

A SURVEY OF THE GENERAL SCIENCE SITUATION IN ILLINOIS.¹

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The motive for this investigation originated from ideas advanced in regard to the reorganization of science education after it has been given the acid test of war.

It is very evident that science is to command larger recognition in our program of educational reconstruction. Our scientists and engineers compared favorably with those of other nations because we were exceedingly fortunate in having conditions in this country that made science and engineering attractive to college and high school students, not so much because of elementary exploratory courses of their abilities and aptitudes, but because of rewards offered in a rapidly growing country with great engineering and commercial projects. We are aware that time will in a measure eliminate some features that heretofore have been a source of attraction, and that preparatory courses must induct pupils into science courses. During this period of reconstruction the call for trained specialists will be more insistent than any previously known. Our leaders can clearly see that this nation's future depends largely on its standing as a scientific nation. This embodies the exploration of the child's abilities, proper direction, and an awakening of latent possibilities, bringing him into sympathetic appreciation with this new trend so necessary to the future development of the nation. School administrators are fully awakened to the demands and are groping for a panacea to solve their difficulties. The War Department's announcement of July 10 very clearly expresses the vital significance of emphasis on science teaching as it affects the training of officials in the S. A. T. C., as the following extract shows: "This is a war in which soldiers are not only marksmen, but also engineers, chemists, physicists, geologists, and specialists in many other lines—science training is indispensable." The Bureau of Education has recently made public the report of the Committee on Science Teaching in Secondary Schools, emphasizing expanded and radical changes in science teaching, from which I quote in part: "To encourage high school students to elect more work in science and at the same time to lay the foundation for a general appeal to science and its methods, every effort should be made to arouse a lively interest

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in science, particularly in grades seven to nine." "Wherever practicable, certainly in grades seven to nine, in junior high schools, and the first year of four-year schools, the artificial separation of the sciences so that they are treated as separate subjects should be ignored for the greater end of interpreting the problems of daily life. In solving a problem appeal should be made to any science that will contribute to the problem in hand." It will require time and careful thought to realize this program. For the present, at least, the problem must remain as a standard by which we may check progress and towards which we may seek to approximate. I have discussed the present unsettled situation with many administrators in this and other states—always with the same results. The doctors cannot agree; the authors, judging from textbooks, cannot agree on even a general aim; the courses are not standardized; the advocates are not on common ground; the courses are not generally accredited; and the money, teachers, or facilities are lacking for a "trial and error" experiment.

The administrator has a different viewpoint from many agencies advocating general science—his board of education and patrons must be shown that the subject deserves and will maintain its place in the curriculum permanently. He admits that he is not satisfied with his beginning science courses, and demands that "the powers that be" get together and agree on certain aims and standards at once practicable as a basis for organization and accrediting.

As an ideal, justification or elimination of this new subject depends upon how safely we avoid the error of falling back into the textbook type of course, and how skilfully we make use of the newer types of teaching that are being developed. Yet according to the best available information, and being handicapped by the scarcity of properly trained teachers in the technique of presentation, most of us must admit that the textbook at the present time determines the content and organization of the majority of courses offered in this state. At the present time there are over thirty general science textbooks in use, with very few having a common basis. During this investigation I was surprised at the number of administrators whose only charge against general science was the textbook, and still further surprised that many were not just sure what they really desired for a textbook. In spite of the general feeling in certain sections general science is discredited by few, and there is a very enthu-

siastic demand. Because of unsettled conditions many have assumed the attitude of "watchful waiting." Administrators admit that they are simply marking time with what special science they inherited, or using the expensive "trial and error method" in an effort to satisfy local needs.

In several near-by states general science has made rapid strides, due somewhat, I believe, to its recognition by colleges of the state. Michigan leads with 138 schools teaching general science and lists 118 North Central Association schools. Iowa is next with 135 general science schools and 80 North Central schools. Wisconsin has 130 general science schools and 106 North Central schools. Illinois has 120 schools teaching general science, but the effect of 172 North Central schools not generally receiving credit for general science undoubtedly has checked the number of adoptions. And yet, upon investigating the attitude of the accrediting agencies, I do not find them adverse to recognizing general science. Their attitude is one of caution, anticipating each year to see something tangible in standardized form grow out of this controversy. I hope that this investigation will shed some light on the subject, because administrators are personally responsible for all of the data used as a basis of conclusions.

North Central Association schools were selected as being representative of the most progressive type of schools in Illinois because in most cases they are supervised by professionally trained educators who are students of new educational problems. A questionnaire was sent to every North Central Association school in the state, exclusive of the Chicago schools, and to a select few representing a special type of township community high schools rapidly being established in the state. No effort was made to reach schools teaching general science, and you will notice from the figures submitted that they average about 50-50. In all two hundred questionnaires were sent in the following form:

GENERAL SCIENCE QUESTIONNAIRE.

NOTE.—If answer to Question No. 1 is "No," skip to Question No. 9. If answer to No. 1 is "Yes," answer Questions No. 1-No. 9 and No. 12. ALL SHOULD VOTE ON THE AIMS OF GENERAL SCIENCE.

1. Does your school offer general science?.....
2. Required or elective? (Underline one.).....
3. In what grade or grades?.....
4. How long has it been taught in your school?.....
5. In your opinion is the course regarded favorably? (1) by teachers?
..... (2) by pupils?.....
6. Is there evidence that the course leads to further interest in science?
.....

7. Is this indicated by more intelligent election of further science?

8. What criticisms do you have of general science as now taught?

9. Why is general science NOT offered in your school?.....
10. Provided its aims were clearly defined and acceptable and the course fully accredited, would you desire to add it to your curriculum?

11. Are you altogether satisfied with your ninth grade science?.....
12. If colleges and universities prepared teachers of general science, would it simplify your problem?.....

I was unfortunate in that the questionnaires were placed in the mail just as a state-wide quarantine was ordered, which undoubtedly delayed some replies which are coming too late to classify. You will note that the questionnaire is brief, arranged in this order, because it was to be answered by administrators personally, and I was convinced that they would not answer it unless this form was used to economize their time. At the time this paper was prepared 112 were returned, of which sixty schools were teaching general science and fifty-two schools were not. Let us first take for consideration the sixty schools now teaching general science. In twenty-six schools it is offered as elective, and in thirty-four schools it is required. The returns are rather definite as to the place of general science in the curricula, as fifty-seven offer it in the ninth grade and three in the eighth and ninth. In each case of the latter it is offered in the eighth grade the second semester, and the ninth the first semester. I found in some cases that where courses of nature study and elementary science were offered there is a growing inclination to require general science of all pupils who have been trained in and are graduates of the country district schools, while the graduates of the city schools who have had some elementary science are given the privilege of election in ninth-grade science.

It is apparent from the answers to the next question that general science should be properly defined, and that there is much variation of opinion as to just what such a course should include. Some seem to doubt the data that general science was really in existence, as such, over a period of time as long as some of the figures indicate. The length of time that general science has been taught in these schools varies as follows: one year, seven schools; two years, twelve; three years, fourteen; four years, eleven; five years, three; six years, two; ten years, one; fifteen years, one; sixteen years, two; twenty years, one; uncertain, six.

In reply to the question, "Is general science regarded favor-

ably? (1) by teachers? (2) by pupils? I am somewhat impressed by its popularity and felt need among teachers and pupils. In sixty schools, fifty-five teachers regard it favorably, three unfavorably, and two as questionable. The pupils of fifty-nine schools regarded it favorably and one unfavorably. In several instances this question was answered, "Very much so," indicating real enthusiasm. I presume there are those who will say that pupils fed on highly spiced "dessert and faddism" from the whole field of science would naturally be pleased. But they must remember that pure interest which originates in the child's environment will many times surmount great difficulties in learning. Just now we are seriously concerned with the special value of general science to those who drop out of school after completing the common pabulum of science. Dewey says in part, "We must remember that although in school we are always treating pupils as embryonic scientists who are interrupted and cut off before they get very far, the great mass of pupils will never be scientific specialists. The value of science for them resides in the added meaning it gives to the usual occurrences of their everyday surroundings and occupations. None the less, we want a high school which will tend to attract those who have distinct calling for specialized inquiry and one which prepares them to enter on it." "What we need is to hitch the horse of concrete experience with daily occupation and surroundings to a cart loaded with specialized scientific knowledge."

In order to verify the assertion that a course in general science is explanatory of the child's abilities and aptitudes, I asked the question, "Is there evidence that the course leads to further interest in science?" Forty-nine administrators answered "Yes," many giving the proof of the assertion, while six answered "No," and five had not taught it long enough to draw conclusions.

In reply to the next question forty-eight asserted that this was evident by an increase in the size of science classes, showing increased stimulus in science election, and five were uncertain for reasons mentioned above.

Throughout this investigation it was very evident to me that the time is here for administrators, college professors, specialists, and teachers to exchange ideas and come to some understanding regarding the elements of contention. At the high school conference at the University of Illinois recently, many administrators expressed approval of the action taken in the combined science meeting, where a resolution was passed, signed by leaders

of the various factions, who were willing to concede their "hobbies" in order to get unified action which has long delayed marked progress in this state. I think in view of this statement, that criticism coming from administrators with varying degrees of experience in dealing with general science in their schools will be of special interest to this group. These criticisms I have tried to group in the following statements because the ideas expressed by many were practically the same and are consequently grouped somewhat after the plan of a composition measuring scale.

CRITICISMS OF GENERAL SCIENCE

1. A piecemeal mixture of science, still kept distinct.
2. Courses unbalanced, lack unity of organization.
3. Emphasis placed by the authors or teachers on special lines of enthusiasm.
4. Too difficult, not adapted to the age of the pupils.
5. Laboratory equipment not standardized.
6. Lack consciousness of a general aim.
7. Lack of properly prepared teachers make it a textbook science.
8. Teacher does not have the general science attitude. He thinks because of his special science training of each phase as a definitely segregated area, and classifies any subject matter under heads of special sciences before presentation.
9. It is simply a "trial and error" science.
10. General science teachers should be the most resourceful teachers in the faculty, and this type is difficult to find.
11. Is not accredited.

A brief consideration of the above criticisms will very clearly indicate that unified action on the part of the various agencies concerned will obviate the majority.

Considering the reasons fifty-two schools are not teaching general science, we find lack of teachers prevents ten from adopting it; thirty-five would adopt it if accredited; four expect to adopt it next semester or next year; and three have discontinued it for reasons mentioned above or because of a change in administrators not believing in the subject.

In reply to the question, "Provided its aims were clearly defined and acceptable and the course fully accredited, would you desire to add it to your curriculum?" forty-seven answered "Yes," and five "No." Five believe that the special science

commonly offered to the ninth-grade pupils is superior, but forty-seven are dissatisfied with their present science and are anxious for relief.

There seems to be a felt need for the special preparation of general science teachers in colleges and universities. From the 112 questionnaires, seven did not answer the question, six answered "No," and ninety-nine are convinced that it would simplify their problem. There is little doubt that general science will repeat the history of physical geography unless teachers are adequately prepared. How many general science teachers have taken at least a course at a good university in chemistry, physics, botany, zoology, physiography, bacteriology, astronomy, and mineralogy, all of which an adequately prepared teacher of general science should have because of the wide scope of the subject. This teacher should be extensively prepared in the sciences, versatile, enthusiastic, and most resourceful. Administrators demand this, and for the lack of it general science may not survive.

In practicing my previous assertion that we must "get together" and have at least a general aim in common, I have included C. M. Howe's aims in my questionnaire, and followed the same plan of tabulation as found in his article in the *General Science Quarterly* for May, 1918:

AIMS OF GENERAL SCIENCE.

Please number, in order of their relative importance to you, the commonly expressed aims of General Science. (Write 1 in front of most important, 2 in front of next. Please try to rank entire list as best you can.) Aims—General Science in the first years of high school should give each pupil:

- (a) A fund of valuable information about nature and science.
- (b) The greatest possible understanding, appreciation, and control of his every day environment.
- (c) Preparation and foundation for the later study of special sciences.
- (d) Appreciation of the applications of science in modern industrial and social life.
- (e) Training in the use of scientific method in solving vital problems.
- (f) A vocational survey of the sciences to guide and inspire plans for life work.
- (g) Interest and motivation to vitalize his work and prevent his elimination.
- (h) Appreciation of the unity and beauty of science and of the work of its master minds.
- (i) Training in cold, scientific thinking, carried on with strict self-elimination. (Coulter.)

Aim of General Science—As Ranked by Eighty Science Teachers.

Adapted from C. M. Howe.

Rank	1	2	3	4	5	6	7	8	9	Total
1.....(b)	53	10	7	2	4	3	00	00	1	149
2.....(d)	5	23	15	17	11	2	5	2	00	282
3.....(a)	12	13	13	17	10	7	4	3	1	293
4.....(e)	8	11	12	14	7	7	11	9	1	357
5.....(c)	6	6	10	11	14	8	12	11	2	400

6.....(g)	1	10	12	9	10	15	13	8	2	406
7.....(f)	1	7	9	8	17	16	13	6	3	421
8.....(h)	1	2	5	5	10	16	11	27	3	506
9.....(i)	1	3	5	4	3	2	4	6	52	609
	1	2	3	4	5	6	7	8	9	Total

Rank	Aim of General Science—As Ranked by Eighty-one Illinois Administrators.									
1.....(b)	38	13	14	7	4	4	2	00	00	192
2.....(d)	5	29	21	9	8	8	1	00	00	257
3.....(a)	18	16	16	12	9	3	1	4	2	266
4.....(c)	11	9	10	13	19	12	5	2	00	323
5.....(e)	4	4	5	15	14	11	24	2	2	425
6.....(g)	3	4	8	12	12	23	12	8	00	429
7.....(f)	1	5	4	11	10	18	24	8	00	457
8.....(h)	1	1	3	2	2	1	9	49	13	609
9.....(i)	00	00	00	00	3	2	3	8	64	688

Peculiarly in the number of questionnaires tabulated, we were fortunate to have practically the same number. Mr. Howe tabulated eighty and I tabulated eighty-one. This gives us an opportunity to make a comparison of the composite judgments of science teachers of actual experience with that of administrators, the majority of whom offer general science in their schools. The tables give the final ranking and frequencies. The total score is secured by multiplying the frequency by the rank, and adding the products. I have followed this plan because it makes more convenient a comparison of results. Careful study of the tables shows conclusions almost identical. The aim, "Understanding, appreciation, and control of his everyday environment" is placed first. Second, "Appreciation of applications of science in industrial and social life." Third, "A fund of valuable information about nature and science." These rankings for the first three aims are identical with those of Mr. Howe, but after the first three there is some variation. This is not of any great consequence as agreement extends far enough down the scale so that it leaves room for little controversy. In view of the agreement on aims between people so vitally concerned in the general science question, it seems evident that some agreement could be reached on content that would at least show progress, or perhaps an agreement on projects would offer promise of desirable results. The latter, however, is far from being developed to a point where most teachers can make much use of this idea.

I am convinced that extended controversy and disagreement will only serve to complicate the situation. At present many schools in Illinois are planning to qualify under the Smith-Hughes Bill. The interpretation of this bill by state inspectors is such

that it demands segregation of boys and girls in science classes largely because of the natural division in training for vocations. I am sure that the people who are planning such courses to include general science are soliciting a definite recommendation for organization of the science with general aims adaptable to such courses. Electing to come under the provisions of this bill will lead to a type of general science for boys that will deal with problems closely related to vocations for boys and at the same time give them an understanding, appreciation, and control of their everyday environment. Girls will be given special courses correlated with their vocational courses. More schools because of this work have during the past year required general science in only certain courses and have left few subjects for election in the ninth grade. I can foresee that different texts and plans of instruction will be used in the same school, a type for boys, a type for girls, and a special exploratory course leading on to college courses with a view to training those for specialists who have natural ability in that direction.

Finally, I believe, enough pioneering has been done in Illinois to offer sufficient data that will warrant a unified effort to suggest a practicable working basis of organization around definite aims that will before any great time lead to a solution of our ninth-grade science problem.

CLASSROOM SAYINGS.

1. Latent heat is heat that is left over.
2. Friction is the movement of something without the power to lessen it.
3. Energy of our bodies is traced back to horse power.
4. A moment of force is a watt.
5. Ozone is obtained by subjecting oxygen to electrical shocks.
6. How would the world be changed if there was no nitrogen?
 War would never come to pass,
 And we wouldn't need to fear
 That our friends and relatives
 Had lost an eye or ear.

 Gasoline accidents would be no more,
 And explosions would be very rare,
 And last of all we would have to breathe less,
 For there wouldn't be so much "air."
7. Tin is abstracted from its ores by heating with coke.
8. White lead is a fine alloy for a paint.
9. Focal length of a lens is the point at which the distance between the distant object and the lens is brought to a focus.
10. Succulent roots are roots that stick to the walls by suction.
11. Inertia is the state in which all inanimate objects stand and some times in which all animate objects stand.