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The Development of Critical Thinking Through Science Instruction

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One of the major goals in science teaching is to develop critical thinking in each student. After instruction in science, we as science teachers, hope that students have learned to analyze scientific data, to interpret data which will allow them to arrive at reasonable conclusions, and to evaluate approaches to problem solving in science. At Middle School, Bettendorf, Iowa, one of our major goals is to develop the ability of each student to think and analyze problems in relation to his or her ability. To go along with this, each course in science is designed with an attempt to continually challenge each student to use and develop his thinking and reasoning abilities.

In order to discover if this goal in science teaching was being developed in students after a year course in science, the writer chose to give the Watson-Glaser Critical Thinking Appraisal to students in seventh and eighth grade science at the beginning and at the end of the school year. The Watson-Glaser was chosen because its test time of forty minutes and its length of ninety-nine items conveniently fits into a class period. Secondly, the five tests of the Watson-Glaser test for areas in critical thinking that are basic to science. The five tests with descriptions quoted from the test manual are:

> Test 1. Inference. (Twenty items) Designed to sample ability to discriminate among degrees of truth or falsity or probability of certain inferences drawn from given facts or data.
>
> Test 2. Recognition of Assumptions. (Sixteen items) Designed to sample ability to recognize unstated assumptions in given assertations or propositions.
>
> Test 3. Deduction. (Twenty-five items) Designed to sample ability to reason deductively from given premises; to recognize the relation of implication between propositions; to determine whether what seems an implication or necessary inference between one proposition and another is indeed such.
>
> Test 4. Interpretation. (Twenty-four items) Designed to sample ability to weigh evidence and to distinguish between unwarranted generalizations and probable inferences which, though not conclusive or necessary, are warranted beyond a reasonable doubt.

Test 5. Evaluation of Arguments. (Fourteen items) Designed to sample ability to distinguish between arguments which are strong and important to the question at issue and those which are weak and unimportant or irrelevant.

A final reason for choosing this test is that a score on this test is known to have a positive correlation with success in science according to the Watson-Glaser Test Manual provided with the test.

The test was given to 245 students, 90 seventh graders and 155 eighth graders, with three teachers participating to minimize differences in instructional technique. Class sizes ranged from twenty-eight to forty-eight students and no provisions to group the students by ability were made. The test was given on October 13, 1964, and the retest was given on April 8, 1965. The results of the test showed that the students were acquiring an ability to think logically and analytically. All class means showed a gain of from 1.4 to 10.9 points over the first testing period, (Table 1) Table 1 also shows the seven classes tested with the class size, and the mean scores for each testing period with the gains noted.

Table 1. Table of results of the Watson Glaser Critical Thinking Appraisal

Class No.	Class size	Grade	Mean Beginning	Mean End	Mean Gain or Loss
1	46	8	52.4	53.8	gain 1.4
2	31	7	43.1	52.4	gain 9.3
3	33	8	50.2	58.2	gain 8.0
4	30	7	45.6	52.5	gain 6.9
5	48	8	53.1	56.1	gain 3.0
6	29	7	42.8	53.7	gain 10.9
7	28	8	56.9	60.9	gain 4.0
Total	245	All	49.1	55.5	gain 6.4

It is significant to note that the larger classes showed the least improvement while the smaller classes had the largest gain in mean scores. This result agrees with many studies that have been made and it is generally recognized that teaching in the larger classes is more impersonal and students in these classes have difficulty acquiring the fundamental concepts needed in science. Furthermore the seventh grade science classes showed the greatest improvement in scores with one of the classes showing a mean improvement of 10.9 points. This shows that during the school year the seventh grade students acquired many of the important concepts related to science quite readily and, as this writer has found, are eager to learn and inquire into the scientific areas of thought.

191 out of the 245 students who took both tests showed a gain in score with many students showing an increase of up to

twenty–five points in their scores over the first testing period. The mean for the 245 students taking the first test was 49.1 while the mean on the retest was 55.5 which resulted in a net gain of 6.4 points.

Since this test did not include comparison norms for seventh and eighth grade students, the study will have to wait until next year before a comparison of this type can be made. Furthermore, one might assume that the entire critical thinking development of these students is caused by their courses in science alone, but we all should realize that all the subjects a student takes tend to contribute to the student's ability to think critically. Further studies and additional testing will be needed before a definite conclusion can be made. But from preliminary results of one year of testing, it appears that science teaching can and does develop the ability of students to think critically.

New Directions in Earth Science in Iowa Schools

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Abstract: Earth science was a common part of the high school curricula fifty years ago. It dropped from about 30% to .4% of the total school enrollment from 1900 to 1949. The decline of earth science was paralleled by an increased offering of biology. In the modern high school curricula it is replacing general science, mostly at the ninth grade level. Earth science offerings are on the increase in Iowa from 7 districts in 1960 to 53 in 1965, an increase of 757%, which is roughly 10% of the schools. Other schools have plans for the adoption of an earth science course in the near future. It is taught 75% of the time at the junior high school level (grades 7, 8, 9). The size of the class is about 26-30 students taught by a married male with a BA degree and 4-7 years exeprience. Most states have no certification requirements specifically for earth science teachers. They are certified under general science or science in general. There are not enough qualified earth science teachers at present and as the growth continues the problem will become more critical.

INTRODUCTION

The purpose of this paper is to explore the past and present status of earth science in the secondary schools and from these try to predict trends in the future. It is the purpose of this paper also to explore some of the problems in staffing an earth science course with a well qualified teacher.