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ELEMENTARY TEACHERS' UNDERSTANDING OF SCIENCE AND ITS METHODS

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ABSTRACT

The purpose of this study was to measure the understanding of science and its method possessed by a group of elementary teachers. The Processes of Science Test was administered to a sample of 161 elementary and prospective elementary teachers in order to determine background deficiencies. Results of the study indicated that the subjects had difficulty answering questions related to judging facts, principles, and concepts of science; judging the results of scientific experiments; and quantitative relationships. The study has implications for curricula change in the science methods requirements of prospective elementary teachers.

INTRODUCTION

Since the mid-fifties many changes have been taking place in the teaching of science. The focus of instruction in the elementary grades has shifted from a passive role for the student in which he read about science to an active role in which the student works with the tools and techniques of the scientists. Curriculum materials have been developed that focus on increasing student understanding of scientific principles and the methods of science. The major intent has been to help students develop appreciation of what a scientist does, i.e., how to set up an experiment, how to test hypotheses, and what conclusions may properly be drawn from the results of a given experiment. As a result of these curriculum changes, emphasis on teacher training has shifted.

Traditionally, prospective elementary teachers in Tennessee have completed a minimum of 18 quarter hours in natural sciences including a study of the best uses of natural resources as a part of their undergraduate teacher education program (Tennessee State Board of Education, 1975). Also, many prospective elementary teachers have completed at least one course in methods and materials of teaching science in the elementary school. Recently questions have been raised relative to the level and type of science courses that prospective elementary teachers should complete as undergraduates. For example, in a limited study conducted by Avers (1974) it was found that almost 85 percent of all of the graduates of Tennessee Technological University, who complete requirements for certification as an elementary teacher, had taken only courses in the biological sciences. However, it should be noted that the results of studies conducted by the American Association for the Advancement of Science (1970) revealed that there was little correlation between the amount of science completed by a teacher and success in teaching a modern elementary science program, such as Science: A Process Approach. Therefore, based on this finding it might be concluded that an individual who had completed the science requirement for high school graduation might be able to do an adequate job as an elementary school science teacher. It would, therefore, seem desirable to ascertain the level of understanding of science and its methods that prospective elementary teachers have based on the level of a high school student.

The purposes of this present study were to measure the understanding of science and its methods possessed by a group of elementary teachers and prospective elementary teachers utilizing a standard high school level examination to disseminate the results of the study in order to aid college instructors in the pure sciences and in science methods in course improvement.

METHODOLOGY

The subjects for this study were 161 students (36 males and 125 females) enrolled in eight sections of a three hour science methods course (Science for the Elementary Teacher) over a two year period (Summer 1973 through Summer 1975) at Tennessee Technological University. The subjects were either teachers pursuing work toward the masters degree in elementary education or early childhood education, or they were certified teachers taking additional work to add a teaching endorsement as an elementary teacher. The median teaching experience of the subjects was two years with a range from zero to a maximum of 15. The mean number of hours completed in the study of the formal sciences was 20 with a range from 12 to a maximum of 64. Most individuals had completed their science requirements as undergraduates by taking one or more years of biology.

The Processes of Science Test (POST) was administered to the subjects at approximately the mid-point in the science methods courses. The POST was originally developed by the Biological Sciences Curriculum Study (1965) and was designed to provide an estimate of a high school students' understanding of science and its methods. The test was specifically designed "to appraise a student's understanding of *general* scientific principles and scientific reasoning ability" (BSCS, 1965, p. 3). Although, the test was framed in a setting of biological science, a detailed knowledge of biology was not a prerequisite for scoring high on the test. The test focused on several important aspects of the understanding of science and its methods. General topics covered by the test included: methodology of science; the bases of judging facts; principles and concepts; the extent to which the student has developed standards for judging or appraising data; the student's ability to interpret qualitative and quantitative data; and his ability to screen and judge the design of experiments. The test was designed to measure the ability of a student to recognize adequate criteria for accepting or rejecting hypotheses and to evaluate the general structure of experimental design in science including the need for controls, repeatability, adequate sampling and measurement. These abilities are also necessary prerequisites for an individual teaching elementary school science utilizing one of the modern curricular projects; such as, Science: A Process Approach, the Science Curriculum Improvement Study or the Elementary Science Study.

The mean score and standard deviation was computed for the POST. Correlations of POST scores with graduate quality point averages and course grades in the science methods courses were also computed. A detailed item analysis of the POST was made in order to ascertain deficiencies of the students in the above mentioned science skill areas.

RESULTS AND DISCUSSION

Test scores of the POST ranged from 17 to 36 with a mean of 29.0 and a standard deviation of 5.1. The Kuder-Richardson Formula-20 Reliability of the test was .85 with a standard error of estimate of 1.85. In comparison, the mean score for a sample of 24,389 students in the tenth grade who had completed a year of high school biology using one of the versions of BSCS, was 26.1 with a standard deviation of 6.6 (BSCS, 1965, p. 6). Correlations of POST scores with graduate quality point average of the subjects ($\bar{X}$ = 3.66, SD = 0.56) and grade in the science methods course ($\bar{X}$ = 85.3, SD = 6.4) were, respectively, .64 ($p > .01$) and .52 ($p > .01$).

The 40 items of the POST were classified into five areas accorrding to the original concerns of the developers of the test. The five areas and the number of items included under each area was as follows: methodology of science (9); bases for judging facts, principles, and concepts of science (7); standards for judging or appraising scientific data (7); ability to interpret qualitative and quantitative data (10); and ability to screen experiments (7). An item analysis of the results of the test was performed in order to identify apparent weaknesses in the background of the subjects.

Results of the item analysis indicated that 25 percent of the subjects missed the seven questions related to judging facts, principles, and concepts of science and over 35 percent missed the seven questions related to standards for judging or appraising scientific data. About 30 percent of the subjects missed four of the seven questions related to the quantitative interpretation of data. The subjects achieved the highest number of correct responses to questions concerned with scientific methodology, the ability to screen scientific experiments, and questions dealing with the qualitative interpretation of data. On the average the subjects achieved above the 72 percent level on most questions.

As an integral part of the newer science curricula, children are expected to judge facts, principles, and concepts of science and also to judge and appraise the results of scientific experiments with a particular emphasis on quantitative relationships. Therefore, it appeared that the subjects in this present study might be deficient in these areas and further work appears warranted as the subjects assume their positions as teachers in the elementary schools.

It would appear that college instructors of science and science methods courses should give due emphasis to the above topics in future revisions of their curricula. In turn this should provide prospective teachers with more of the needed skills to teach the newer science curricula that are being placed into more and more of the schools.

LITERATURE CITED

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AAAS 142nd ANNUAL MEETING SET FOR BOSTON 18-24 FEBRUARY 1976

Washington, D.C.—"Science and Our Expectations: Bicentennial and Beyond" is the theme of the 142nd Annual Meeting of the American Association for the Advancement of Science (AAAS), to be held 18-24 February 1976 in Boston. Several thousand scientists are expected to attend the 7-day meeting in the Sheraton-Boston Hotel and the adjacent John B. Hynes Auditorium at the Prudential Center.

Some 180 symposia will be presented on topics centered around three sub-themes: Frontiers of Science, Uses of Science, and Perspectives on Science. In 20 daily concurrent sessions, speakers will explort not only advances in research in various areas of science, engineering, and medicine, but also the application of science and technology and the social and ethical implications of such use.

The AAAS meeting also will feature ten public lectures by noted scientists on such topics as "Exploration of the Mid-Atlantic Rift," "Towards a Human Scientist," "The Emergence of Biochemistry," "Income Distribution and Economic Equity in the United States," and "Mapping the Grand Canyon."

Science International, a major exhibition of scientific instruments and publications, will be an integral part of the meeting for the second consecutive year.

As a part of its new Project on the Handicapped in Science, AAAS will make this year's meeting fully accessible to people whoare in wheelchairs, who have visual or auditory disabilities, and who need assistance because of other disabilities.

For further information, see the 14 November issue of *Science*, write to the AAAS Meetings Office, 1776 Massachusetts Avenue, N.W., Washington, D.C. 20036, or contact Carol L. Rogers, 202-467-4485.