or pond and its inhabitants, all have contributed in the attempt to increase the children's understanding and appreciation of natural objects and phenomena.

Also, in this work, experimentation has played an increasing part. These experiments were very simple, as was the apparatus used. That, however, is all to the good, for the children may repeat them at home with the ordinary things of the household. With this increase of experimental work, there should be a corresponding increase in power to observe, describe and record simply.

A survey of the course will disclose the fact that the study of relationships has played a large part. Thus, for example, the relationships between evaporation, condensation and precipitation were probed, likewise the relations between the growing plants, the sun, water and soil, also the balance between the plant and animal life of the aquarium.

If material for the aquarium is to be gathered from pond or stream, this must be done in early September. The aquarium will then be set up in the class-room and observed long before the detailed study described above is undertaken. On the other hand, if the teacher waits till January or February to set this up, she will have to buy plants. For this purpose the one which grows most quickly, and which appears to be the most efficient oxygenator is Anacharis. This can be bought cheaply in bundles one of which will be quite sufficient to stock a good-sized aquarium. The slips are merely stuck into the sand or gravel and secured as has already been described, and root very quickly. Vallisneria and Sagittaria are with Anacharis considered to be the best oxygenators, but these two are more expensive than the latter, as separate rooted plants must be purchased. The Vallisneria however, multiplies rapidly.

Snails and tadpoles are excellent for keeping the aquarium clean. Ramshorns, the commonest of aquarium snails, will breed in captivity. They deposit their eggs in jelly-like clusters on the plants or sides of the aquarium. The development of these forms an interesting study.

Throughout the Nature Study of this Grade the children should be encouraged to observe and ask questions; some of these will be answered by experiment, others the teacher will have to answer sufficiently to allay the child's present curiosity. It must not, however, be assumed that a complete answer can be given to many questions children of this age will ask, at least, not complete from the point of view of the science teacher. Attention should be focussed on the main principle, and not side-tracked by involved explanations as to minute details, however important these may seem to a fuller treatment. Naturally enough, the first explanation given to a child will differ from that given to a science student. Both, however, should be as accurate as possible between these imposed limits.

Grade V.

This Grade forms the transition between the second and third stages of Nature Study - from the predominent study of relations to question of why things behave so. The object of Nature Study for Grade V and subsequent grades may, therefore, be stated as follows:

A. Exploratory - increased knowledge and interest in the physical world.

B. Study of Relations - The relationships and inter-relationships between all things in the world - e.g. plant life and animal life; the sun's altitude and plant growth, etc.

C. Why is it so? - The old and yet ever new and progressive explanation of the numerous phenomena of animate and inanimate Nature.

1. Autumn flowers will at first occupy attention;most of the local flowers should now be familiar, but one can

discover many new things on studying even familiar flowers more closely. The work on the parts of a flower and plant, fertilizing agents and so forth should continue, in order that the child may recognize the specific function of these parts and their importance to the whole organism.

A chart may be commenced to show flowers found in Autumn and their colours, in order to bring out the fact that definite colours seem to predominate according to the season - e.g. the relatively pale colours of Spring flowers, the bright and varied ones of Summer, the rich, deep, shades of Autumn.

2. The work on seed dispersal may be continued, but the classification should still remain that of the means of dispersal, rather than the more technical classification of Botany.

3. Tree study should be extended to include not only the maples, horse-chestnut, poplars, birches, beeches, but also the willow, ash, bass, and oak. The characteristics of leaves, bark and general shape of these trees should be familiar.

Former methods of leaf study may be continued and in addition blue prints may be made with the blue paper used by engineers. The leaves are simply laid on the paper, held in place by glass, and exposed to the light; the print is "fixed" merely by leaving for a time in water, and then drying the paper.

Leaf skeletons may be prepared by immersing leaves - as perfect as can be found - in sodium hydroxide for a week or more. The soft parts of the leaf may then be separated by placing the leaves between blotting paper or cloth and beating with a clothes brush. In this way, the beautiful tracery of veins may be obtained. Such skeleton leaves can occasionally be picked up in the woods, but they are seldom perfect.

The children may be told of why the leaves fall, due to the formation of the cork-like plates at their base, one covering the leaf-scar on the tree, the other adhering to the leaf. They will be interested to know that the oak tree gets rid of its old or decayed branches in a similar way.

4. Collections of caterpillars and other larvae, etc., may be continued for observation in the class-room.

5. The children may be taught to read a thermometer and then may include temperatures in their weather-charts. The temperature may be read by means of an ordinary thermometer say three times a day at 9 a.m., 12 a.m., and 3.30 p.m. Still better would be the use of a maximum and minimum thermometer. The children should be encouraged to watch the temperature records in the weather observations of the daily newspaper.

6. In November star study should again become prominent. Those groups previously studied will again be looked for, also the Dragon; Orion with the red star Betelgeuse and Rigel the white star at his foot, may be pictured as warding off "The Bull" of which Aldebaran is represented as the red eye. That interesting group, the Pleiades may also be introduced. The whole star study should be connected with the ancient legends which gave rise to their names.

7. In January a review of the water cycles should

be made. The principal types of clouds - cumulous, cirrus, stratus and nimbus, may be discussed, and observed in due course. In any discussion of clouds, there are always eager questions as to how thunder and lightening are produced, and the teacher must answer these as simply as possible.

A study of the rainbow and its formation may then be made. For this purpose a prism is desirable, but failing this, a piece of cut-glass may be used. The spectrum formed by an icicle and the spectrum colours around the frost crystals on the window may also be observed. That formed when the sun shines on the bevelled edge of a mirror or through the aquarium should also be noted. The experiment with a tumbler of water protuding over a table-edge may also be tried; a rainbow, sometimes two, appears on the floor. If a mirror be placed under the tumbler, the rainbow will then appear on the ceiling. Also, a mirror placed in water at an angle, with a beam of light falling on it, will also yield a spectrum.

The children may also be told how the sunset is caused by the diffraction and scattering of light by dust particles in the earth's atmosphere, and also, to some extent by rain-drops; likewise that dust particles by scattering the blue light more than that of other colours gives the sky its blue colouring.

In this season of severe weather the ice crystals on the window will frequently become objects of attention. This may be used as a starting point for observation of crystals. The children will already be familiar with the six-sided arrangement of snow crystals also with the needle-like crystals which are seen occasionally. They may be shown crystals of salt with forms cubic in structure; iron pyrites, also cubes; quartz (rock-crystal) which crystallizes in six-sided prisms topped by six-sided pyramids; alum, regular octahedra i.e. three equal axes at right angles to one another; and, also, copper sulphate which crystallizes with unequal axes at an oblique angle. Concentrated solutions may be made and a small quantity placed on square pieces of window glass, when small but perfect crystals will appear, and these can easily be examined with the naked eye or with a pocket lens.

Professor Tyndall's beautiful experiment with a block of ice may also be tried. This is exposed to the action either of the sun or of an electric bulb. Some of the heat entering the ice causes internal liquifaction. Growing points of light are seen and six rays shoot forth from these, forming most beautiful patterns. The explanation of these "ice flowers" is that the hollow spaces formed by the melting of ice crystals are filled with water which reveals the previously invisible crystal-structure of the ice.

8. The above may be followed by a study of the tree in Winter, when its characteristic shape can best be seen. Winter buds may be examined, and the fact impressed that the bud-scales, hairs, stickiness, etc., are primarily devices for preventing evaporation. That evaporation (transpiration) from leaves really occurs may be demonstrated by placing a dry glass vessel over a plant and observing the moisture which collects on its inner surface. The fact that

the tree is virtually asleep may be impressed, for the processes of absorption of water, growth, evaporation, and even breathing are almost suspended. The leaves then, had they remained on, would have enlarged the surface for evaporation very materially. Also, the necessity for the leaves as food factories ceased, when sufficient food had been stored up, due to their work throughout the Summer.

While comparing the bark of the trees which have been studied, bark prints may be made. White paper is pinned firmly on the trunk then rubbed with cobbler's wax until the pattern of the bark is seen. In this way records of the various types can be made, without actually removing bark from the tree.

As Spring approaches with warmer days and nights still cool, the circulation of the sap commences, and the buds begin to swell. The flow of sap in the maple tree, the collection and preparation of maple sugar may be discussed, and if possible the children may be taken to a sugaring camp. The fact that frozen water cannot flow, and, therefore, cannot rise in plants or trees may be emphasized to bring out the connection between the circulation of sap and the temperature.

9. Seeds will again occupy attention and the process of germination should be watched. A special study may be made, e.g. the bean, the development of radicle and plumule, the types of roots, the gradual withering of the cotyledons as the shoot develops. The function of the root should become apparent:- 1. to absorb moisture and the mineral salts necessary for the growth of a healthy plant and 2. to anchor

plant - primary root, lateral and even root-hairs all aiding to some extent.

10. Types of storage structures such as the bulb (as in Spring flowers) the corm of the crocus, the tuber of the potato, the underground stem of the lily of the valley, Solomon Seal, or mint, the root as in beetroot or turnip, the seed, such as bean, corn, etc., may be examined and their importance to the development of the plant discussed.

11. Following this study of special storage structures a general study of the plant may be undertaken with the function of the various parts, root, stem, leaf, flower and seed. As the Spring flowers appear, a comparison of them with regard to these various parts will naturally occur; the colour and shape of petals, the type and arrangement of stamens, the stigma, the ovule, and finally the seed will also be observed.

12. Further work on tree flowers should be undertaken, to observe the type and arrangement of the flower structure and the special adaptations to secure fertilization.

13. The study of birds will be continued together with bird records. The children should become familiar with the Canada bird, the bobolink, Baltimore oriole, wrens, the king-bird, kingfisher, loon and sandpiper - or such of them as they are likely to see in their locality or during holidays.

Stories and pictures of Jack Miner and his birds always create interest, and any local sanctuary should also be discussed, possibly visited.

The sanctuary for sea birds at Percé and Bonaventure Island also interests the children greatly, particularly if pictures or snapshots, or post-cards of this is available. The use of movies, when they can be obtained, will also add much to the study of birds.

14. The earthworm castings on lawn or in the garden should be used to create interest in the life and work of these insignificant yet important animals. They may be studied in the class-room by placing several on the surface of a large glass jar or beaker, filled with layers of differently coloured soils. The action of the worms in churning up these layers will then become apparent. Dark paper or cloth should be placed around the sides of the container, or the worms will make for the dark interior and their work will not be seen so readily. If this is done their tunnels may frequently be observed next to the glass.

15. A grass-snake may be brought into the class-room for a few days for observation. It should be kept in a terrarium similar to that used for frog or toad, and should contain grass or plants growing, also water, which may be placed in a flower-pot saucer. It can live without food for several days so it may be studied then released.

16. The pond, always a source of interest, may be searched for "wigglers", the larvae of the mosquito, caddis worms, with their strange homes, and daphnia, one of water fleas, a small crustacean. The life cycle of mosquito and caddis worm should be studied, and the queer movements of the daphnia should be observed.

Frog spawn (in jelly-like masses) and toad spawn (in long jelly-like strings) should be obtained and the development of the tadpoles compared.

17. The life of the bee forms an interesting study. An observation hive will add greatly to this, but even when this is not available the children should become familiar with the social life and work of the bee.

The wasp and its paper nest may also be studied. A nest may be procured in Winter, so that the structure may be observed.

The stories of the leaf-cutter bee, also, is an interesting one. It may frequently be observed cutting rounds and ovals from the rose-leaves in the garden. These it uses in lining its nest dug out of a rotten post or tree, and each cell is closed when the egg has been laid, by one of these round "lids".

The mason wasp who forms its little "vase" on the willow will also be observed with interest, not only because of its earthen vase, but also when it is known that this contains, with the egg, a supply of caterpillars for the larva's food supply. These have been stung and paralysed but not killed by the mother wasp.

18. The spider and her web also forms an interesting study - one which the pupils may continue during the Summer themselves. The spider and its habits, the making of the web, the silken egg-sack, and the gossamer of the young spider all make fascinating objects of study.

Discussion of Grade V Work

An attempt has been made to provide studies both physical and biological in nature. The arrangement of the course, while still largely seasonal,is centred around topics of general interest. These are explored not only by means of discussion and observation but also by experimentation. The attempt to answer the frequent "why" and "wherefore" so characteristic of this period of Nature Study should proceed, then,in a thoroughly scientific manner, by observation and perhaps experiment, the framing of explanations or hypotheses and finally the testing of these by further observation and experimentation. Throughout the whole Year's work, the inter-relations between plant, animal and insect life should be emphasized.

Grade VI

The aims of Nature Study in this grade are the same as those outlined at the beginning of Grade V work (p.133), with possibly more stress on the third of these aims.

I. The Seasons

Observations on the shortening day, the sun lower in the sky, the cooler nights, should be used as an introduction to the physical basis of the seasons. This will have been treated in a simple fashion either in Nature Study or Geography, but the stage of mental development now attained by the pupils will enable this treatment to be amplified and rendered more systematic. The sun, as a first necessity for all life of animal and plant must be presented clearly.

2. Autumn

A review of the activities of Autumn will then be attempted, e.g.:-

a. The withering and fall of the leaves.

b. The storing of food by plants and animals.

c. The migration of birds.

d. The ripening of fruit.

c. The necessity for seed-scattering may be discussed.

A classification of fruits may be attempted at this stage, but this should still adhere to the means of dispersal as a basis for classification. The principal methods of dispersal are:-

I. By wind:-

a. by means of a "wing" as in maple or bass.

b. by means of a parachute-like pappus, as in the dandelion and milkweed.

2. By animal agency:-

a. passively:- by adhering to the animal's coat as in the case of burdock, beggartick and some grasses, or in the case of some water plants, adhering to the feet of the birds.

b. actively:- when the fruits are eaten by birds, the seeds often pass through their digestive tract unharmed and are dropped far from the parent plant. Also, nuts are frequently scattered by squirrels either on being dropped or on being hidden and in some cases forgotten.

The terms "berry" and "drupe" may be introduced at this stage, the first as exemplified by currants, gooseberry, grape, tomato, orange, etc.; the latter by stone fruit such as the cherry and peach.

3. Dispersal by the plants themselves:-

   a. By sudden splitting as in the pea, jewel-weed, wood-sorrel, violet etc, when the seeds are hurled for some distance.

   b. On the capsule splitting a little lengthwise, thus forming a fringed cup from which the seeds are scattered by the wind rocking the stem, as in the case of the stitchwort and evening-primrose.

   c. By the opening of pores which enable the seeds to be disseminated as the plant is rocked by the wind as in the case of the poppy.

   d. By the splitting open lengthwise of the seed-vessel at the edge where the seeds are attached, as in the delphinium and columbine.

   e. By the splitting of the style in several parts, each wrapping itself about a seed, as in the geraniums or in two parts hinged at the top of the style in which case the seeds are attached to a thin membrane running down the centre of the style as in the wall-flower.

   f. Seeds are also dispersed by water, in which case the structure is light and floats easily. e.g. the seeds of the water-lily and the cocoanut.

The Use of Fruits:-

1. To protect the seeds from the weather.
2. To prevent the seeds being eaten by animals.
3. To prevent too early sprouting.
4. To secure seed scattering, etc.

g. The Autumn showers of gossamer - the "flight" of the young spiders with the observations and explanations of Jonathan Edwards (1716) when a boy of 12 years.[I]

III, Plants Which are not Green

The work of fungi and bacteria may be connected with the processes of putrefaction and decay.

1. Mushrooms and toad-stools both gill type and type with tunnels (fomes) such as the brackets fungus. Spore prints of the former may be made by laying the mushroom, gills downward, on white paper.

2. Moulds - grown on moist bread and on jelly.

   a. They are minute unicellular plants.

3. Bacteria - Their great importance in natural processes. Some are helpful; some are harmful; Thus the nitrogen bacteria in the root-nodules of leguminous plants enrich the soil. Others aid in decay by breaking down the substance of dead vegetable and animal life. Others cause fermentation, still others cause disease.

   b. Sterilization experiments; bacteria cultures on gelatine or agar-agar. A fly may be allowed to walk over one such prepared culture-medium and the various colonies of bacteria observed where it has walked. This work to be done properly requires a good microscope, but whether this is available or not, the subject because of its importance to everyday life should be treated.

   c. The work of Pasteur and Lister.

I. Thomson, Sir J.D. - "Natural History Studies." p.175

d. The pasteurizing of milk.

e. Vaccination; isolation for infectious diseases.

IV. The Conifers

1. Contrast with deciduous trees.
2. Recognition of the common types and their cones. For this purpose an exhibit of branches and cones may be arranged.

V.

In January star study may be resumed. The children may by way of review make charts of the groups they already know, and write or tell the stories and legends associated with them.

Andromeda and the Square of Pegasus can be seen best this time to the west of Cassiopeia and Cepheus. Perseus will also be seen to the north of Andromeda. Mirfak is its brightest star, but Algol perhaps the most interesting due to the rapid variation in its brightness (from second to fourth magnitude) in the course of two or three days.

Orion and the Great Dog (Sirius) have been introduced previously; the Little Dog, with the pale yellow star Procyon may now be added. The three prominent stars Betelguese, Sirius and Procyon form a great Equilateral triangle in the southern sky in Winter.

VI. Different Ways of Meeting Winter

1. Hibernation - as with the hedgehog, bear, frogs, bees, snails. Others are only partially hibernators such as the squirrel.
2. Dormant pupae of insects are already familiar; it should be pointed out that insects in the imago state also survive the Winter - e.g. the queen wasp, bee, ant,

also some butterflies. e.g. "Some butterflies survive the Winter in the egg state others as dormant caterpillars, others as pupae, still others in the imago state"[I].

3. Dormant plants, trees, seeds.
4. Change of colour in animals and birds, as in the jack rabbit, ptarmigan, etc.

VII. Snow and Ice.

From the more immediate studies of snow and ice, the subject of avalanches, glaciers, icebergs, can be approached. An experiment with a glass of water and a piece of ice will demonstrate the fact that a large proportion of the berg will be under water. The expansion of water on freezing may be shown by the frozen milk-bottle with its raised cap, or simply by a jar full of water. The children should be encouraged to watch for these effects when the melting of the snow and ice occurs in Spring. Frequently sections of the side-walk are raised during the Winter; the large clods in the field ploughed in the Autumn are found to be broken; freshly fallen rock, broken by the expansive force of the ice may be found at the foot of cliffs, etc.

VIII. Spring

About March 21st., special emphasis should be placed on weather study with a review of the reasons for seasonal change and the discussion of the importance of the winds, rain, and dust of early Spring.

Spring is a season of awakening life. The following characteristics may be considered in detail:-

1. The awakening from Winter sleep - as in the case of the hibernators.

I. Weed, C.M. - "Canadian Butterflies Worth Knowing". p. 17 et seq.

2. Re-invigorating - the rise of sap in the trees and the consequent growth.
3. Young Things - birds, fish, animals, insects, seedlings, tadpoles, etc.
4. Re-peopling - the pool, the meadows, the woods, the return of migratory birds.

The return of Spring may be suggested as an explanation of such stories as the Sleeping Beauty and her awakening, also of the return of Proserpina and the renewed activity of Mother Earth.

IX

Seeds such as the pea, bean, corn, maple, nasturtium, marigold, may be grown and their development observed and compared. It will be interesting to watch what happens to the seed-coat in these various cases.

X. Bird-Study

A review and discussion of familiar birds should be attempted and the cardinal, scarlet tanager, wax-wing, nuthatch, owl and Canada jay may be introduced. In addition to the bird-charts which may have been carried on through the previous years, comparison of the colouring of male and female birds may be made. After considering the cases one by one, a generalization with regard to the relationship between colour and sex may be arrived at. The relationship between the song period of the male and its relation to mating and nesting would also prove an interesting study in localities where birds abound.

XI. Tree Study

Further work with buds and tree flowers may be attempted

The rising of the sap, mentioned above, should be related to the swelling of buds and the growth of the leaves. Whenever a tree is cut down, and the annual growth rings are visible these should be observed. A slice of a tree-trunk would be useful to have in the school for such purposes.

As the season progresses, the study of leaf mosaics may be commenced. The arrangement of leaves on a tree, of climbers on a wall or around a stick, the nasturtiums or beans on a fence, the arrangement of leaves about the stem of a plant all can be used to show that the leaves arrange themselves to get the maximum quantity of light - so necessary in their work of food manufacture.

XII. Insect Study

In each case this should consist of observation in order to learn of the habits of the insect, and the stages in its life-cycle.

1. The Caterpillar, its movement, parts, food, etc.
    a. The pupa:- Its silken cover.
    b. The butterfly:- Its colour, shape, head and mouth parts, the flowers it visits. If a microscope is available, the children may be shown the beautifully shaped scales on its wings. The Cabbage White, the Swallow-tail, the Monarch, and the Viceroy may be examined if it is possible to procure them. There should be a book in the school library to aid the children to find the names of the butterflies they find from time to time. The life story of the most interesting ones

should be told - e.g. the Monarch and its migrations.

At this point any pupil who makes a hobby of butterfly collecting should be allowed to describe and exhibit butterflies of interest, or perhaps the school Nature Study or Naturalist's Club may take charge of this part of the work.

It may now be pointed out that butterflies and moths have a number of ways of hibernating. There are four possible cases:- hibernation in the egg stage, in the larval stage, in the pupa stage, and in the adult or imago stage. The Bronze Copper, and many moths are examples of the first of these; more than half of Canadian butterflies hibernate in this second stage- e.g. the Graylings, and Fritillaries; the Swallowtails are examples of hibernators in the larval stage; while some of the Anglewings survive the Winter as adults (in hollow trees or adhering to bark or branch.[I.]

2. The Moth:- Comparison of its colouring, etc, with that of a butterfly. Thus, in the moth the upper side of the wings is exposed when it alights; this is protectively coloured while the lower side is more highly coloured. When the butterfly alights the under side of the wings is exposed, this, therefore, is protectively coloured while the upper side is brightly coloured. Both the moth and the butterfly belong to the order of Lepidoptera.(scaly-winged.
3. The Common Fly:- Its parts, its habits, life-cycle, etc. It belongs to the order of Diptera i.e. of two-winged insects.
4. The Ant and her Ways:- Parts, social life, etc. The

I. Weed, C.M. - "Canadian Butterflies Worth Knowing".

ant belongs like bees and wasps to the order of Hymenoptera (gauzy-winged).

5. The Ant and the Aphides:- The story of how the ants care for, and milk the Aphides.

6. The Aphides and the Lady-Bird:- The former belongs to the order of Hemiptera (Half-winged) and have sucking mouths; the latter belongs to the order of Coleoptera (sheath-winged) or beetle family.

7. The Ant Lion in the Sand:- How this insect makes its home in shifting sand and obtains its food by constructing a pit into which the hapless ant, etc., slides and is engulfed.

XIII. Pond or Aquarium Studies.

The pond forms an excellent example of the "repeopling" process in Springtime. Swarms of wigglers, tadpoles and other larvae abound. After a visit to the pond, small aquaria - jars and dishes of all sorts with a little sand and a few healthy plants, are all that is necessary - should be filled with the various "catches". In this way further observation of those animals and insects already known will be possible and in addition the following may be studied:-

1. The Dragon-fly:- larvae and adult. In this insect there is no pupa state.
2. The Water Beetle:- Its habits, breathing, etc.
3. The Pond-skater:- which causes great interest by its jerky movements on the surface of the water.
4. The Newt:- Its habits, feeding, etc.
5. The Turtle:- Its habits, feeding, etc.

Care must be exercised in placing the above in the Aquaria.

Thus, the dragon-fly larvae will made short work of small tadpoles; they may, however, be placed with caddis worms and snails. If their home be filled with pond water they will live on the water fleas and other organisms found in this. They may also be given blood-worms, which can be obtained at any aquarium shop.

The carnivorous water beetles must be kept alone, or with snails. These eat tadpoles and worms, but may also be given small pieces of raw meat.

The pond-skater may be kept in a shallow dish with a tilted stone, under which they hide. They, also, live on the small organisms of the pond-water.

The newt may be kept in an aquarium containing fish and snails. There should be plenty of weeds reaching to the surface on which they will frequently rest with their noses out of the water.

They can be fed red-worms, and gentles and occasionally will take a morsel of raw meat if this be kept in motion in the aquarium.

The turtle must be kept in an aquarium with a rock or "island" on which it can rest. Its natural food is aquatic larvae of insects, tadpoles small newts and fish and worms. In the aquarium it may be fed with worms. It will also eat raw meat, and its manner of shredding the latter is interesting.

XIV

A collection of ferns of the neighbourhood may be started. The fronds should be pressed carefully between dry blotting-paper. The children should become familiar with the fact that like fungi, the fern is a flowerless plant. Their attention may be drawn to the spore cases (sori) on the back of the fertile leaf. They may be told that the spores like those of the mushroom, etc., eventually form new plants, though there is no necessity , at this stage, for telling the whole history of this process (the formation of the prothallus, on the underside of which develop the antheridia and archegonia from which, if fertilized,the new fern plant arises).

XV

As the season advances,further studies of flowers may be made. Close observation of their insect visitors should result in the discovery that flowers are visited by four classes of insects:- bees and wasps with mouth parts of an intermediate length; flies and beetles both with short mouth appendages; and butterflies and moths with relatively long mouth appendages.

They should also attempt to find out what attracts these various insects - perfume, colour or nectar. The arrangement of petals, stamens and stigma should be noticed. - specially arranged, it would seem, to aid pollination. The devices for insuring cross-pollination rather than self-pollination may also be observed - though, of course, this subject can merely be touched upon.

If a school garden is available pollination experiments should be attempted. Thus, of flowers on one plant, one may be covered with a muslin bag to prevent insects entering the flower to cause pollination; a second may be artificially pollinated by means of a pencil point, a pen-nib or a paintbrush; and others left free for insect visitors. The following facts may be demonstrated in this way.

1. Seed does not form when a flower in not fertilized.
2. Artificial pollination will ~~not~~ produce seed.
3. When the right sort of insect enters a flower, pollination and consequently fertilization occurs.

With regard to the second of these the children may be asked to learn something of the wonderful work of Luther Burbank in the creating of new types of flowers, fruits and vegetables.

The importance of the above considerations to horticulture and agriculture should be brought out. Darwin's story of the connection between clover, humble bees, mice, cats and maiden-ladies may be told in this connection.

XVI

As the concluding work of this grade, a review of the main biological and physical ideas presented in the primary school course may be made. Thus the connections between animal and plant life in relation to the earth, the weather, the seasons and finally the sun will be brought out.

A Commentary on the Preceding Course of Study

The following brief considerations may serve to amplify from the teacher's point of view the preceding suggestions for Nature Study:-

I. I cannot claim that this course of study has been tried as a whole. Parts of it, in particular the work of Grade III and IV, I have myself used. The children exhibited increasing interest in the study of flowers, trees, animals and natural phenomena in general, which is one of the only measures by which one can judge the success of Nature Study teaching. In addition

I have utilized the work and suggestions of other teachers, together with still other work of which I have read and which, as far as I could judge, had been carried out with some degree of success. To any, therefore, who say such a scheme is impracticable, I may at least reply that in parts this work has appeared successful either in Canadian, English, or Scottish schools. My arrangement, however, has been made with the Quebec school and the climatic conditions of Quebec particularly in mind.

2. I am of the opinion that, should this scheme of Nature Study be carried out somewhat as I have endeavoured to outline, the child's knowledge of the common physical and biological phenomena of his environment should steadily increase, together with his ability to observe and enjoy these same.

3. This course of study is to be regarded as an outline of suggestions for Nature Study, closely related to the seasons, which either the city of the country teacher may adapt and extend to suit her particular environment and her particular school. Uniformity is <u>not</u> the goal of Nature Study; on the contrary, the best teaching of this kind is that which makes fullest use of the material found in the immediate environment and this, of course, varies from place to place. Nature Study certainly begins at home, though it should not finally rest there.

Moreover, I am firmly convinced that the city teacher has no grounds for the plea that this Nature Study is impossible for her. Collections and excursions will naturally be more difficult, but she has the parks, market-places, shops, museums, libraries, and in some cases even botanical and zoological gardens at her disposal. The country teacher has the fields, gardens, farms, woods and streams and the general closeness to Nature to aid her in this work, but she has none of the above advantages. A general solution would seem to be, that, where much work on plants and birds is impossible, greater emphasis should be placed on the physical side - e.g. weather and star studies. Undoubtedly the city school should be provided either with some place to grow plants and seedlings for Nature Study, or some arrangement for this purpose should be made between the school and park or even university authorities who may have the necessary green-house facilities.

4. In case any criticism should arise as to the yearly recurrence of seasonly themes, it may be pointed out that even in topics of adult conversation such habitual, seasonal recurrence takes place. Thus, the zero weather of January, the thaws of February, and March, the appearance of bulbs in the gardens in March and April, the gardens in Summer, the thunder-storms of July and August, the crops of Autumn, the rain of November all recur, year in and year out, at their appointed time. In this Nature Study course, however, there is no idle repetition, but a purposeful consideration of things already known in order to become more familiar with them, to love them better, and to see them in relation to an ever-widening natural environment. The class Nature Study book carried on from year to year should prove somewhat of a check against mere repetition.

5. Even a cursory examination of this course will reveal the fact that its success depends largely on practical work with plants, aquaria, terraria, etc. No elaborate apparatus

is necessary, the maximum and minimum thermometer, a barometer, and possibly a larger aquarium are the only things which will not be in use in most homes. The few chemicals mentioned can be obtained very cheaply - in fact a very small quantity from the High School laboratory will suffice. Its main success is to be derived from a skilful use of the children's propensity for collecting, and their interest in watching and observing things in which their interest has been aroused. Experimentation of a simple yet genuinely scientific type must be employed whether it be in the class-room, Nature Study room, or out-of-doors in garden, wood or field. Moreover, this work out-of-doors is indispensable. If one wishes to learn of pictures one looks at them in a picture-gallery, home, or book; to study Nature then, we must go where it is found - to that large realm beyond school walls.

6. Two other things will add greatly to the success of the Nature Study in schools, namely, a special room for this study and the practical work arising from it, and a school garden. These two should, I venture to say, be included in every new modern school, and the former is all the more necessary when one considers the length of the Canadian Winter during which out-door work is almost impossible. It must not, however, be assumed that Nature Study is impossible if these facilities are not available; a truly enthusiastic teacher can do amazing things without either.

Throughout the course of study I have made little reference to work in the school garden. This is simply because I did not wish to catalogue minutely the various tasks and procedures of the garden. Nevertheless this work should be associated very intimately with Nature Study - in fact work in the garden may be so arranged as to support and expand the leading biological ideas presented from time to time - e.g. the needs of the plant; the processes of pollination and fertilization, and so on. The main function of the school garden is, however, to create a pleasure in growing things, and thus lay the foundation of what may develop into a healthful and fascinating hobby.

7. With the necessity for observation and experiment, I have laid great stress on records of various sorts. I am quite convinced of their value, for very frequently facts can be represented diagrammatically, more simply and conclusively than in any other way. Definite experiments in High Schools have revealed the fact that when experiments are recorded, they are remembered better and are more fully understood; the records of the Junior School answer the same purpose, quite apart from their value as creative and aesthetic expression. These records will vary from the prettily illustrated season charts of the early grades, to the temperature records of Grade VI; from the bird scrap-book of the Kindergarten, to the personal nature study diary of the eleven or twelve-year-old.

Apart from the values the children may receive from such records, these may also be of value as local studies in natural history. There is still plenty of scope for such work in Canada, and children in other countries have lent valuable aid in recording local observations of flowers, trees, animals and insects. Thus, in the course of years a school can build up quite complete records with regard to the weather and its influence on the appearance of buds, flowers, birds and so on - for instance, the connection between a mild Winter and the early appearance of, say, hepatica and robins, or on the other hand, the connection between a severe Winter and the late and sparse appearance of leaves on the trees. This would as far as I know, be quite a new type of enterprise for a Canadian school.

8. Also, there is the question of time allowance. I think two periods per week would be a fairly liberal allowance for Nature Study. This will not represent all the time actually spent on this subject, for there will be time spent almost daily on weather observations and recordings, on the observation and feeding of animals, and the care of plants or seedlings.

It is possible, however, to spend more time on this study in Spring, Summer and Autumn when things crowd in upon our senses and changes in Nature occur almost daily,and less time in Winter when Nature-material is relatively scarcer.

9. Moreover, the closest possible connection should be made between Nature Study topics and the seasonal activities - the ploughing in the late Autumn, the sowing in the Spring, the harvesting in late Summer and early Autumn, and so on. Science teaching has long neglected to illuminate everyday happenings, and to lend its aid to made more interesting " the trivial round, the common task". Nature Study should be absolved of this sin as far as possible. Nevertheless, this teaching should never become narrowly utilitarian; there is a tremendous difference between saying that Nature Study should encourage the country child to enjoy and appreciate his surroundings, and that Nature Study should

become a study of Agriculture.

10. In conclusion, the primary object of Nature Study is to encourage the development in the child of an appreciative understanding of Nature. The training of specific powers(if this is possible) is not the object of Nature Study, which should deal with the whole child and his attitude towards his natural environment. Thus the first duty of the Nature Study teacher is to arouse interest; the desire to observe, to record, to learn, to solve problems and so on, all depend on the initial interest and enthusiasm thus created.

Chapter 6.

The Course in General Science.

It has already been suggested, that the Junior High School will eventually include what is now Grade 7 of the Elementary School. For this reason I intend to treat the course of study in science for Grade 7 separately from the previous, primary grades.

There is another excellent reason for doing this; I have already pointed out that about adolescence, a gradual, yet marked development in the quality of the mental processes occurs, during which the power to appreciate causal relationships, and to think abstractly seems to emerge. This necessitates a different treatment of the pupil in science, no less than in other activities of the school curriculum.

Throughout the course in Nature Study experimentation became increasingly important; in General Science experimental work, individual work, as well as that done by the teacher, is of still greater importance. Moreover, General Science, in seeking to answer the "why" and "wherefore" of common phenomena, needs must commence some study, however informal, of physics and chemistry, and for this purpose a laboratory is necessary. It will be remembered that the suggested Nature Study Room would contain plants, terraria and aquaria; consequently, as neither animals, plants, or insects, are likely to thrive in an atmosphere in which the vapours of chemicals will appear from time to time, it would seem that for successful General Science teaching some special room should be provided. This is an added reason for making a division in the treatment of science at this point.

For these special reasons, as well as those general arguments already advanced in favour of the Junior High School, it would seem that the curriculum for Grade 7 is much more closely related to the Junior High School than to the Primary School period of education. The fact remains, however, that at present this grade is included in the elementary school. It is for this reason that I have included a treatment of General Science and a course of study for Grade 7, as a necessary part of the present subject, although this would normally fall outside the treatment of science for the Junior School. Also, I am strongly of the opinion that science work- be it Nature Study or General Science- should be provided for Grades 6 and 7"[1]; otherwise, this important stage

1, In the present brief outline of Nature Study for the Protestant schools of Quebec, no work is specified for Grade6and7. As far as I can ascertain, such teaching is, almost without exception, neglected.

in which the pupils are eagerly questioning as to the reason for everyday facts and phenomena, will be totally neglected in the school. It is a mere quibble to say that High School Science fulfils this function, when statistics go to show that a very large percentage of the children who attend the present elementary school, never reach the stage of High School Science in Grades10 and 11.

A General Science Course for Grade 7.

This course differs little in aim and method from Grade 6; it is however more systematic in its treatment of a single topic (as the seasonal arrangement is no longer followed strictly) and the whole work depends to a larger extent on experimention.

The main work of the year is a study of the simpler aspects of the chemistry and physics of air and water, though no attempt is made to organize this work into the separate fields of these two sciences. This, it may be remembered, is characteristic of the treatment of General Science (ch.III p.40).

I have very definite reasons for the selection of this material. After the stage reached at the end of Grade 6 work, I do not think that any real progress can be made in the attempt to discover the reasons for biological and physical phenomena unless some elementary knowledge of physics and chemistry be acquired. Since all life depends, in some way or another, on air and water, this would seem to be, logically and psychologically, the best way to start a more thoroughly scientific study. This will, therefore, permit of a great development in biological studies in Grade 8, (and possibly Grade 9, depending on the length of the Junior High School course) and this is eminently desirable, for reasons which will be presented in the chapter on Hygiene.

Some may object that, if this be the case, the pupils should immediately commence the study of physics and chemistry. From my own observations of the past few months, I conclude that pupils at present in Grade 10 and 11 are not equipped as they should be to study Chemistry or Physics, simply because they have not enough experience of elemental facts and phenomena necessary on which to build a science. To start the study of these two sciences several years earlier would only tend to aggravate the situation; on the other hand, I firmly believe that a scheme of Nature Study and General Science such as I suggest would provide incidentally this most necessary sense data so necessary as a foundation for systematic Science.

1. The Importance of Plant Life:-

All animal life depends on plants; Thus, no matter whether we start with the whale,the cow or the lion we finally arrive at the fact that its food,directly or indirectly through a chain of links, depends on plant life.

b This may be further developed by a consideration of food:-e,g. the milk from the cow who ate the grass, the chicken who ate the corn,we who eat the lettuce and cabbage and sugar from the sugar cane and so on:- as Sir J.A.Thompson phrases it:- "All flesh is in the long run in transformed grass"[1].

c The above work can be correlated with the harvesting operations still in progress in September.

d It is a small step from the above, to show that unproductive areas of the earth,e.g. deserts do not support a large population, because they do not yield sufficient food in the form of animal or plant.

e The main fact to be brought out is, that plants manufacture their own food, while animals are dependent on plants, as they have not this power of making food themselves.

f It may be pointed out that fungi,which are not green plants, cannot make their own food, but live on dead animal or vegetable matter.

g Also, the Carnivorous plants may be treated briefly, for they,it seems, turn the tables on the animal kingdom, and become insect-devourers. The pitcher plant is perhaps the best known in Canada; but the Venus Fly Trap,the Sundew,and the

1 Natural History Studies;- p57.

Butterwort are also interesting. Utricularia (the bladderwort) a water plant which grows just beneath the surface, also captures minute animals as food. It has been suggested in explanation of this carnivorous habit, that these plants usually live in acid soil, deficient in nitrogen, and the insects they catch supply this deficiency.

2. Soils.

In October when the harvest work is over, the farmer begins to plough before winter frosts set in. These operations (or even the above work on the plant) may be used to create interest in soils.

Samples of soils may be obtained and dried sufficiently so that they may be spread out on paper. Each specimen may be examined with the naked eye or with a magnifying glass. Three main constituents can be observed in this way:-

a organic matter such as fragments of leaf, wood, stem or root;
b stones of various sizes;
c finer dust or sand-like particles.

These may be also observed in another way. A sampleof soil may be placed in a glass jam-jar(a graduate or tall gas bottle willbe even better, if these can be had), and water added. The contents are stirred thoroughly, and the light organic particles will come to the top, these may be removed.

After all the organic particles are removed in this way, the remainder is again stirred up. After this has stood for a few moments, the water, slightly muddy in appearance, is decanted into another, larger vessel. This prosess is repeated several times. The heavier contents of the jam-jar can now be removed, dried and finally sifted,through a sieve or wire gauze. This will then be seen to contain gravel and sand. The contents of the larger vessel may be allowed to settle for some time, then as much of the water as possible may be decanted into a third vessel. The contents of the former may be dried and will be found to consist of fine sand. The latter should be left for several days, when a fine mud will be deposited on the bottom; this may be also dried and examined. Thus the organic constituents or humus, the gravel, the coarse sand, the fine sand and finally the clay are separated one by one.

Other experiments may be devised e,g. A weighed quantity of dry soil may be incinerated to get rid of the organic material. If the remainder is weighed when cooled, the weight of the organic material can be calculated. Similarly, by careful heating, the amount of water in the soil may be found.

That soil contains air may be shown by the following experiment; 50cc,of soil is poured into a 100cc, graduate containing 50cc. of water. The volume will be found to be less than 100cc., due to the fact that air escaped in pouring.

A weighed quantity of soil may be soaked in 1% solution of citric acid-the action of which is similar to that of rain water. This is then filtered and the filtrate again evaporated to dryness and weighed. This weight represents the amount in the original sample, of soluble constituent available to plants.

3 Some Common Rocks:-

Before the snow arrives to make collecting impossible, the commoner kind of rocks may be examined and discussed. The pupils should become familiar with sandstone, limestone(calcium carbonate), granite(in which the crystals of quartz, feldspar and mica may be pointed out); gneiss(metamorphozed granite in which the constituents appear to be pulled out into bands), and marble(metamorphozed limestone). Shale formed from clay, and slate(metamorphozed shale) though relatively uncommon, yet are so frequently mentioned that they may also be included.

The three types of rocks, sedimentary such as sandstone, limestone and shale; igneous such as granite; metamorphic such as gneiss, marble, and slate may be introduced, and their formation discussed. The fact that all rocks are largely composed of the four minerals, quartz, calcium carbonate, feldspar and mica may also be presented.

Excursions should be made to find and collect these rocks in the district. Also, any local geological feature should be visited and discussed, for example, for the Montreal district the chain of ancient volcanoes,which are left behind as Mount Royal,Mount Bruno, Rougemont etc,as the geological feature worthy of attention.

The formation of coal may be treated at this point. The fossils in coal and limestone may also be mentioned - particularly if specimens are available.

4. Air - What Can it Do?-

a Compression- as in bicycle tire and football, expansion.

b The power of moving air - as in wind.

c Pressure of air - the Barometer. A simple barometer may be constructed, but the pupils should learn to read the ordinary mercuary barometer.

The principle of the aneroid barometer may also be introduced.

d The Effects of heat:-expansion and contraction;change of state as from water to steam, This should be carried out on a thoroughly experimental basis.

e Temperature:- This notion has been introduced previously, so the work on temperature and the thermometer will be in the nature of a review.

f Having discussed the effects of heat and the temperature of bodies, the ways by which heat is disseminated may be shown experimentally;eg.

conduction - the heating of a piece of wire or metal,

convection - the currents in boiling water,the direction of which can be shown simply by placing tiny pieces of paper in water in a Florentine flask; Numerous experiments can be devised to show these currents in air, and this will in all probability lead to a discussion of the connection between these currents and ventilation.

radiation - Radiation should be discussed in connection with the sensation of heat produced by a fire, a radiator, an electric bulb or heater,and the sun. The absorption of heat may also be treated simply-eg, by experiments with dark and dull surfaces and light-coloured and polished ones. This should be discussed in connection with the colour of clothing and radiators in the home or school, also with the thermos bottle.

g A simple explanation of air currents, winds,and weather may be given. The school should obtain the Meteorological Maps from Toronto[1].And watch closely the forecasts in the newspapers.

1.These may be obtained free from the Meteorological Bureau on request.

2. What Is Air?.

a The physical and chemical properties of air may be treated.

b Rusting may be observed, also the effect of heating copper, magnesium and iron. The fact must be brought out that in each case there is a change - a different thing has been formed. This change does not occur if air is not present. Air contains oxygen.

c The preparation, properties and tests for oxygen may now be introduced.

d Burning:-

This is simply the union with oxygen - the relatively unimportant exceptions should be waived at this point. Experiments should be conducted to demonstrate this fact.

It may now be shown that in the burning of a candle, gas and fuels, oxygen is used and carbon dioxide formed when there is plenty of air for complete combustion, and carbon monoxide when combustion is incomplete.

The construction of stoves and furnaces may be discussed to show how the supply of air is assured. The possibilities of the formation of carbon-monoxide when coal-oil stoves or Quebec Heaters are used in closed rooms should also be pointed out.

The pupils should also be warned against the danger of carbon-monoxide poisoning when coal-gas taps are not turned off properly, for there is about 7% carbon-monoxide in ordinary coal-gas; also, of the formation of carbon-monoxide in a closed garage, when an automobile engine is running.

Before leaving the question of burning it may be shown that active burning with flame is due always to a current of burning gas. Consequently only substances which, when heated by means of a burning match or burning paper, yield a current of gas to burn are useful for fuels, eg:- wood. coal, oil, and to give light as in the case of the candle. It may also be shown that these substances are ones with a relatively low Kindling or Ignition Temperature.

It should also be pointed out that some substances vaporize so easily that on ignition they may cause an explosion. These substances, such as gasoline, benzine and ether, must therefore be kept away from flame in order to avert accidents.

Respiration:- This should be contrasted with burning. In this process also, oxygen is used and carbon dioxide formed. The latter can be shown by blowing into lime-water.

e The action of plants in manufacturing food may now be treated simply. Apart from respiration which is essentially the same as in animals, plants absorb carbon dioxide from the air during the day, and build this into food(starch) by the aid of leaf-green or chlorophyll. During the process, oxygen is restored to the air. Thus, another most important cycle is established.

Experiments should be conducted to show that starch can be actually detected in green leaves during the day. A solution of starch turns blue in the presence of iodine[1]. But this colour-change would be masked by the green of the leaf. If the green leaf or stem is allowed to stand for a few minutes in boiling water, and then placed in methylated spirits, which has been heated over a water-~~bottle~~ bath, the chorophyll will dissolve readily in the latter leaving the leaf pale. The colour-change due to iodine can now be seen readily. Fresh green leaves,ones which have been removed frome the plant some time,and others picked very early in the morning may be compared. Experimental"night conditions" may be obtained by covering a leaf,both upper and lower sides with black paper. A good comparison can be made if this be removed, with another leaf from the same plant, after several hours of sun-shine and tested as described with iodine solution. The former will yield no test for starch;the latter should give a decisive colour-change.

1. The iodine is dissolved in potassium iodide solution. The coloration with starch is blue,violet or black according to the concentration of the solution.

A varieigated leaf may also be tested, when it will be found that only the green parts of the leaf show the colour-change with iodine.

f The presence of oxygen and carbon dioxide in the air has already been shown. The teacher may demonstrate the fact that, when phosphorus, placed in a small vessel floating on the surface of water in a bell-jar is burned, the water rises to occupy one fifth by volume of the bell-jar. The remaining air should be tested and a glowing splint or taper will be found to be extinguished;proving that there is no oxygen left in the bell-jar. This gas occupying four-fifths of the bell-jar is nitrogen.

The properties of nitrogen may then be demonstrated and discussed.

We have shown that the air contains oxygen(1/5 by volume) and nitrogen(4/5by volume). The presence of carbon-dioxide may be shown be the fact that lime-water turns milky when left standing in the air. Thus air contains oxygen, nitrogen and water vapour. The pupils will already be familar with the fact that air contains water vapour, dust and bacteria. The first of these may be demonstrated by numerous experiments.

g The importance of fresh air to health may be discussed at this point.

h The question of humidity and its relation to health may also be discussed. The relative humidity may be determined in the class-room or laboratory by the use of a wet-and-dry bulb hygrometer and a relative humidity chart.

5 Star Study:-

At the end of February or the beginning of March star study may be resumed. The previous work on stars was carried on largely in November and December. I have purposely postponed the work in this grade, so that the pupils may become familiar with the skies of late winter and early spring. Constellations already introduced may be reviewed, and the following new ones added to the list:-the Lion, whose head forms the sickle; the Leonids(meteors) appear from near the sickle in November, Regulus in the handle of the sickle is the prominent star of the group. The Twins, Castor a white star,and Pollux golden in colour, may be found in the south-western sky,to the south-east of Orion,and higher in the sky. Bootes(the Herdsman)or Ox-Driver)with the striking reddish-yellow star Arcturus,will be found in March,and will increase in prominence till mid-summer.

By the simple experiment of heating a piece of wire, it may be shown that colour is associated with temperature. The colour of the stars in relation to their temperature may then be treated.

Planets, meteors and comets should also be treated, and the pupils may be told of the nebulae, and directed to search for the Great Nebula in Orion's sword (the middle star of the sword).

The pupils of this grade should be taught to identify star groups from charts or a planisphere. Phillips "Stars at a Glance" willbe found useful. The method of using the charts should be explained, and the book left in an accessible place, where the pupils can refer to it at will.

6 Water;-

a Its importance to plants and animal life.

b The three states of water:- solid, liquid and gas. This should be correlated with the previous work on the "water cycle"

c Freezing point and Boiling point; Possibly the pupils would be interested at this point to see how a thermometer is made and calibrated.

d Ice is lighter than water, and therefore, floats to the surface:- the importance of this fact in nature

e Water seeks the lowest possible level--experiments; the use and principle of the siphon.

f Surface water; permeable and impermeable strata.

g The well, the pump, the spring and artesian well.

h What is water?- its composition; electrolysis in Hoffman apparatus- yielding oxygen(already familiar from the work on air)and hydrogen. Note the volume and properties of each. The history of the discovery of the composition of water,by Cavendish,Watt,and Lavoisier may be told - the latter also the discoverer of hydrogen. Some metals can decompose water at ordinary temperatures;eg., metallic sodium.

j The formation of water when hydrogen burns in oxygen.

k The physical and chemical properties of water.- with particular reference to water as a solvent. Common substances such as salt,copper sulphate, sugar, sand, should be tested to determine their relative solubility. The story of the Alchemists as they tried to find the "Universal Solvent" may be told in this connection.

l Water will also dissolve gases;eg, the oxygen by which aquatic animals live; carbon dioxide, which when dissolved in water forms carbonic acid which will act on limestone or chalk to form soluble calcium bicarbonate.This seeps through cracks in rocks and sometimes through the roofs of caves where drops lose co_2, and deposit calcium carbonate,thus forming the beautiful icicle-like stalactites and stalagmites.

m Hard and soft water-- temporary and permanent hardness.

n The city water supply:-

a Filtering to get rid of suspended impurities.

b Treatment to purify it by chemical means - such as, with dissolved oxygen or chlorine; by certain kinds of bacteria.

o The importance of pure drinking water to the health of a community.

p Surface tension;- experiments to show this; Attention may again be drawn to the aquarium where the pond-skaters "skate" over the upper side of the film; the snails seem to hang and crawl on its lower side; and the tiny duck-weed floats on the surface, the tips of the leaves attracted(to lower surface energy) while the sides ofthe plant remain free to put forth shoots.

q Capil~~l~~ary action:- experiments with capil~~l~~ary tubes and with two plates of glass,together at one end, and separated at the other by a small cork. When these are immersed in water,the water creeps up,higher as the plates approach one another,thus a curve is obtained(a hyperbola) As the weight of the liquid supported at any point in the curve is always the same(equal to the force of the surface tension)as the width between the plates increases, the height decreases. This capil~~l~~ary action partly explains the rise of water in plants; An experiment may be tried with a white flower, such as a narcissus or a trillium, placed in water containing some dye such as red ink. After some time the small veins in the flower will appear red.

r Osmosis - or root absorption may be demonstrated by a number of experiments; eg,

1 The thistle tube covered with some sort of semi-permeable membrame such as parchment, the skin from suet, pig bladder etc, is filled with a sugar solution, or diluted golden syrup and then placed in a vessel of water. The level of the water in the thistle-tube will be seen to rise.

2 One end of a potato is hollowed out vase-wise; from the other a slice is cut to make it stand, and the skin is peeled off for about an inch. This end is immersed in water, while the hollow is filled three-quarters full of sugar solution. This will again be seen to rise - in this case by the plant cells, just as in the plant. This is a one way process, as no food or water leaves the root and returns into the ground.

3 The shell of an egg is dissolved when left for fifteen or twenty minutes in hydrochloric acid. The egg is then removed, washed, and placed in clean water. The water passes through the egg-membrame and causes the egg to swell appreciably.

s Transpiration may next be treated. This was mentioned in

Grade 5, but now the reason for this process can be seen. Leaves should be examined to detect the stomata,afterit has been determined by experiment whether these afe on the upper or lower side of the leaf(usually the lower side,but they are on the upper side in water-plants). Quantitative experiments may be devised to show the amount of transpiration. For this purpose a small plant such as a geranium or nasturtium will found most convenient.

It will interest the pupils to know that the so-called "dew-drops" on the end of grasses or the edge of strawberry leaves after a moist day or evening,may be caused by the breaking of cells in order to get rid of the water which could not evaporate in the ordinary way - This process is known as guttation.

The transpiration of plants and perspiration in animals may be contrasted.

t Adaptations in animals and plants for storing water may be discussed:-eg, The hump of the camel,the thickened root, or thickened stem as in the cactus. Adaptations for preventing too great evaporation may also be mentioned:-eg, the silk,and stickiness and scales around tree-buds, the limp leaves during the hot part of the day in summer; hairy stem and leaves, reduction of leaf surface into needles,spines,or hairs, as in the case of conifers, gorse and cactus and the bloom on leaves, such as the cabbage.

7 <u>Changes in the Earth's Crust</u>:-

<u>a</u> The story of the earth.

<u>b</u> Earthquakes - the raising and lowering of the crust.

<u>c</u> The folding of mountains.

<u>d</u> Their erosion and weathering.

Evidence of these processes should be looked for in the district. Pictures may also be collected, and models made to show these processes. This is one of many subjects in which lantern slides or ~~in which~~ a suitable moving picture would be valuable, could ~~it~~ they be procured.

8 <u>The Work of Water in Shaping Land Surface</u>:-

The following topics may be treated:-

<u>a</u> Erosion - mechanical action.

<u>b</u> Leaching - chemical action. This cannot be more than mentioned, but the effect of carbonic acid may be used in this connection.

<u>c</u> The effect of ice.

<u>d</u> The wearing back of the land from the sea, or lake; the formation of brook, stream and river.

<u>e</u> The relation between the velocity of water and its ability to carry solid material:- the formation of deltas.

<u>f</u> The change of course in a river in its meandering through a valley from the early to the final stage of ox-bow lakes.

New and old river systems may be compared.

These effects should be observed whenever possible, but the construction of models, and diagrams will also aid in understanding them,

g The "salt" of the ocean, inland seas and lakes is due to the continual dissolving of the soluble parts of rocks in water.

9 Plant, Tree and Flower Studies:-

a The remainder of the year may be spent on studies of plant, tree and flower. Further work on the fertilization of flowers may be attempted,with their adaptations to insure pollination,and also the connection between the latter and the type of their insect visitors.

b Some attempt may be made to group local flowers according to their habitat,eg, flowers of the field, flowers of the open woods, flowers of shady woods, flowers of the swamp.

c A collection and study of ferns and mosses may be made with a view to finding the particular structures connected with reproduction.

I regard this study and also that of the pollination and fertilization of flowers as highly necessary for the purpose of establishing a basis for work in biology on reproductive functions. this seems to be the simplest way of approaching the problem.

Discussion of the Grade 7 Course

It will be seen on examination of the above, that the studies presented are based very largely on experimentation General Science teaching, it seems to me, is almost useless if it is separated from experimental work. I do not think that the pupils should do all the experimental work necessary; some of it must be done by the teacher at the demonstration bench - eg, the experiment with phosphorus to show the presence of nitrogen in the air; or the Koch test for starch, using methylated spirits to extract the chlorophyll. No experiment should be set the pupils which necessitates a refinement in laboratory technique which they do not possess, for the technique of the physicist or chemist is acquired gradually. Difficult or dangerous experiments should, therefore, be done by the teacher only. Only simple experiments which yield decisive results should be set the pupils at this stage and for these, simple but clear instructions should be given. After the school has developed and tested its General Science course somewhat, such instructions could be prepared on mimeographed sheets, thus obviating the necessity for manuals or text-books in the laboratory.

Further Work in General Science in the Junior High School.

It is useless to detail further work in General Science untill the Junior High School approaches reality. The content of the General Science course will depend very largely on whether the school course shallbe two or three years in length ie, whether it shall include merely Grades 7 and 8 or Grades 7 8 and 9.

All the pupils of the Junior High School, should, I think, take the General Science course, at least in the earlier years. Thereis, as far as I can see, only one exception to this. Should this school include Grade 9 and contain all the pupils of the present High School:-ie, those who leave at the end of Grade 8 or 9, as well as those who will continue through Grade 11 it may be advisable for the former to continue their General Science, while the latter begin a more systematic study of the special sciences. The main difficulty at present in giving a really good course in High School chemistry and physics is lack of time.- and, it must be acknowledged, lack of the elementary science knowledge we advocate. It would however, be better to start one year earlier than to spend more time on these sciences in Grades 10 and 11. This difficulty of organization, which I have no doubt, will also be encountered in other subjects, eg, mathematics, could be solved by having two types of Grade 9 classes - one in the Junior High School, another of a more academic nature in the High School. This would obviate the necessity for having two types of science teaching in the Junior High School.

Further work in General Science should be designed to increase the pupils' understanding of the general principles at work in Nature, and how the work of the world is also an embodiment of these same principles.

Such a scheme will include topics such as the following:-

1 A further development of the Grade 7 studies of water, air, weather, geology and plant and animal study.

2 Further work in Chemistry,eg. acids, bases and salts;the commoner elements;the chemistry of any local industry,if this is not too complicated for treatment in school. The terms "atom and molecule" should not be avoided, but should be introduced naturally. An extended treatment of the subject is, of course, out of the question.

3 A simple treatment of hydrostatics; energy and work; the simple machine. The terms mechanical advantage and efficiency should be understood.

4 A simple treatment of light should include a consideration of colour,mirrors,prisms,lenses,the telescope,the camera, the eye and defects of vision.

5 A simple treatment of the vibration of a turning fork, strings and pipes may be attempted to bring out the fact

that sound is a form of wave motion. The ear and the principle of the telephone may be discussed.

6 Simple experiments to show the magnetic and heating effects of electric currents may be performed, induced currents, alternating and direct currents and the principle of the motor and dynamo, the electric bell, the electromagnet, telephone and telegraph may be treated simply.

7 Biology in the Junior High School should concern itself rather with larger ideas, than with a more detailed and technical study of botany, zoology etc. Thus, such topics as the following may be attempted:-

a Some idea of the process of evolution from a simple study of representative types of animals and plants.

b The characteristics of ~~the~~ living plants and animals - the life functions of animal and plant.

c The inter-relations in the web of life:- the balance between plant and animal life etc.

d the distribution of plant life in the world due to temperature and other factors.

e The question of food and its relation to health:-

f The factors involved in health, etc.

The above are merely suggestions, but these subjects most certainly should not be approached in the formal manner of the separate sciences.

The criticism most likely to be levelled at the General Science course is that of superficiality. The validity of this criticism will depend entirely on the teacher, for such work must not be merely the imparting of information, but must involve teaching designed specially to develope scientific habits of thought and inference. For this reason, I think it were better to sacrifice breadth of scope, to the treatment of fewer topics, which could then be conducted in the manner most likely to yield the desired scientific training.

I have conversed with teachers of General Science who declare that their pupils after such teaching tend to develope an all-sufficient attitude of knowing all that is to be known. But this, it seems to me, should not be regarded as a criticism of General Science, so much as a criticism of the teacher. In the cases where I have heard this criticism, the course in question has been taught without laboratory work, with little demonstration and much text-book. It is in all probability the fault of the teacher, who, having insufficient science training himself, has neglected to indicate by reference to experiments, everyday phenomena, andto other books, that the teaching and the text-book employed only touches the fringe of fascinating subjects yet to be explored by the pupils.

Thus we are back to the same question which has arisen in numerous cases in the preceding pages - that the knowledge and training of the teacher is all-important if General Science, or any other science, is to be taught well in our schools.

Chapter 7.

The Connection between Nature Study and Geography

Geography is concerned not merely with the earth, the natural stage, as it were, but also with man's activities on this earth. Thus it has two aspects:- the scientific or physical side which deals with the interaction of the physical forces which have made the earth what it is to-day, and the human aspect, which deals with man in this physical setting, why he has chosen certain parts of the earth in which to live and left others uninhabited, why he has selected travel and communication routes, why some peoples are still savages while others have developed a complex civilization, where and how food is grown and how it is distributed, and so on. Thus the aim of the geography teacher is:- "to build up a conception of the surface of the earth as a product of interacting physical forces, in order that that surface may be intelligently viewed as the scene of social activities"[1].

The teaching of geography falls, like Nature Study, into three natural divisions. The first of these is the work of the early years of primary education. It is concerned largely

[1] H.J. Mackinder, as quoted, P.125 in "Broad Lines" in Science Teaching."- F Hodson.

with the forming of definate mental images- the association of things with the names of things.

This is an extremely important stage in the preparation for geography, for we must teach things before their relations to one another can be considered. Moreover, as geography depends very largely on the power to imagine or visualize things accurately, the teacher must lay the foundations carefully, so that the pictures which are conjured up before the mind's-eye will be correct both in outline and detail. Obviously, then, the main danger inthis period is hurry, which will confuse and blunt these mental images.

The child will have acquired some valuable geographical knowledge before he arrives at school. Thus, from the first time he leaves his home alone and returns safely, he may be said to have some idea of direction and distance. When he learns to go to the candy shop, or any other store or market-place, he is forming some conception of markets as convenient places for buying and selling. When he wonders where the sun is going as it appears to sink in the west, he is ready for the idea that there are places beyond his sight. Though such simple conceptions are usually taken for granted, they are none the less necessary as a basis for the study of geography.

The first real task of the teacher is to aid the child to visualise not merely what he can see, or what he has at some time seen and is likely to see again, but also, things which he cannot even see, and, therefore, must be taught with care to imagine accurately. Thus, he can see his own classroom, and he knows that there is another class-room across the hall for he saw it this morning, but he has never seen China.

The conception of other countries must at first be built up by means of stories, not merely of China, or any other country, but rather of particular individuals in the country in question, for the young child is not interested in a general formula such as the children of China. In this way, by carefully selecting stories of different types of peoples, the simpler ones first, of course, the child will be able to imagine other people different from those he sees every day. Similarly, by stories of little Pierre who lives on a farm in rural Quebec, of the children of a fisherman in, say, Gaspe, of the children of a miner in Northern Quebec or Ontario, and so on, conceptions of people in different parts of his own country may be built up little by little. The various individuals come first, their back-ground will be filled in later; in fact, all geography teaching throughout the school will be concerned with the amplification of this detailed background.

The second stage will, like the corresponding stage of Nature Study, be concerned with relations of things. During this stage regions of the home country will be treated, and will at length merge into a regional treatment of world geography"[1]. J.Fairgrieve.[1] suggests that, while a region should be treated as a whole, it may be considered under the following headings:- structure,relief,climate,and vegetation on the physical side; the settlement and movement of man, the economic and historical aspects on the human side of the question. If the first stage of geography be characterized by description, this second stage is not only description but also comparison, but even yet the geographical principles involved are not discussed.

The third stage of geography, like the similar stage of Nature Study, concerns itself with reasons and causes- in other words, this is,the commencement of real,systematic geography which attempts to explain the"how?"and"why?" of both its physical and human aspects. This study is only barely begun in the primary school, and should be developed greatly in the secondary school, due to the fact that the pupil will then have acquired some grasp of physical principles, and at least some insight into human motives.

1. Geography in School; P.39.

Thus, this stage will involve a re-treatment in this larger light of both home and world geography.

The above outline is to be considered not as a complete treatment of the aim and method of geography teaching, but rather as a rapid sketch to show how the natural divisions of geography and Nature Study appear to coincide. The first stage in each consists of an informal study designed to evoke in the child both wonder and interest while the teacher must make a special effort to present things as realities. These will be used as the tools with which to develop subsequent ideas and relationships. The second stage of both deals not only with further exploration, but also with relationships. The third stage not only expands these two functions but uses them to work out the principles involved,and to form what may be termed a"geographic whole"."The skill of the teacher in framing the teaching syllabus is seen not only in arrainging that all the parts of the syllabus are covered, but that the parts are covered in such a way that they build themselves up in the pupil's mind into one coherent idea"[1].

It will also be noticed that while Nature Study was concerned with the physical world,the human side of the study

1. "Geography in School" loc cit,P,106.

was observed in the attempt to create in the individual an aesthetic and intellectual appreciation of the varied phenomena of Nature, Geography must also attempt to do this, but as it is concerned not only with the physical but also with the human realm, this, appreciation must be extended over still wider a range.

Nature Study has a very definite contribution to make to geography. Before any real geography teaching is possible the pupil must have become familiar with the seasons and their effect on plant, animal and human life and activities. He must have observed the sun in the morning, at noon, in the afternoon; he must have seen the setting sun, the apparently-moving sun, before he can be taught that, in reality, it is the earth that moves. We must not forget too readily that man observed this everyday phenomenon for thousands of years, before he discovered the fact that the earth revolved in space. Likewise he must have learnt that plants grow better in soil than in sand, before he can even entertain the idea of a desert. And how, indeed, can he visualize a tropical forest with ~~their~~ its dense growth, until he has at least seen plants crowding each other for space, and the countless small maples, or other trees, in the woods, choking each other as they grow, and the climbers on fence, bush or tree, Thus, there are countless things, usually associated with Nature Study, which the child must have experienced, at least in part, before even the most elementary geography of the first stage is possible. Still more is this true of the second and third stages of geography when comparisons must be made, and relationships and principles worked out. Consequently, it would seem that geography depends to a large extent on the sort of experience of natural phenomena which is gained through Nature Study.

In discussing this connection of Geography and Nature Study, H.J.Mackinder says:-"...the geographer has something to beg of the teacher who answers the questions of children in regard to the home around them. Gradually, very gradually, the child should be got to ask not merely what things are, but how they are connected. On the turn which has been given to Nature Study of the sixth and seventh years, depends the practicability of asking in the ninth and tenth years not merely the question "where?", but also the question "why there?" In other words, geography can be taught rationally only if the preliminary Nature Study has been taught with an eye on geography which is to follow"[1].

I do not think for one moment that Nature Study

1. "the Teaching of Geography and History"; P.15

should be made to subserve the needs of Geography; rather, it would be better that they work hand in hand. This is particularly true of the earlier years of these studies. Thus, F. L.Holtz declares; "In fact, in the beginning, in the primary grades, geography is not separated from nature study, but is taught under that name. . . .

"It is not, usually, till the fourth year of school that nature study and geography come to the parting of the ways. Even then they should not entirely lose sight of each other, but whenever it is to their mutual advantage should bridge the gap by correlation. In many well-organized school courses these two subjects are so planned as to permit this correlation. In fact, nature study should be the handmaid of geography throughout the elementary school course, as natural science is the auxiliary of the science of geography in higher institutions."[1]

Perhaps the largest contribution Nature Study can make to Geography is the establishment of the two fundamental cycles of Nature:- the life of plants and animals in its close conjunction with the seasons, and what I have previously called the "water cycle." There are other subjects, such as the apparent course of the sun,

1. The Principles and Methods of Teaching Geography," P,277.et seq.

the examination of rocks and soils, the work of streams or rivers etc, which appear to fall within the province of both Nature Study and Geography. Consequently, if these subjects are taught by different teachers, unnecessary overlapping should be eliminated by common planning.

Thus, it would seem that there is a real and necessary connection between Nature Study and Geography. This connection must be observed in the curriculum and teaching of the Primary School, if Geography is to be taught successfully.

Chapter 8.

The Teaching of Hygiene

The object of hygiene teaching is to assist the children to develop habits conducive to personal and social health. It is <u>not</u> the aim of this study to train would-be medical students, as would seem to have been the case in the past, but rather to emphasize the rules of health in everyday life and, finally, to establish, as far as possible, the reasons for these. According to Miss Ravenhill"---in hygiene is found the sum of scientific knowledge directly serviceable for the right conduct and beautifying of life"[1]. This is the aspect of hygiene which should be emphasized in schools.

Obviously then, this teaching must have a double aim:- first, to establish desirable individual health habits; and secondly, to awaken a social consciousness in matters concerning health. This latter is of great importance in the modern world, and the school must foster this awakening sense of responsibility.

Much discussion has arisen in educational circles as to the basis upon which hygiene teaching is to rest. Is it to be based on rules of thumb, or to be developed scientifically from the principles of chemistry, physics, and biology?

1. The Teaching of Hygiene;P50,in"<u>Broad Lines in Science Teaching</u>" editedby F.Hodson.

The choise is a serious one, for if the former method be chosen, the hygiene teaching cannot be expected to yield any scientific training; and in the latter case, it is only possible toward the end of the High School years. But all children should have some such training, thus, it is out of the question that hygiene teaching be given at the end of the science course. Consequently, it is evident that this teaching must develop with the Nature Study of the Junior School. It is certain, however, that it must be placed as far as possible on a biological foundation.

Then, there is the question of how this teaching is to be approached. Here again, there are two ways:- the direct and indirect method. American practice seems to favour the former, while contemporary English pratice is definitely in favour of the latter[1]. The choice between these two methods will determine very largely the emphasis to be placed on the teaching of hygiene. The mere allotment of time in a time-table is no assurance that this teaching will be given; the main factor is the teacher who must be convinced of the necessity for such teaching, and equipped to do it well.

The main arguments against formal hygiene teaching are, as follows. First, there is the danger of focussing a childs attention on his health. It is unnatural that a child

1 e.g. In the Report of the Consultative Committee on "The Primary School" p. 201: "The majority of our witnesses were of the opinion that health education must, for the most part be given indirectly as an integral part of the daily life of the school."

should be self-conscious and introspective in this matter, and such a condition arises only from a negative presentation, or from the fussiness of a parent, due in both cases to an emphasis on the abnormal rather than the normal condition of life. Then there is the objection to the teaching of physiology rather than the practice of health rules. It has been found frequently that hygiene teaching has been so theoretical as to be totally unconnected with the practical conduct of life. Text-books on hygiene are useless from the present point of view, for the reading aloud of a text-book, is not a hygiene, but a reading lesson. Moreover,it is impossible to develop the principles of hygiene in the elementary school; such treatment must wait till later in the school life.

The instruction in hygiene will not be the work of the class teacher alone; the medical officer and nurse, as well as the physical-training instructor all will play some part. There seems to be a growing tendency to regard the latter as the specialist upon the school staff,who should supervise matters pertaining to health education. It may also be observed that the school buildings themselves actually aid or hinder such teaching. Thus, in discussing health education Dr Crowley, Senior Medical Officer of the Board of Education in England, says:

"When we are assured of a proper understanding of what is involved in Health Education, we may with some confidence expect to raise the life ofthe adolescent and of the adult on to a higher level than heretofore. To this end, we shall find there is involved, first, the training of the child in personal responsibility for its own health; secondly, facilities provided by the school and the school buildings to ensure the practice of health, of life in the open air, of the midday meal, of the shower-bath and swimming pool, natural and artificial, of gymnasium and playing field; thiedly, the securing of a sound foundation in a science course based upon the life around the child; fourthly, the introduction of the child to the practical steps taken to protect the health of the individual and the community through the various channels of communal activity. No aim in education short of this should suffice, and at no price short of this can we expect the aim to materialize[1].

Neglecting for the present the above influences, and the important factor of the home in health education, I think the Junior School can best achieve its ideal by stress on the simple rules of health. For this purpose,the aid of the Junior Red Cross Society is invaluable. The children are proud

[1] "Biology in Education"; p,92, et seq.

to belong to the Society,to own its badge and card of health rules, and to take part in its programmes. It can, therefore be used with great success to emphasize the rules of healthy living, and to encourage the children to make a "game" of trying to keep them.

At the beginning of each school year badges and printed cards with the twelve health-rules to be practiced, are sent to each school in which members have previously been enrolled. Under the general direction of the teacher, the children in groups, usually corresponding with the classes of the school, decide in their meetings how they are going to enforce the health rules, and what additional projects they are to attempt. The interest they exhibit is truly amazing. The teacher leaves the responsibility for seeing that the rules are carried out as far as possible with the children. For this purpose the group selects several of its number for a period of a week or more to act as "nurse" or "doctor", etc, in the daily inspection of hands, finger-nails and the like. Thus, the child who fails to measure up to the group standard, is judged not by the teacher or school nurse, but rather by his own class-mates, whose approval he is usually anxious to earn and retain. This is, I believe, a powerful motive in securing adherence to these rules, in the early stage of habit - formation. The teacher thus gains her ends rather by subtle suggestion and guidance of the general programme than by direct teaching. This method can be used quite definitely in Grade 3 and subsequently, but in the earlier grades, the teacher will have full responsibility for the programme.

Commencing, I think in Grades 3 and 4, the community or social motive for keeping health rules may be introduced. This has a strong influence on the children,who are much more reasonable than they are generally given credit for. They enter with enthusiasm into this new phase of the Junior Red Cross programme--including such projects as"Clean, Up-Week", the making of clothes and gifts for the children in hospitals under the care of the Junior Red Cross Society, and also the making of portfolios and the like to be sent to groups in other countries. This latter should, of course, be linked closely with the work in geography.

Until this present session, the work of this society has been confined to the elementary school, and has, therefore ceased after Grade 7. Mrs R.B.Shaw,the Director for this society in the Province of Quebec, informs me that this year the work has beem extended with marked success to include Grade 8 in the Montreal schools. Consequently, there is a possibility that in the near future suggestions for programmes in the Junior and Senior High School will also be available, as in many European countries.

Hygiene, whether it be taught directly or indirectly, should be closely associated whenever possible with the work in science, and even with history and geography. This correlation will probably commence in Grade 3, but will be of particular value from Grade5 on through the school. The correlational method as Miss Ravenhill[1] terms it, will therefore increase in value through the "why?" stage of Nature Study, in General Science and finally in Physics, Chemistry, and Biology.

"In geography and history for instance the effects on human development of climate of soil, of food-stuffs, of water supply or of indigenous diseases may be traced. The influences of local conditions on industries, nutrition, customs, civilization, social progress and position among the races of mankind will emphasize the fact that civilization and sanitary science are most intimately related; that according to the character of the artificial climate with which man surrounds himself in clothing and home, according to the attention he gives to the disposal of refuse or to the due supply of wholesome food, according to his restrained and intelligent use of his instincts - personal and racial - will be regulated not merely his own personal efficiency and civic worth, but

1. <u>Broad Lines in Science Teaching</u>, F.Hodson.(editor) p.55.

the position of his people among the great powers of the world."[1]

The final preparation for citizenship, thraugh a knowledge of personal and social hygiene, would come at the end of the school course,"[2] This, Miss Ravenhill describes as the "Superstructional Method"[3]. This should, be given either as a part or in close connection with a broad course in General Biology such as outlined in S.A.MacDowall's book, "Biology and Mankind". Sir Arthur Thomson seems to have the same sort of thing in mind in Course B.part 2; at the end of Course C; and also in Course D of Scheme 3,of the Appendix to;"The Place of Biology in Education".

There is considerable doubt yet as to whether the school should give definate instructions in matters concerned with sex. Some authorities think this should be given, others that class-instruction in such matters may even be harmful. There is little doubt, however, that should such teaching be attempted it should be approached through the study of life-cycles in plants and animals, and the work on fertilization and reproduction that this entails.

1. p,55.et seq) "Broad Lines in Science Teaching"F.Hodson.(editor)
3. p,58.)
2. cp. Natural Science in Education; p.69.
"We agree with the opinion of some of our witnesses,that the subject should be taken as late as possible in the school course,preferably at the 16-18 stage,After a course of systematic work in the sciences on which it depends."

Thus apart from the influence of the daily life of the school, the health education falls into three stages:-

1 a the practice of the elementary health rules, with a view to forming habits conducive to health. This will be stressed when the child enters school - but should already have commenced in the home.

b From Grade 3 onwards, the social aspect of health education will be emphasized along with the personal aspect

2 With the approach of adolescence the health training will be given in close conjunction with the rest of the school programme. This may be termed the "Correlation Method". In this stage the training will be placed on a Biological basis, and an attempt will be made to show the broad scope of the problem, but even yet there will be little stress on the principles introduced.

3 Finally, towards the end of the school course, the principles upon which Hygiene, as an applied science, is based will be treated broadly. This is most frequently taught in close connection with the Biology course.

Chapter 9.

Is Such a Scheme of Science Training Possible in Quebec Schools ?

The answer to this question involves two distinct phases of the problem:-

a A discussion of the present situation with regard to science teaching.

b Recommendations as to how this situation can be improved.

A 1 In the preceding pages we have been driven repeatedly to the conclusion that the success or failure of Nature Study depends very largely on the teacher. We have also seen that, in order to teach Nature Study well, The teacher must have some knowledge of the aim and method of Science, as well as an interest in the phenomena of Nature. There is no doubt that, while most teachers have at least some interest in natural phenomena, their knowledge of Science is sadly deficient. The reason for this is plain. Heretofore, it has been relatively easy to gain admission to the teacher-training colleges of Quebec without any real knowledge of Science "1". Consequently, many of the present teaching body have not the requisite science training necessary to teach Nature Study even moderately well.

Moreover, unless the teacher has some knowledge of Science and also a love of Nature in its varied manifestations, she will not be able to appreciate the cultural value to the child even of elementary science. Thus, Nature Study willbe crowded out of the school programme in favour of subjects which can be tested readily by examination. The lack of science training and the consequent attitude of the teacher, combined with the emphasis on examinations are important reasons why Nature Study has been largely neglected in our schools.

2 The lack of equipment has undoubtedly also been a factor in this neglect. Aquarium vessels, plant-pots, magnifying glasses, a few bunsen burners or spirit lamps are essential, and a Nature Study Room and school garden are highly desirable.

Library facilities also are necessary both

"1" I do not consider that the Physiography which many candidates for Matriculation formerly presented as their only science-subject should correctly be designated by the term "science" for it was almost invariably unaccompanied by laboratory work.

for teacher and pupils, and when these are lacking the teacher will naturally feel some temerity on commencing work in Nature Study. Nor can she be entirely blamed in this, for even those who have had adequate science training are frequently at a loss to answer children's questions if reference books are not available. Moreover, it is unreasonable to expect teachers who have had little science training themselves, to have such reference books in their personal library, unless their own interest and curiosity concerning natural phenomena has been aroused.

Means for providing nature-material for city schools have already been discussed, likewise, the fact that a specialist teacher will do much to solve this problem. A school garden, whatever its size, will also solve in part the seeming lack of Nature-material for city schools.

3 The time-factor has, undoubtedly influenced the neglect of Nature Study; crowded programmes, the time to prepare lessons and obtain material necessary for them, and emphasis on subjects to be examined all have played some part.

4 Another factor in the situation has, without

doubt, been ~~that~~ the present Nature Study programme suggested by the Provincial authorities. This is so general in character, that none but a specialist in the subject would be able to gain much assistance from it.

Of these various considerations, however, I am convinced that the largest factor is the scientific attainments and training of the teacher.

General Science.

The present situation in General Science in Quebec is even more serious. This subject is, I firmly believe, relatively useless unless a highly trained teacher and adequate laboratory and demonstration facilities are available. But even the best equipped schools in the province have not these facilities, nor are they using their physics, chemistry and other equipment as much as they might, to remedy this deficiency. Until the need for laboratory work in General Science is more commonly accepted, the teaching of this subject cannot be expected to improve. For the same reason, General Science work should not be attempted in small schools where there is no science specialist; it were better to spend the time on a broad study of geography.

The Separate Sciences

The need for specialist-teachers for chemistry and physics is, I believe, fairly generally accepted now, With the introduction of Biology as a subject leading to Matriculation, the scarcity of teachers specially trained in this branch of Science has become apparent.

B Recommendations:-

Nature Study

1 It is useless to expect the teacher-training centre to supply deficiencies in science-knowledge. Thus, candidates for entrance to these colleges should have had a thorough training in Science at school.

As it is unreasonable to expect every candidate to take Chemistry, Physics and Biology, I suggest that a good General Science course, in which the fundamentals of Physics and Chemistry have been presented, and a course in General Biology be accepted as the minimum requirments for intending - teachers.

2 Should the course of teacher-training be lengthened from one to two years in the future, additional work in Science should be provided in the first year.

3 For those already in the profession, vacation-schools in Nature Study should be organized. These should

treat broadly, not merely the pedagogy, but also the material or content of the study"[2]. Such schools may also be used to develop Nature Study specialists.

4 A wider use of the many <u>Aids to Nature Study</u> should be encouraged. These may be listed shortly as follows:-

<u>a</u> The growing of plants and bulbs in the school.

<u>b</u> The keeping of aquaria, and of animals and insects in suitable terraria.

<u>c</u> Visits to field, wood, stream and river etc.

<u>d</u> Visits to parks, museums and the like"[1].

<u>e</u> Visits to markets, gardens and farms.

<u>f</u> A wider use of the school garden, where this is available.

5 A centre or exchange should be instituted for the distribution to the schools of slides and films of interest in Nature Study, General Science, Biology and Geography. This could well be established in Quebec on similar lines to the existing reference library for teachers of the Province.

1. In this connection it may be noted that a Botanical garden is to be opened in Montreal within the next few years. This should be used freely by the schools in Nature Study, Biology, And Geography Teaching.

2. Schools of this nature have been established in England with excellent results.

General Science

6 To facilitate the training of science specialists in general, and specialists for General Science in particular, the prerequisites for a High School Diploma should be made more elastic. Under the existing conditions, it is almost impossible to qualify broadly in Science, and obtain this Diploma.

7 These recommendations are mainly connected with the training of teachers, and undoubtedly well-trained teachers will vitalize the programme of the school:- It must be remembered, however, that some equipment is necessary not only for the High School, but also for the General Science of the Junior High, and the Nature Study of the Junior School.

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