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James S. Perlman
University of Minnesota

5. Therefore the results of the experimental study showed a significant difference between the Control and Experimental groups on the final scientific attitudes tests.

Outcomes

The class found a great difference in the soil content, water-holding capacity, plant, and animal life between the areas which were habitually burned and those which were known to have not been burned over for at least 25 years.

On the five unburned four-foot-square plots was found an average of 26 specimens of plant life, and 9 of animal life in each plot.

On the five burned over four foot square plots were found an average of 9 specimens of plant life and 3 of animal. The types in the two areas were also found to be quite different. On the unburned area were specimens of native wild flowers and other woodland types. On the burned over areas, were found hardy weeds and grass — chiefly quack-grass.

Equally startling differences in top soil texture, content, and water-holding capacity were observed in the two areas.

Individual discovery and observation of these results by those students taking the field trips apparently resulted in an increased development of scientific attitudes as measured by the results shown in the scientific attitudes tests administered in this study, since a significant difference was found between the final scores of the Control and Experimental groups.

This significant difference together with the first-hand information obtained from field trips conducted in such a manner as to be a functional application of the scientific method, seem to indicate that the extra effort involved in planning and carrying out such field trips is well worth while.

AN HISTORICAL VS. CONTEMPORARY PROBLEM-SOLVING USE OF THE LABORATORY PERIOD IN COLLEGE PHYSICAL SCIENCE FOR GENERAL EDUCATION

JAMES S. PERLMAN
University of Minnesota

The original paper was read as a preliminary rather than as a final report upon a study for which data had just been collected.

General Purpose and Character of This Study

Problem-solving involves learning and experience. It also involves challenges and reveals intelligence. With the lives of all of us a never ending succession of personal and social problems, it would seem that one of the primary functions of the school should be the pointed and persistent training for a scientific, that is, an open-minded, systematic, and critical approach to problems. For such a purpose, we are emphasizing the use of the science laboratory period, unique in its possibilities for the use of first hand materials as first hand evidence in scientific problem solving.

The study briefly described in this abstract was designed to investigate the comparative values of two possible approaches to such a use of the college physical science laboratory period, an historical as against a contemporary problem-solving approach.

Description of Experimental Method

The population consisted of all students, mostly freshman and sophomores, regularly enrolled in the Natural Science IV and V sequence of the PHYSICAL WORLD of physics, astronomy and chemistry at the University of Minnesota during Fall 1950 and Winter 1951. The original ninety students were divided into five groups, two historical individual laboratory groups, two contemporary individual laboratory groups, and one demonstration group with all students attending the same three lecture periods each week. The laboratory or demonstration time was a single two-hour period a week.

Differentiation of methods was essentially in respect to problem treatment and materials. The laboratory course consisted of fourteen contemporary problems parallel to fourteen case histories, all of which, in topic, were similar and concurrent to the accompanying demonstration group. The historical groups, however, involved historically centered problems and laboratory equipment; the contemporary groups involved contemporarily focused problems and equipment; and the demonstration group was apparatus centered in its problems with both contemporary and historical equipment. For example, in connection with the refraction of light, the historical groups worked on the Galilean telescope and its significance as empirical evidence in the Ptolemaic-Copernican issue of "Does the Sun Revolve Around the Earth or the Earth Around the Sun?" At the same time, the contemporary groups were considering their own eyes as optical instruments, particular optical defects that they may have developed, and correction by lenses, while the demonstration group experienced standard class room refraction demonstrations.

Preliminary Data were obtained through 1947 A.C.E. College Aptitude Tests, through G.E.D. Test No. 3, "Interpretation of Materials in Natural Science" as well as through a pretest on scientific thinking compiled by the writer involving: (1) judgment as to use of written authority, personal authority, first hand evidence, and group opinion in a variety of life situations; (2) judgment as to basic factors or as to procedures necessary for given problem solutions;

(3) interpretation of data with concern for suspended judgment, overcaution, or hasty judgment; and (4) determination of assumptions behind conclusions.

Actual class procedures may be summarized as involving critical experiment duplication by individual students with emphasis upon the problem-solving involved, as against class arguments or discussions initiated, e.g., through newspaper clippings and then scientifically resolved and evaluated with instructor-class planning and individual experimentation. The demonstration group activity has already been described as highly audio-visual and as apparatus centered in its questions, discussions and problems.

**Problem-solving generalizations emphasized in the historical and contemporary groups may be found in smaller type at the end of this paper.

Final tests were two-fold: (1) the written pretest repeated, and (2) a "practical" based on 14 actual situations, set up for evaluation of openminded, systematic and critical thinking.

Statistical methods involved reliability and validity of measurement and emphasized random sampling equalization of groups through Fischer's analysis of variance and co-variance.

Results and Conclusions

Since time has permitted only a preliminary reduction of data, any indications as to findings must again be emphasized as merely preliminary.

1. On the written scientific thinking test, no group had a significant advantage, although the contemporary groups showed a slight advantage over the others.
2. In the "practical", one contemporary group was decidedly superior to its corresponding historical group and to the demonstration group, whereas the other contemporary group showed about the same results as the others.
3. Although we are not able to give any conclusions until we report or publish final results in this study, we are able to point out that:
   a. A number of former experiments that give some advantage to demonstrations on the question of the use of the individual laboratory vs. demonstrations may be fallacious in being based only upon facts and principles learned rather than upon accompanying development of open-minded, systematic and critical thinking.
   b. There is need for more experimentalism in education: less opinions — more experimental verification.
   c. There may be room for reconciling the contemporary vs. historical argument by using historical materials to the extent that they *directly* throw light on specific contemporarily posed problems.

NATURAL SCIENCE IV-V LAB.

** GENERAL PROBLEM SOLVING "HIGH POINTS"

1. Basic aspects of all problem solving, although in various orders and combinations, are the following five Deweyian steps: felt difficulty, clarification of problem, suggestions for solution, selection, and verification. These involve the abilities, attitudes, and considerations involved under A, B, C below.

A. CONSIDERATIONS OF CRITICAL DISCRIMINATION.

2. We can not always trust our senses.
3. There are both similarities and differences in things.
   a. Analogies based on similarities often afford fruitful leads in solving problems.
   b. Dangers of analogies lie in not recognizing differences.
   c. It is important to understand things in terms of opposites.
   d. Look for the exceptions to things.
4. Definitions also based on similarity and difference afford an excellent tool for establishing a basis for problem solving.
5. The use of authorities involve careful considerations.
   a. Authority is relative to given fields.
   b. In the same field, equally good authorities do not always agree.
   c. Individual thought with first hand evidence in addition to use of authority is necessary for progress.
   d. Best basis for judgment of value of a source is the training and purpose of the author.
6. Variation, change, and motion are common to all things.
7. Look for the basic elements and factors in a problem situation.
8. Know the differences among fact, assumption and definition.

B. CONSIDERATIONS OF SYSTEMATIZATION AND GENERALIZATION.

9. Systematization is based on similarities.
10. Graphs and charts afford a valuable tool for the organization and interpretation of data.
11. Shrewd, careful, tentative guessing can be very fruitful and productive in problem solving.
12. Generalization, however, that is either too hasty or too cautious blocks progress.
13. Technology and medicine reflect the tremendous tool of cause and effect relationships on a natural rather than supernatural basis.
14. Other things being the same, the simpler the explanation, the more the probability of success.

C. CONSIDERATIONS OF VERIFICATION.

15. Everyone is entitled to his opinion, but not all opinions can stand up equally under the facts.
16. It is more important to be able to anticipate and to detect errors in problem solving than to expect perfect solutions.
17. Many leads and hypotheses often have to be tested before the best solution is found.
18. Conclusions and statements, therefore, should be qualified according to the limits of the particular problem, conditions and evidence.
19. Since facts are never completely all in, certainty can merely be approached, not arrived at. Conclusions, therefore, are merely the best evidence of the time, and require open-mindedness for further verification, improvement, or change.
20. In some cases there is more than one correct answer to a problem due to two answers being different aspects of the same thing, or due to need for additional knowledge.

21. The larger the number of cases as evidence, the greater the possibility of truth.
22. Every statement, opinion or idea rests upon some assumption, and is no more solid than its assumption.
23. The hypothesis, the theory, the law, and the axiom indicate degree of certainty.

OPPORTUNITIES FOR EDUCATION IN VETERINARY MEDICINE

A. F. SELLERS

School of Veterinary Medicine
University of Minnesota

We are receiving many inquiries regarding entrance requirements and opportunities in veterinary medicine. A School of Veterinary Medicine, as you know, was established at the University by the Legislature in 1947, and has been in operation since that time.

This presentation will attempt to summarize material relative to present needs for veterinarians, high-school and college entrance requirements, other requirements for entrance, and the general nature of the professional curriculum.

Present Needs for Veterinarians

The need for veterinarians is acute and is continuing to increase.

Allow me to illustrate. In the years 1908-18, there were about 725 veterinary graduates per year. These were largely graduates of privately supported schools. During the early 20's these privately-supported institutions experienced curtailment of their programs due to lack of funds. Thus, by 1925-26, only about 100 were graduated per year.

Subsequently, veterinary medical education in publicly-supported institutions increased. By 1936, however, the existing schools could accept only a portion of the qualified applicants, and this situation has continued to the present time.

In 1950 there were 575 graduates in veterinary medicine throughout the United States. Seven new schools have opened. When all of these are in full operation, the output will reach 825-850 per year. Thus we will not much more than replace the graduates of the 1908-18 era, who are now growing too old to maintain active practices. This situation will obtain in essence for the next 10 years.

Consequently, from 1918 to 1951, a 33-year period, the number of practicing veterinarians has remained essentially static and will probably remain so for another 10 years. Over the 33-year period mentioned, there has been a constant improvement in services rendered and a constant increase in demand for qualified veterinary