Stephen Guy Bierma. AN EVALUATION OF SCIENCE EDUCATION IN THE SECONDARY SCHOOLS OF EASTERN NORTH CAROLINA. (Under the direction of Robert L. Dough) Department of Science Education, July, 1971.

In attempting to learn more about the status of science education in eastern North Carolina five different test instruments were administered to about 50 classes. The tests given were: the Physics Achievement Test, the Test On Understanding Science, the Semantic Differential Test, the Pupil Activity Inventory test, and the Learning Environment Inventory test. A questionnaire was also given to the teachers. Computer programs were written to score three of the five test instruments. The other two instruments were scored by a standard test grading program. Statistical analyses were run on each test separately. No attempt was made to intercorrelate the various test scores.

Using one-way analysis of variance and a correlated "t"-test it was found that: (1) Students' understanding of science and physics achievement made a significant increase from the pre-test to post-test, (2) Project Physics classes and other physics classes are not significantly different in their understanding of science, (3) Project Physics classes and other physics classes are significantly

different in their physics achievement; the Project Physics group attained a higher achievement in physics as measured by the PAT, (4) students generally do not participate frequently in any science related activities, (5) students feel science is both worthwhile and lively, (6) the classroom environment in eastern North Carolina does not compare favorably with schools in the northeastern United States.

AN EVALUATION OF SCIENCE EDUCATION
IN THE SECONDARY SCHOOLS OF
EASTERN NORTH CAROLINA

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INTRODUCTION

Rationale of this Study

Decisions affecting science education in the public schools of this country must be based on sound and up-to-date information. It is necessary to understand the situation in the schools before decisions can be made as to the changes that should take place. The justification for making changes should be based on students' needs, teachers' needs, and societies' needs.

The purpose of this study is to indicate the needs of those affected by science education. This study will accomplish its purpose by providing new information. The interpretation of the data gathered by the use of test instruments and questionnaires should provide a clearer picture of science education in the schools of eastern North Carolina.

Much of this researcher's time was spent in establishing correct statistical techniques to be used, and in writing computer programs to save time in collecting and analyzing data. By initiating this research project the procedures and processes necessary for more detailed studies will be established. This will save following researchers time and effort that can be put forth on new problems.

Results of this study should be useful to educators in general and to those who are interested in improving the specific teaching areas of physics, chemistry, and physical science in the high schools. By having a better understanding of the type of science student in the high schools in this locality, colleges and universities can adjust their programs accordingly before the students are subjected to what might be inefficient programs. High schools might also wish to revise the type of science curriculum they are using after seeing how students react to other science curriculum projects.

RESEARCH DESIGN

The Scope of this Research

This research was intended to serve as a pilot project only. It is the responsibility of anyone doing such a study to find the best possible combinations of research tools and techniques so that others may take advantage of what was learned. With this in mind, this investigator administered a wider variety of tests, tried more new methods, and developed more computer programs than could possibly be used in the study.

The greatest value realized from this research will not come from this study alone, but from others which follow utilizing the vast amount of data gathered in this pilot study. This study will present some results found from the data but a greater value will be that of indicating what additional research could be carried out.

Statement of the Problem

Many new test instruments have developed in the last ten years which measure academic interest, science attitudes, values, opinions, learning environment, and activities in science. All of these tests cannot be administered at one time due to the time factor involved. Some are more valuable than others, and many are very difficult to interpret.

This study will show which tests have been found to be of most value for further evaluation studies in the area of science education. Other questions to be answered are:

1. Do the students in local high schools gain in their understanding of science after taking a course in science as measured by the Test On Understanding Science?

2. Do physics students in local high schools learn enough physics to cause a significant increase in

their achievement in the course as measured by the Physics Achievement Test?

3. How do students taking the Project Physics Course compare with students taking other physics courses in terms of achievement and understanding of science?

4. How does the learning environment differ between a physics class, a physical science class, a chemistry class, and a biology class?

5. How do some of the attitudes toward science differ between students in local schools and students in other studies?

6. In what science activities do students frequently participate?

7. What seems to be the available possibilities for further research?

Evaluation Tools

The Test On Understanding Science (TOUS) was developed in the course of research at the Graduate School of Education, Harvard University, and is printed by the Educational Testing Service, Princeton, New Jersey. This test was given to determine to what extent a realistic understanding of science and scientists has been attained as a result of taking science courses. The test itself is broken down into the following three areas:

I. Understanding about the scientific enterprise

II. Understanding about scientists

III. Understanding about the methods and aims of science.

The test is composed of 60 questions and requires 40 minutes for testing time. The scoring for this study was done on the three areas combined. The total reliability coefficient as measured by the Kuder-Richardson Formula 20 is 0.78. Norms have been established for grades nine through twelve.

The Physics Achievement Test (PAT) was developed by Harvard Project Physics specifically for an evaluation of their Project Physics Course. For this reason it has a higher percentage of interdisciplinary items than are found on other standardized achievement tests in physics. The reliability coefficient of this test using the Kuder-Richardson Formula 20 is 0.77. No specific norms have been published for this test, however many test scores for this instrument have been reported in science journals. The test consists of 40 multiple choice questions and the total testing time is 40 minutes.

Because variables other than achievement and understanding are important when looking for student changes, three other test instruments were used in this study but will not be reported on extensively. These are the Semantic Differential Test, the Pupil Activity Inventory, and the Learning Environment Inventory. A questionnaire was also given to 52 science teachers in eastern North Carolina. A copy of the questionnaire can be found in the Appendix.

The Semantic Differential Test (SDT) was also developed by Harvard Project Physics for their evaluation purposes. This test was developed to measure students attitudes toward science and how they would describe concepts such as doing laboratory experiments and physics. Testing time is twenty-five minutes.

The Pupil Activity Inventory (PAI) was designed to determine the type of science related activities in which the students engage. Testing time is about fifteen minutes.

The Learning Environment Inventory (LEI) test was also written in conjunction with the evaluation of Project Physics. The test was developed to determine classroom group properties and their relationships to student behavior. This test consists of fifteen scales and 105 items. Goal Direction and Competitiveness are two examples of scales. Testing time is forty minutes.

The Local Questionnaire given to the teachers in this area was partly original and partly taken from a Project Physics Questionnaire.

Administration of Tests

The pre-post testing situation which gives the most valuable and complete data also consumes about six hours of class time. Since it was felt that this amount of time was excessive for a pilot evaluation, the tests were given to only every other student. One student would receive one test and another student in the same class received another. Thus two different tests could be given in one class period.

Letters were sent to various superintendents and principals requesting their permission and cooperation to test a specified class under a specific teacher. This was done in the early fall of 1970. The teachers involved had previously agreed to cooperate in the evaluation project. From the list of those that agreed to participate, as many as possible were included in the evaluation. The limiting factor was the number of test booklets available.

The teachers were mailed test booklets, answer sheets and instructions in early October for the pre-test and again in late April for the post-test.

Scoring of Tests

All of the data collected from students was on either a form 510 or 511 IBM answer sheet. All answer sheets were scored by a Model 1231 optical mark page reader. The PAT and TOUS results were then analyzed by a standard test grading program using an IBM 360 Model 30 processing unit.

The SDT, PAI, and LEI do not have specific answers and therefore could not be run through the standard test grading program unless only a frequency distribution was needed. For this reason another way of analyzing the data was necessary. Another problem which presents itself is that many concepts in the SDT and LEI are deliberately reversed in the test booklet and must be changed in the final data analysis. The scores were reversed so that students would not be tempted to consistantly mark the positive position of the scale. Because some answers were reversed a special program was used which would read any answer on the sheet and would print any number for an answer that the programmer requested. The data thus generated was submitted to another program specifically designed for one of the three tests mentioned and the average scores were therefore obtained for the various test instruments.

Chapter 2

LITERATURE SURVEY

A survey of education since the time of the Greeks and Romans indicates that science was not held in very high esteem. During the middle ages science was even less recognized than it was during the time of the Roman empire. Even during the time of the Renaissance, the scholar did not consider science as a separate and worthy subject. Modern science probably got its first foothold by the use of inductive reasoning which had been suggested by Sir Francis Bacon.[1]

Science was generally ignored by schools in America prior to the year 1872. To understand why this was so, one should first look into the early requirements for entrance into Harvard University, and in the same glance look at what was being taught in the Latin Grammar Schools. The Latin Grammar School existed for nearly the exclusive purpose of fulfilling the entrance requirements of Harvard. To enter Harvard one needed the ability to write Latin verse, prose, and to "read, construe, and

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[1]George W. Hunter, Science Teaching (New York: American Book Company, 1934), pp. 15-16.

parse" ordinary Greek.[2] The Latin Grammar School could not find the rationale nor the time for science since the University did not require it.

The public academy was developed between 1750 and 1850 as a school to enroll the non-college-bound student. In contrast to the narrow restrictions of the earlier Latin schools, the curriculum of the academy was more practical. Natural philosophy, a forerunner of physics, was a part of the curriculum.[3]

The entrance requirements of Harvard University finally changed and in 1872 it announced that physics and other sciences were accepted for college entrance. Within a few years most of the other universities followed the example set by Harvard. This led to the development of detailed standards for the high school science course.[4] These science courses were developed exclusively as a prerequisite for the student going to college. For this reason, the science courses that were developed reached standards greater than those attained previously.

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[2]Ibid.

[3]Ellsworth S. Obourn and John H. Woodburn, Teaching the Pursuit of Science (New York: The Macmillan Company, 1965), pp. 169-71.

[4]Claude Gatewood, "The Science Curriculum Viewed Nationally," The Science Teacher, XXXV (November, 1968), 18-21.

With the above background in mind, one should now review what has developed in order to better understand the future developments. Until about 1880, high schools existed almost exclusively for college-bound students. The average high school student was one who came from a refined family. The high school students at that time were an elite group. Since almost all of the students in high school were to go on to college, eminent practicing scientists developed an "elite" curriculum that would prepare these students to enter their University classes. The function of the high school science curriculum was almost purely college-preparatory for an elite group of students.

This type of curriculum may have been appropriate and effective before this nation was transformed from a largely agricultural to an industrial society. This function was destined for change, however, and the cause is to be found in the Kalamazoo Case of 1874 in which the courts held that public taxes could be levied for building and supporting high schools.[5]

Free, tax-supported high schools could now legally be instituted by citizens. This meant that even poor families could now send their children to school. An

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[5]Ibid.

influx of average and below average students were now flooding the schools. It was evident to everyone that the "elite" science curriculum no longer satisfied the needs of a majority of the students. The science curriculum of the past was then redesigned and transformed to meet the needs of all the nation's high school students.[6]

The new science curricula were continually "watered down" to the point that the science courses did not resemble the same course that was being taught in 1870 or 1880.[7] Scientists also lost interest in overseeing high school curricula. Their interests turned from education to research as the era of "modern science" began to unfold.[8] For these reasons and others the quality of science education continued in a decline.

The enrollment in high school physics classes has been increasing steadily for several decades. However, the total population of high school students has been increasing at a rate far exceeding the rise in physics enrollments. Figure 1 illustrates just how the enrollments have been changing during this century. It is

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[6]Ibid.

[7]Ibid.

[8]Ibid.

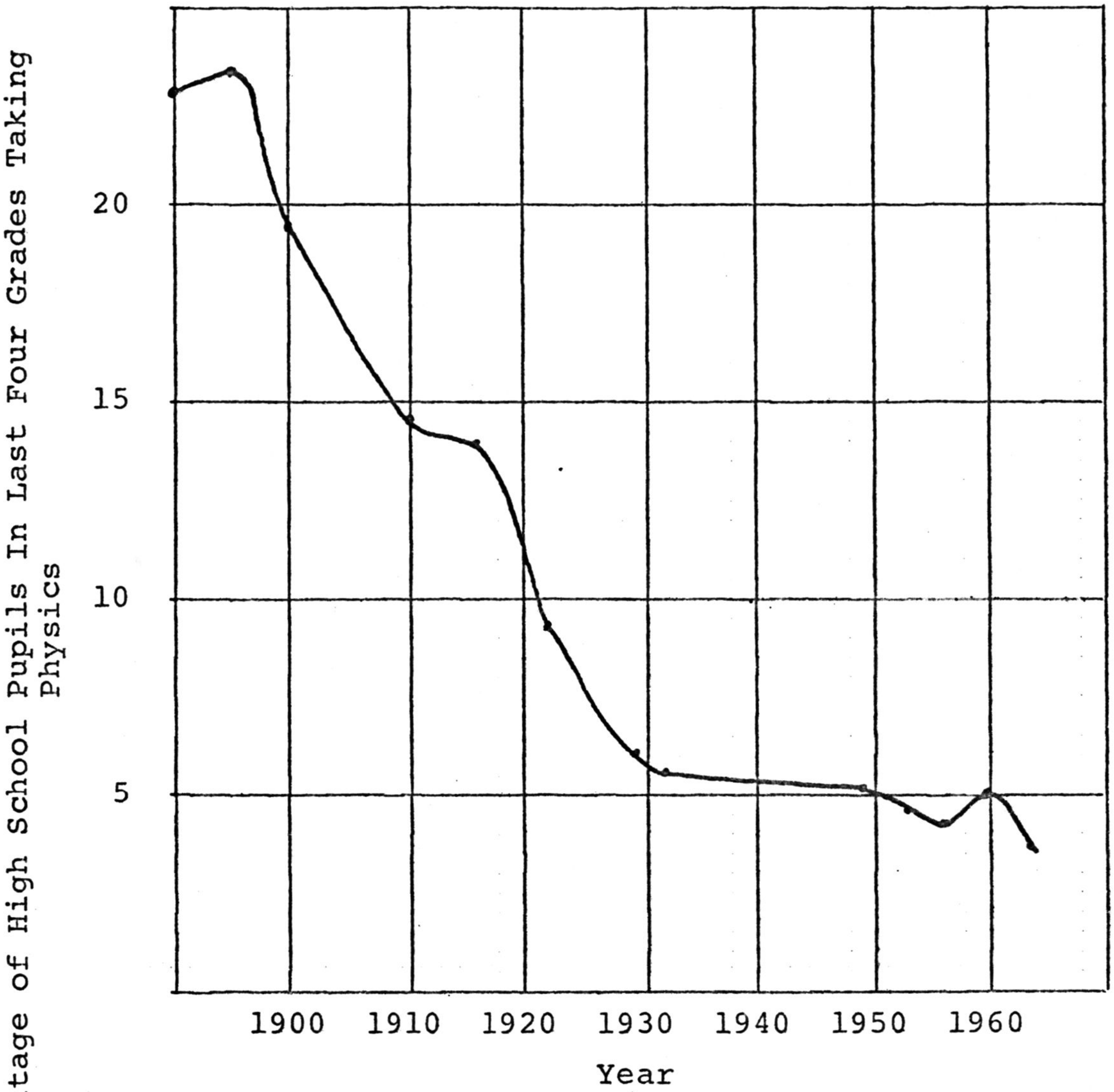

Figure 1

Percentage of High School Students Taking Physics[9]

[9]Newsletter 1, "Decline in Physics Enrollments," Harvard Project Physics, Fall, 1964, p. 2.

interesting to notice that the drop has been almost continuous since about 1895.

During the past 30 years, scientific discoveries have come with increasing frequency to improve our lives. The high school science course, however, remained an unsophisticated and out-of-date version of what science had been.[10] Scientists and mathematicians had begun curriculum reform around 1952, but met with very little success. The launching of Russia's Sputnik I was influential in starting curriculum changes. This event jolted educators and laymen into making a more thorough investigation into the science teaching status in our nation.[11]

An increase in physics enrollments began about 1956. Two or three years later the increase stopped and a decline began once more. The continuation of the decline has caused great concern among professional organizations, and high school physics teachers. There are facts, however, that to some extent refute the accepted opinion that there is a percentage decline in physics enrollments.

In a study by Gladys S. Kleinman, there is evidence to indicate there has been a large increase in

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[10]Gatewood, pp. 18-21.

[11]Deborah P. Wolfe, "Trends in Science Education," Science Education, LIV (January-March, 1970), 72-75.

physics enrollments.[12] This study shows that in 1900, ten percent of our 14-17 year olds attended high school. Nineteen percent of those students were enrolled in physics. This indicates that approximately two percent of the total high school population received physics education in a formal high school class in 1900. In 1965 about 80 to 90 percent of the potential high school population was actually attending high school. Of this group, about five percent were enrolled in high school physics. This means that in 1965 about four percent of the total high school population was enrolled in physics. The actual percentage change in the enrollments of high school physics from 1900 to 1965 has therefore doubled.[13]

Since this study was completed the percentage of the high school population, actually in school, has nearly leveled off, while the percentage decline has continued in physics.[14] (From this point on in this study, decline in physics enrollments will refer to a percentage decline and not to a total number decrease.) This continued decline

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[12]Gladys S. Kleinman, "All is Not Lost: The High School Physics Enrollment Picture is Not as Black as it Seems," The Physics Teacher, III (March, 1965), 120.

[13]Ibid.

[14]Pake Committee for National Academy of Sciences, "The Most Pressing Problems in Physics," The Physics Teacher, VI (January, 1968), 33.

is of great concern to many people in science. They are concerned about the total impact this lack of interest will have on society and on our country.

Teachers, professional organizations, and others ask if it is reasonable to allow high school graduates to enter the labor market, vocational schools, or for that matter any type of school or work force with the same scientific literacy that was considered satisfactory in 1920.[15] Others feel that graduates from high school without a sufficient science background may one day find themselves standing in the job lines next to people who have no high school diploma at all.[16] Still others go so far as to say that democracy is in danger of survival with an uninformed people who are ignorant of scientific technology.[17]

It seems reasonable to assume that those students who are not going to college should get the best science background in high school since they will probably not have another opportunity in the future. The facts

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[15]Milton O. Pella, "Science Needed by All," Science Teacher, XXXII (September, 1965), 51.

[16]Newsletter 1, "Importance of Physics Courses," op. cit., p. 4.

[17]G. Abegg and G. Crumb, "Why Not High School Physics?" School Science and Mathematics, LXVI (February, 1966), 211.

indicate, however, that the students composing the lower three quartiles have been ignored in all science areas except biology.[18] The trend is to have college bound students enroll in as many science courses as possible. What happens to the other 75 percent of high school students? Has the high school forgotten about the majority? The problem is acute and must be eliminated as quickly and efficiently as possible. To do this one must first understand the causes of the problem.

The reasons for low enrollments in physics are many. This investigator will make a systematic explanation of the most prominent reasons for the declining enrollments. It should be noted that there is no single cause of the problem, but a conglomeration of many which all contribute to the overall problem.

Upon asking high school physics teachers why more students did not take physics, the overwhelming reply was that the students felt the course was either too difficult or not suited to their abilities and desires.[19] Science has the general image of being cold, hard, and true.[20]

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[18]Pella, op. cit., p. 52.

[19]V. J. Young, "Survey of Enrollments in Physics," The Physics Teacher, III (March, 1965), 117.

[20]Addison, E. Lee, "Current Problems in Science Education," Science Education, XLIX (March, 1966), 147.

Are our physics teachers giving students the impression that physics is hard, cold, and probably not suited to their needs? If this is the case, then perhaps part of the problem lies in the teacher.

"Physics teachers have been found to be more poorly prepared than any other type of science teacher."[21] This is not because physics teachers are "lazy" in any sense of the word. North Carolina in 1964 had 517 high schools teaching physics in which 520 teachers taught a total of 538 classes. This means that the usual case is for one physics teacher to teach one class of physics in almost every high school in the state.[22] In 1971 this researcher found the situation unchanged. It is clear that the main teaching load of a "physics" teacher is not physics but another subject, or perhaps two other subjects. The teacher cannot concentrate his efforts on physics but must prepare for possibly two other classes. Often, a teacher who has had little or no college training in physics is given the responsibility of teaching the course.

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[21] P. W. Tweeten and R. E. Yager, "Science Curriculum Trends in Iowa," School Science and Mathematics, LLXVII (January, 1967), 32.

[22] N. D. Anderson and J. M. Goode, "The Status of Physics Teaching in North Carolina" (Paper presented at the Fourth Annual Conference on Recent Advancements in Physics, December, 1965, Chapel Hill, North Carolina).

Students today are involved with more school activities and non-school activities than in the past. They find they do not have time to do everything they want. To resolve this problem many students take courses which they feel will take less time and effort.[23] Students are many times looking for high marks rather than the subject matter. They hear of courses that are easy to make good marks in and yet require little effort. Physics has a reputation for not being such a course and therefore students shy away from it.

High school counselors might also contribute to the problem of enrollments in physics. Do counselors really understand what physics is? Do they understand the role physics plays in the future of education of youth? Perhaps counselors feel that physics is only for those students who plan on becoming engineers or scientists.[24] Counselors may think that since they got along without physics, there is no reason for the average student to study physics. This researcher admits that there is little or no evidence of the effects high school counselors have on the declining physics enrollments. The suggestion

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[23]Clinton Kaufman, "High School Physics Enrollments," The Physics Teacher, III (March, 1965), 120.

[24]Statement by R. Marshall Helms, personal interview, July 29, 1970.

that they do affect the enrollments must, however, be made. Further evaluation and research must be done before any concrete statements can be made.

Other stated causes for the decline in physics enrollments range from, "the price that must be paid for excellence,"[25] to the nature of the rigorous prerequisites which only about one-fourth of high school seniors possess.[26] Whatever the causes, something in the future must be done to curb this decline. Various steps have been taken in the past to stop this decline which started about 1900. What have been the results, and what steps have been taken?

"In the next five years the proportion of physics students in high schools should be doubled."[27] The quote just mentioned was made by the American Institute of Physics in 1960. In 1965, five years later, the decline in physics enrollments was continuing. Perhaps the reason for the continued decline in those years was that the truly major efforts to stop the decline did not begin on a large scale until about 1965.

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[25]Peter Thompson, "Unpopularity of Physics: A Transient Anomaly," The Physics Teacher, VI (October, 1968), 364.

[26]Kleinman, op. cit., p. 121.

[27]American Institute of Physics, Physics In Your High School (New York: McGraw Hill Book Company, Inc., 1960), p. 17.

Selected Physical Science Curricula Projects Implemented in this Decade

Curriculum changes constitute the major efforts in trying to improve the reputation and enrollments in physics. Introductory Physical Science (IPS) is a new course taught at the ninth grade level. Laboratory periods are scheduled often and it is hoped students will be more interested and motivated as a result.

The Physical Science Study Committee (PSSC) initiated an aggressive program for the high ability student in physics. PSSC physics is a "high quality" course where laboratory experiments are used to prepare the student for future work in physics and for research in physical problems. Some critics of PSSC point out that this course is beyond the ability of 60 percent of the average physics students, and therefore the reputation of the course will get so bad that only a few students will enroll in it.[28]

The Project Physics Course is the result of an effort to curb the decline in enrollments by stressing more of the humanistic side of physics. History and philosophy in physics, a series of paperback books, single concept

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[28]Oscar L. Brauer, "Attempts To Improve High School Physics Education," Science Education, XLVII (October, 1963), 373.

films, and other supplementary materials are found in this program. With advanced mathematics not being a pre-requisite, and with frequent laboratories, Project Physics seems to be designed for the average students as well as the above average ones.

Ideas and Investigations in Science (IIS) advocates that it is devoted to making science exciting and relevant for the educationally uninvolved student. The IIS project is being directed by its originators, Harry K. Wong and Malvin S. Dolmatz. The IIS program, directed to grades 9-12:

(1) stresses student success,

(2) is completely lab and experiment-centered,

(3) has a sixth grade reading level,

(4) has major conceptual themes as the basic framework,

(5) involves the student in all major science processes.[29]

Another new curriculum project developed for students in grades 7-9 is the Intermediate Science Curriculum Study (ISCS). Perhaps the best way to describe this course would be by quoting its main objective.

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[29]The IIS Project, IIS Project News, Vol. 1, Number 1, n.d.

> The basic objective of ISCS is to develop a comprehensive science program for grades seven through nine that is based on good learning theory, consistent with modern science, and that provides a vehicle whereby recent advances in pedagogical technique can be assimilated into existing school settings.[30]

Many courses just discussed have been reviewed in journals. Wayne Welch and Arthur Rothman made a study on the success of recruited students in the Project Physics course (1968). The test instruments used were the Physics Achievement Test, Test On Understanding Science, Pupil Activity Inventory, and the Welch Science Process Inventory. The study indicated that students recruited in the Project Physics course gained as much or more than those students who signed up of their own choice.[31]

In another study by Welch (1969) a course satisfaction score was established from about 450 students enrolled in the Project Physics course. The satisfaction grade was correlated with many variables. The findings of this study indicated a significant positive correlation between course satisfaction and achievement gains, greater participation in science activities, and course grades.

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[30] Intermediate Science Curriculum Study, Newsletter, Number 7, February, 1971.

[31] W. W. Welch and A. I. Rothman, "The Success of Recruited Students in a New Physics Course," Science Education, LII (April, 1968), 270.

Course satisfaction was negatively correlated with perceived course difficulty.[32]

Physics teacher characteristics and student learning were studied by Rothman, Welch, and Walberg (1969). Their conclusions indicated that the teacher personality and value system is more strongly related to students' changes in physics achievement, attitudes toward physics, and interest in science than are the teacher's knowledge of physics, years of physics teaching, preparation in physics and mathematics, and the history and philosophy of science. It was also found that students of teachers who engage in social activities with the opposite sex and are regarded as attractive are more likely to exhibit growth in the knowledge of the processes of science, the understanding of science, and physics achievement.[33]

In trying to further determine the causes for declining enrollments in physics, a study by Welch and Walberg (1967) indicated that nothing in the beliefs of the physics teachers studied appeared to be a direct cause

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[32] Wayne Welch, "Correlates of Courses Satisfaction in High School Physics," Journal of Research in Science Teaching, VI (January, 1969), 54.

[33] A. I. Rothman, W. W. Welch, H. J. Walberg, "Physics Teacher Characteristics and Student Learning," Journal of Research in Science Teaching, VI (January, 1968), 59.

of low physics enrollments. The average physics teacher in the high school wants more students and is capable of absorbing almost double the enrollments. Welch and Walberg did suggest possible reasons for declining enrollments. Most of the reasons they presented have already been discussed in this study.[34]

Welch (1968) did a study dealing with determining some characteristics of high school physics students. He found that the average physics student places a high value on the pursuit of truth, is probably a school leader with strong power and accomplishment drives. He is a senior and generally plans to attend a four-year college or university. He is likely to be bright compared to the rest of his classmates and has developed a strong interest in science and mathematics.[35]

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[34] W. W. Welch and Herbert J. Walberg, "Are the Attitudes of Teachers Related to Declining Percentage Enrollments in Physics," Science Education, LI (December, 1967), 436.

[35] Wayne W. Welch, "Some Characteristics of High School Physics Students: circa 1968," Journal of Research in Science Teaching, VI (March, 1969), 242.

Chapter 3

RESULTS

The data gathered from teachers will be presented first so that one might compare their characteristics and scores to those of the students. The teachers participating were, in most cases, physics teachers and physical science teachers. The information collected from the teachers consisted of a questionnaire, which contained twenty-two items and a test score from the Test On Understanding Science. Table 1 indicates some basic characteristics of the teachers.

Other information gathered from the questionnaire indicated that 76% of the teachers in eastern North Carolina feel their school does not have adequate laboratory equipment. This fact alone must indicate that there is some dissatisfaction with the present science program in our high schools. Upon asking if a teacher was in the same school this year as last, 31% indicated they were not. This relatively high level of reorganization might cause considerable disorganization in our schools. It was found from this questionnaire that 41% of the science teachers took physics when they were in high school. This seems to be a high percentage when considering that only about 20% of all high school students ever take physics.

Table 1

Characteristics of Teachers Surveyed

Item			Number of Teachers Reporting
I.	Sex:	Male	22
		Female	30
II.	Age:	25 or under	5
		26-31	7
		32-37	10
		38-43	12
		44-49	10
		50-55	7
		56-61	1
III.	Highest Academic Degree:		
		B.A., B.S., or B.Ed.	15
		B.A., B.S., or B.Ed. plus some graduate work	20
		M.A., M.S., or Ed.M.	8
		M.A., M.S., or Ed.M. plus additional graduate work	9
IV.	Years Since Bachelors Degree:		
		0-3	6
		4-6	2
		7-10	9
		11-13	6
		14 or more	29

Table 2 indicates the teacher's present teaching schedule of those surveyed.

The average number of sections taught by each teacher is five. The course which is taught with the most frequency is physical science with chemistry second, and physics third. It should be remembered that the group surveyed was not a random sample but a selected group of teachers interested in physical science and physics.

The amount of physics the teachers had while in college and institutes is reported in Table 3.

Upon asking the teachers which subject they would teach if they had a free choice to teach just one, it was found that thirty-seven percent would prefer to teach physics. Thirty-one percent would prefer to teach chemistry while only six percent preferred to teach mathematics. Ten percent indicated they would prefer to teach physical science. (Physics is usually taught in twelfth grade, chemistry in eleventh grade, and physical science in ninth grade.)

As noted earlier many teachers were administered the TOUS instrument. Since this test has been used widely and comparisons between groups are useful, a tabulation of all available scores is reported in Table 4. The average score for the thirty-four teachers tested was 39.79. This compares favorably with the mean score of North

Table 2

Distribution of Courses Taught

Course	Number of Sections	Total Number Teaching This Course	Average Number of Sections per Teacher
Physics	47	32	1.45
Chemistry	59	25	2.36
Physical Science	87	27	3.22
Mathematics	13	5	2.60
Biology	29	15	1.93
Earth Science	4	2	2.00
Health and Physical Education	2	2	1.00
Other	18		
Total	259	52	5.0

Table 3

College Physics Preparation of the Teachers Surveyed

Number of Quarter Hours	Number of Teachers Reporting
3 or less	5
4-12	17
13-20	12
21-28	6
29-36	6
37-44	1
45-52	2
53 or more	2

Carolina Physical Science Teachers as found by Sheppard in 1966.[36] The mean score of the group analyzed by this investigator compared unfavorably with the score of 42.5 made by teachers in a 1970 summer institute in physics at East Carolina University. The average score of those tested in this study is not surprising or unexpected since the group tested was made up of some physical science teachers and some physics teachers.

The TOUS test was given to a total of 611 students which took a pre-test and a post-test. Any student who did not take either the pre-test or post-test was eliminated from the final analysis. The pre-test and post-test scores were submitted to a correlated t-test. The purpose of this test was to determine if a significant increase had taken place in the post test scores. The null hypothesis tested established is that there is no significant difference between the pre-test and post-test TOUS scores. Table 5 indicates the numerical results.

The statistical analysis indicates that the null hypothesis can be rejected. The "t" value indicates that the pre-test and post-test scores are significantly

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[36] Moses M. Sheppard, "The Relation of Various Teacher and Environmental Factors to Selected Learnings of Ninth-Grade Science Pupils" (Unpublished Ph.D. dissertation, The Ohio State University, 1966).

Table 4

A Tabulation of TOUS Scores*

		Mean	Standard Deviation	Remarks
1.	N. C. Physical Science students (9th) grade	22.53	3.96	Sheppard (1966)
2.	Established 9th Grade Norm	29.47	6.03	From Test Manual
3.	Established 10th Grade Norm	28.58	7.66	From Test Manual
4.	Established 11th Grade Norm	31.57	7.02	From Test Manual
5.	Established 12th Grade Norm	32.25	7.38	From Test Manual
6.	N. C. Physical Science Teachers	38.38	6.96	Sheppard (1966)
7.	Summer Institute Participants in Physics	42.5	9.1	1970 E.C.U. Summer Institute
8.	College Freshman Physics Classes	35.3	6.8	As measured at E.C.U. Fall 1970
9.	National Sample of Male Physics Students (12th Grade)	32.8	7.3	Wayne Welch (1968)
10.	12th Grade Students Recruited into a Physics Class	32.0	3.5	Welch & Rothman (1968)
11.	Juniors and Seniors in a Pre-Service Institute for Physics Teachers	45.8	3.6	As measured at E.C.U. Summer 1971
12.	Elementary Education majors taking a second science course	35.3	5.2	As measured at E.C.U. Spring 1971

* All scores are pre-test scores

Table 5

Means and Significance of Pre-Test and Post-Test <u>TOUS</u> Scores

<table>
<tr><th></th><th>Possible Score</th><th>Mean</th><th>Mean of Differences</th></tr>
<tr><td>Pre-Test</td><td>60</td><td>19.52</td><td rowspan="2">8.04</td></tr>
<tr><td>Post-Test</td><td>60</td><td>27.55</td></tr>
</table>

t-value = 25.29 degrees of freedom = 610

t 2.62 significant at .01.
t 3.37 significant at .001.

different at the .001 level of confidence. The conclusion drawn from this is that the students' understanding of science increased enough to cause a significant difference in their pre-test and post-test scores.

In comparing the pre-test score with other scores one finds the mean to be much lower than those found in other studies. This may indicate that the earlier grades in a student's education may not be teaching in the way that students gain an understanding of science. The high mean difference does seem to indicate that science courses in the high school level are contributing to a student's understanding of science. The mean difference in other studies are reported as being approximately a 3.0 point increase.

The TOUS scores were also broken down into two groups. Both groups were physics classes, however one of the groups was Project Physics oriented and the other group was "traditional" oriented. The words "conventional" and "traditional" used in this study refer to physics classes which generally were designed for classroom lecture and little laboratory work. To compare the groups to see if there was a significant difference between the two in the understanding of science, a one-way analysis of variance was employed. The numerical results of the analysis is found in Table 6.

Table 6

Differences between Project Physics TOUS Scores and other TOUS Scores

Source of Variance		Degrees of Freedom	F-Value
Between	.012	1	.0001
Within	11599.8	147	
Total	11599.82	148	

F 3.90 for significance at the .05 level of confidence

	Pre	Post
Mean of Project Physics group =	26.66	34.40
Mean of Traditional group =	24.41	32.17

The results clearly indicate that the F-ratio is too low to be significant. The conclusion is that Project Physics classes and traditional classes were not significantly different as measured by the Test On Understanding Science.

The Physics Achievement Test was analyzed in the same way as the TOUS test. The pre-test and post-test scores were submitted to a correlated t-test using the East Carolina University computer program CORT.[37] Table 7 indicates the numerical results of this study.

The conclusion drawn is that the student's achievement in physics changed enough to cause a significant increase in the pre to post test scores. Upon looking at the mean difference between the pre-test and post-test scores, one will notice only a change of three points. Considering that about seven months of school had transpired between the pre-test and post-test, the three point increase sounds rather dismal.

In the evaluation of Project Physics when it was in its trial stage, the investigators found an overall

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[37]Another computer program gives a t-value and is called COREL. The t-value in the COREL program was found to give an uncorrelated t-value and was therefore not used in this study. Both programs mentioned above are available at the East Carolina University Computing Center. One should select with great care the correct program to be used in analyzing data.

Table 7

Means and Differences of Pre-Test and Post-Test *PAT* Scores

	Possible Score	Mean	Mean of Differences
Pre-test	40	19.83	2.99
Post-test	40	22.82	

t-value = 7.64 degrees of freedom = 155

t 2.617 significant at the .01 level of confidence
t 3.373 significant at the .001 level of confidence

7.0 increase in the Project Physics group while a breakdown for this area shows that Project Physics students only had a 4.7 point increase.[38]

Table 8 lists various Physics Achievement Test scores as attained by other groups. This table is included so that some comparisons might be made between the group in this research and other groups. A conventional group in the Project Physics evaluation had a 4.0 point increase, whereas the conventional group in this study had only a 2.0 point gain. Table 9 presents the means of the two groups mentioned.

The Project Physics evaluation purports to have used a random sample of teachers and students in their evaluation. If this was indeed the case, then both Project Physics and conventional physics in this area compare unfavorably with a national sample. The mean post score for a national sample was 25.0, while the mean post score for the eastern North Carolina group was 22.8.

The PAT scores for this study were broken down into two groups; Project Physics, and conventional. An analysis of the differences can be found in Table 9.

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[38] A. Ahlgren, "Evaluation of Harvard Project Physics Course Interim Report," AAPT (February 3, 1969) 5.

Table 8

A Tabulation of PAT Scores*

	Mean	Standard Deviations
1. 12th Grade Students Recruited into a physics class[39]	16.0	4.3
2. Regular 12th grade physics students[40]	18.0	5.1
3. College freshman physics students not having H.S. physics	18.4	4.5
4. College freshman physics students who have had H.S. physics	19.6	3.9

* All scores are pre-test scores

[39] W. W. Welch and A. I. Rothman, op. cit., p. 271.

[40] Ibid.

Table 9

Differences Between Project Physics PAT Scores and other PAT Scores

Source of Variance		Degrees of Freedom	F-value
Between	340.47	1	
Within	3357.51	154	15.62
Total	3697.97	155	

F 6.81 significant at the .01 level of confidence

		Pre	Post
Mean of Project Physics Group	=	21.18	25.89
Mean of Traditional Physics Group	=	18.84	20.56

The null hypothesis established in this case is that no significant difference exists between Project Physics achievement scores and the scores made by students in a conventional physics class. The results of the statistical analysis indicates that the F-value is large enough to reject the null hypothesis at the one percent level. The conclusion is that with the test instrument used there was a significant difference between Project Physics and conventional physics. Project Physics' students scored significantly better. This might be explained by the fact that a biased test was used. The PAT was written specifically to evaluate Project Physics. Another explanation might be that the Project Physics group actually did gain more in achievement than other groups. This possibility does not surprise this researcher since those teachers using Project Physics have been trained in using the course, they have a well developed course to work with, and in most cases those that teach this course are more highly trained in physics than other physics teachers in the area.

The Pupil Activity Inventory (PAI) was given as a pre and post test. The pre-test data will not be presented by this researcher. Further comments on the PAI will be found in the section on suggestions. The most interesting results are presented in Table 10. The most common percentages for responses of never and often are 5 to 15.

It is very interesting to notice that in almost every case in the entire Pupil Activity Inventory the majority of students responded to various activities by saying that they either never or seldom participated in that activity. The only major exception was question 34 which asked if they thought about problems like how the earth, the sun, the stars, or life came to be. In this case the majority said they did think about these problems frequently and often.

A subjective conclusion of the data from this test is that in general most students do not actively participate in science activities.

The Semantic Differential Test will be discussed in terms of a selected frequency distribution. Table 11 presents such a distribution for several different concepts and scales.

Students were asked to give their first impressions to a scale such as worthless-worthwhile. If the student felt the concept science was worthwhile he would mark 4 or perhaps 5 on his answer sheet. Students answered about 150 usable scales in this test. A selected sample of their responses are given in Table 11.

Table 10

Percentage Responses of Selected Questions to the Pupil Activity Inventory Test*

Things I Have Done This Year Because I am Interested	I Have Done This Thing Never	Seldom	Occasionally	Frequently	Often
4. Built or repaired radio sets or other electronic equipment, because I am interested	48	22	10	9	11
7. Used a home chemistry set	63	18	10	6	3
19. Used a microscope at home	57	17	14	9	3
34. Thought about problems like how the earth, the sun, the stars, or life came to be	4	12	26	25	33
46. Repaired electric lamps and cords, because I like to	44	18	17	9	11
56. Spent time on preparing an exhibit for a science fair	51	24	12	6	4
63. Made extra science models and equipment	48	31	14	5	2
68. Used field glasses to study nature	42	27	18	7	5

* Summation of percentages may not equal 100 due to rounding of numbers.

Table 11

A Selected Frequency Distribution for the Semantic Differential Test*

Science

	1	2	3	4	5	
Worthless	5	3	8	18	67	Worthwhile
Quiet	6	3	9	14	68	Lively
Hard	19	36	31	10	4	Easy

Physicist

	1	2	3	4	5	
Old	6	4	14	24	50	New
Worthless	3	3	17	29	48	Valuable
Boring	5	4	14	21	56	Exciting

Doing Laboratory Experiments

	1	2	3	4	5	
Boring	5	5	11	20	60	Exciting
Wasteful	4	5	13	27	51	Productive
Hard	9	22	40	21	8	Easy
Worthless	10	21	42	17	9	Valuable

Physics in my Life

	1	2	3	4	5	
Worthless	12	13	30	22	22	Valuable
Hard	13	7	29	20	30	Easy

Table 11 (Continued)

Learning about Science

	1	2	3	4	5	
Boring	4	5	10	21	58	Exciting
Wasteful	5	5	14	24	50	Productive
Hard	14	26	29	19	10	Easy

Physics

	1	2	3	4	5	
Dangerous	9	0	16	26	47	Safe
Involved	6	3	11	19	60	Uninvolved
Unimportant	37	32	22	4	3	Important
Boring	6	9	42	23	18	Exciting

Myself as a Physics Student

	1	2	3	4	5	
Cluttered	6	6	21	22	42	Orderly
Weary	5	6	27	29	33	Refreshed
Dull	11	7	26	17	38	Interesting
Hard	13	9	27	19	32	Easy

Solving Physics Problems

	1	2	3	4	5	
Complex	14	14	33	17	19	Simple
Cluttered	32	25	24	10	10	Organized
Dull	3	6	20	20	50	Interesting
Worthless	10	15	26	15	36	Valuable

* Scores are reported as percentages. Total score may not equal 100 due to rounding of numbers.

The first thing this researcher noticed in looking at the responses was that the students were inconsistent in their answers to various scales. The test was constructed such that usually three similar scales make up a dimension and five dimensions make up a concept. An example of a dimension is Interest which consists of the scales: interesting-dull, exciting-boring, refreshed-weary. In many cases the responses to two or three scales in the same dimension were quite different. This might be explained by the students becoming more conservative in their answers as they proceeded with the test. A computer program written to score this test gives the scores for dimensions only so that in future studies the students observed inconsistencies will be averaged.

Students generally categorized science as being worthwhile and lively. They also felt that science was neither exceptionally hard or easy. The average student found laboratory experiments both exciting and productive while not exceptionally easy.

One surprising result was under the concept physics. When asked if the student felt physics was important or unimportant almost seventy percent responded by saying it was unimportant. One possible explanation for this is found in another scale. Almost 70 percent of the students questioned felt physics was uninvolved. If the word uninvolved was interpreted by students as "not being relevant" (this might very well be the case since the other two scales making up the dimension difficulty are consistant among each other but inconsistant with the third scale uninvolved) then this might help explain why 70 percent felt physics was unimportant. Future researchers should perhaps try to confirm how students are interpreting the words involved and uninvolved.

Students also felt that solving physics problems was interesting but somewhat cluttered.

The Learning Environment Inventory test was administered to the students only once during the school year. This test was not designed to be given as a pre-post test but instead to measure the student's overall learning environment in a particular class.

Data from this test is given for four different classes so that comparisons might be made. Table 12 indicates percentage responses for different classes in eastern North Carolina only. Each scale consists of seven questions with the maximum score for each question being four. Therefore, the total score possible for each scale is 28.

Table 12

Percentage Responses for the Scales of the Learning Environment Inventory Test*

Scale	Physics	Chemistry	Physical Science	Biology
	N = 381	N = 158	N = 493	N = 73
1. Cohesiveness	14.77 3.1	15.37 2.7	16.05 3.3	15.86 3.2
2. Diversity	14.70 2.0	15.49 2.5	14.69 2.2	14.95 2.3
3. Formality	18.32 2.7	17.79 2.9	16.69 2.9	17.77 3.1
4. Speed	20.04 3.4	20.74 3.6	20.63 3.0	20.95 3.3
5. Environment	16.10 3.2	16.61 3.	17.20 3.4	16.78 3.1
6. Friction	20.10 3.5	19.80 4.0	16.86 4.1	16.78 4.0
7. Goal Direction	17.38 3.8	17.80 3.5	17.95 3.1	17.84 3.1
8. Favoritism	22.57 3.6	23.58 3.3	20.94 3.8	20.99 3.6
9. Difficulty	19.02 3.3	18.93 3.2	17.91 3.2	17.40 2.7
10. Apathy	18.25 3.9	18.45 3.3	19.47 3.3	19.23 3.1
11. Democratic	22.12 4.2	22.54 4.2	20.75 3.7	21.25 3.5
12. Cliqueness	17.11 2.8	16.96 3.2	19.53 2.8	20.0 2.5
13. Satisfaction	22.81 4.0	22.87 4.7	21.78 4.0	20.97 3.7
14. Disorganization	19.67 3.5	18.54 3.7	20.46 3.12	21.14 2.98
15. Competitiveness	20.26 2.6	18.72 3.0	19.69 2.5	19.40 2.0

* Scores are reported as class means and Standard Deviations

In comparing the scores of students in eastern North Carolina with scores of students in the northeastern United States, it is generally found that classrooms in this area show the following properties:[41]

1. They are less cohesive
2. They are less diversified
3. They are less formal
4. They have greater speed (students are rushed)
5. They have greater friction
6. There is less goal direction
7. There is more favoritism on the part of teachers
8. They are less difficult
9. The students are more apathetic
10. The classes are more democratic
11. There is greater satisfaction among students
12. The disorganization is greater
13. The competitiveness is greater.

An interscale correlation for the LEI was established on the basis of about 1100 observations. The results of this analysis indicate: (All correlations are significant at the one percent level)

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[41]For a complete explanation of each property or scale see the Learning Environment Inventory Manual.

1. Environment is positively correlated to Goal Direction and Apathy.

2. Friction is positively correlated to Favoritism, Difficulty and Democratic.

3. Goal Direction is positively correlated to Apathy and negatively correlated to Democratic and Satisfaction.

4. Favoritism is positively correlated to Friction, Difficulty, Democratic, and Satisfaction, and is negatively correlated to Disorganization.

5. Difficulty is positively correlated to Friction, Favoritism, Democratic, and Satisfaction.

6. Apathy is positively correlated to Environment, Goal Direction, and Disorganization, and is negatively correlated with Democratic and Satisfaction.

7. Democratic is positively correlated with Friction, Favoritism, Difficulty, and Satisfaction and is negatively correlated with Goal Direction and Apathy.

8. Satisfaction is positively correlated with Friction, Favoritism, Difficulty and Democratic, and is negatively correlated with Goal Direction and Apathy.

9. Disorganization was found to correlate positively with Apathy.

Chapter 4

SUMMARY AND CONCLUSIONS

Summary of Procedures

The purpose of this study was to learn more about science education in the secondary schools of eastern North Carolina and to develop a workable procedure for future evaluation projects.

In attempting to learn more about the status of science in this area, five different test instruments were used. These tests were selected so as to measure as many variables as possible. Generally these tests gave data indicating a student's:

1. Understanding of Science
2. Achievement in Physics
3. Science activities
4. Attitudes in Science and Physics
5. Learning Environment

The initial sample consisted of about seventy science classes and the final sample consisted of about forty classes. Lack of testing materials directly and indirectly caused the approximately thirty class drop-out.

Computer programs were written to score three of the five test instruments. The other two instruments were scored by a standard test grading program. Statistical analyses were run on each test separately. No attempt was made to intercorrelate the various test scores.

Summary of Results

1. Teachers' understanding of science compares favorably with similar groups tested.

2. Students' understanding of science made a significant increase from the pre-test to post-test.

3. Project Physics classes and conventional physics classes are not significantly different in their understanding of science.

4. Students' achievement in physics increased enough to cause a significant difference between pre-test and post-test scores.

5. Project Physics classes and conventional physics classes are significantly different in their physics achievement as with the national Project Physics evaluation program. The Project Physics group attained a higher achievement in physics as measured by the PAT.

6. The Pupil Activity Inventory test seems to indicate that students generally do not participate frequently in any science related activities.

7. Students feel that science is both worthwhile and lively. They also felt that science was neither

exceptionally difficult or easy. The above conclusions are based on data collected by using the Semantic Differential Test.

8. The Learning Environment Inventory test generally indicates that the classroom environment in eastern North Carolina does not compare favorably with schools in the northeastern United States.

9. All of the tests used in this study have been of value. Several tests might be omitted or changed. A further discussion of tests can be found in the section on recommendations.

Major Conclusions

1. The results presented indicate that students in the sample studied gained in their understanding of science and their achievement in physics as measured by the test instruments. These increases lead this researcher to conclude that the schools in this area are having some success in the science education of students.

2. Other results from test instruments lead this researcher to conclude that the local schools' learning environment needs to be improved. The above conclusion is based on results from the LEI test given in this area as compared to test manual norms.

3. Students taking Project Physics seem to do as well as other groups in their gain in understanding of

science and, in fact, do better in physics achievement than other students taking physics as measured by PAT.

4. The teachers in this area have an understanding of science which is comparable to other groups. This would lead one to conclude that the teachers' understanding of science in this area is not a critical variable.

Recommendations Regarding Procedures

In the course of doing this study several problems have arisen which could have been avoided if time and knowledge of these problems had been available. Suggestions on how to avoid these pitfalls will be discussed in this section.

1. Any evaluation of schools should be planned with the school systems in the spring. Details as to when the tests are to be given, who should give the tests, how to give the tests and so forth, should be worked out with the school test administrator. Test administrators should be used in order to prevent the teachers from scrutinizing the pre-tests.

2. Identification numbers were established on every student's answer sheet. This is very time consuming. It is felt however, that the assets of this method outweigh the problems associated with it. A computer program should be written which will read the pre-test

identification number and score and match it with the post test identification number and score. Then the data can be read off for analysis by other programs.

3. The most efficient way this researcher found for scoring tests and keeping classes separated was by separating each class of answer sheets by a blank sheet. Then when the output data becomes available, the classes will be separated by a card or paper with a zero for a score. This then would indicate the separation of the classes.

4. Any massive evaluation program will require considerable computer time for scoring and analyzing of tests. It is recommended that arrangements be made so that all the data can be computer analyzed after regular hours. This will help insure that the data is not misplaced and will actually be more efficient for both the researcher and the computing center.

5. The Physics Achievement Test (PAT) was given to all physics students mainly because of its availability at the initiation of this study. A different achievement test in physics (one that is standardized) might be more useful that the PAT.

6. One might wish to substitute for the Pupil Activity Inventory (its overall research value is questioned by this researcher) a different data gathering

instrument such as a Student Questionnaire (SQ), or perhaps the Allport-Vernon-Lindzey Study of Values (AVL). Several other testing tools also exist which might be considered to replace the PAI.

RECOMMENDATIONS FOR FUTURE STUDIES

With Data on Hand

The following topics for future research studies have come about due to this research.

1. The number of variables which interrelate the teacher, the student, and test grades is large. For a reasonable statistical analysis of all the data one is limited by the maximum number of variables a computer program can handle. With the present computer available the maximum number of variables is thirty-five. One short study could be to identify all the variables possible and then using some criteria select out the thirty-five most important.

2. A study to determine what correlations exist between teacher characteristics, teacher's TOUS scores and the many variables possible would be worthwhile.

3. A researcher might investigate all the students' test scores and how they intercorrelate.

4. Another study which has merit is to determine in which sciences classes the students gain least in their

understanding of science and in which classes the students gain most.

5. The ability to statistically equate groups regarding a specific variable is accomplished by covariance. Several studies can come about using this technique. For example one could equate student's learning environment and then determine a correlation between a teacher variable and student's test grades. This technique can be somewhat abstruse and should be done under the direction of a competent statistician.

6. Probably the most valuable research will come from data collected using the Learning Environment Inventory test. Fifteen different scales describing the classroom environment can be correlated with other variables such as student learning and students' attitude changes.

For Collecting New Data

1. How do characteristics of teachers in this area compare to those in other areas?

2. In another evaluation one might wish to collect data on students' final grades and correlate this to test data. Since final grades in one course is not an indicator of the student's overall ability one might also want to determine the student's rank in class or perhaps his total number of quality points.

3. It is possible to give teachers the Allport-Vernon-Linzey Study of Values test and correlate the scores of this test to the teachers characteristics and students' achievement gains as measured under that teacher.

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APPENDICES

APPENDIX A

Information Form and Numerical Responses

1970-71 IN-SERVICE INSTITUTE

Department of Science Education   East Carolina University

Information Form

Mr.
Mrs.
Miss ______________________________ (1-6)

School ______________________________ (7-8)

Address ______________________________

______________________________ Zip ________ 01(9-10)

I. Age?

5	1) 25 or under	7	6) 50 - 55
7	2) 26 - 31	1	7) 56 - 61
10	3) 32 - 37		8) over 61
12	4) 38 - 43		
10	5) 44 - 49		(11)

II. Sex

22	1) Male	
30	2) Female	(12)

III. Highest Academic Degree?

	1) No college degree as of yet	
15	2) B.A., B.S., or B.Ed.	
20	3) B.A., B.S., or B.Ed., plus some graduate work	
8	4) M.A., M.S., or Ed.M.	
9	5) M.A., M.S., or Ed.M. plus additional graduate study	
	6) Ed.D. or Ph.D.	(13)

APPENDIX A (Continued)

IV. During the last 12 months, how many professional meetings have you attended?

4	1) 1	6	6) 6
8	2) 2	1	7) 7
9	3) 3	2	8) 8
8	4) 4	6	9) 9 or more
7	5) 5		

(14)

V. Years since Bachelors Degree

6	1) 0 - 3
2	2) 4 - 6
9	3) 7 - 10
6	4) 11 - 13
29	5) 14 or more

(15)

VI. What is the approximate total enrollment of your school?

2	1) 0 - 250	4	6) 1251 - 1500
8	2) 251 - 500	4	7) 1501 - 1750
12	3) 501 - 750		8) 1751 - 2000
9	4) 751 - 1000	1	9) over 2000
11	5) 1000 - 1250		

(16)

VII. The school is

50	1) Public
1	2) Independent
	3) Church affiliated
1	4) Other (Specify) ____________

(17)

VIII. How would you classify your school with regard to to area it serves?

10	1) Urban: Stable population
3	2) Urban: Transient population
	3) Urban: Ghetto
	4) Suburban: Upper income level
1	5) Suburban: Upper and middle income level
2	6) Suburban: Middle income level
11	7) Town
21	8) Rural
3	9) Other (Specify) ____________

(18)

APPENDIX A (Continued)

IX. For how many years have you held your present position?

10	1) 0	3	6) 9 - 10
13	2) 1 - 2	1	7) 11 - 12
3	3) 3 - 4	4	8) 13 - 14
10	4) 5 - 6	5	9) 15 or more
3	5) 7 - 8		(19)

X. What fraction of your teaching time is devoted to teaching physics?

40 1) one-third or less
7 2) one-third to two-thirds
4 3) more than two-thirds (20)

XI. What was your primary undergraduate major? (Check one)

13 1) Biology
11 2) Chemistry
___ 3) English
___ 4) Education
2 5) Mathematics
2 6) Physics
12 7) Science Education
___ 8) Social Studies
12 9) Other (Specify) ________________ (21)

XII. Do you feel your school has adequate laboratory equipment?

12 1) yes
38 2) no (22)

XIII. Identify the basic text you are now using if you teach physics.

7 1) HPP
3 2) PSSC
1 3) Physics (D.C. Heath and Co.)
10 4) Concepts in Physics
5 5) Matter and Energy
17 6) Other (Specify) ________________ (23)

APPENDIX A (Continued)

XIV. Identify the basic text you are now using if you teach a physical science class.

1	1)	Physical Science - A Laboratory Approach
1	2)	Introductory Physical Science
11	3)	Inquiry Into Physical Science
6	4)	Exploring Physical Science
1	5)	Quantitative Physical Science
24	6)	Other (Specify) ________ (24)

XV. Are you teaching in the same school this year as last year?

33	1)	yes
15	2)	no (25)

XVI. If you had a free choice to teach only one subject, which one would it be? (Check one)

5	1)	Biology
16	2)	Chemistry
1	3)	Earth Science
	4)	English
5	5)	General Science
3	6)	Mathematics
19	7)	Physics
	8)	Social Studies
3	9)	Other (Specify) ________ (26)

XVII. How would you rate science fairs or other science contests?

7	1)	Extremely worthwhile
9	2)	Very worthwhile
27	3)	Moderately worthwhile
4	4)	Not very important
3	5)	Definitely a waste of time and effort (27)

XVIII. How many quarter hours of physics did you have in college? (Undergraduate and graduate)

5	1)	3 or less	6	5)	29 - 36
17	2)	4 - 12	1	6)	37 - 44
12	3)	13 - 20	2	7)	45 - 52
6	4)	21 - 28	2	8)	53 or more (28)

APPENDIX A (Continued)

XIX. Did you take physics when you were in high school?

20	1) yes	
29	2) no	(29)

XX. How is your school best characterized? (Check one)

1	1) General Education	
1	2) Technical Education	
8	3) College preparatory	
5	4) Other (specify) ____________	(30)

XXI. What is your present teaching schedule. (Give numbers of sections taught)

47	Physics	(31)
59	Chemistry	(32)
87	Physical Science	(33)
13	Math	(34)
29	Biology	(35)
4	Earth Science	(36)
2	Health & P.E.	(37)
18	Other (specify) ________________	(38)

XXII. What is your approximate distance from East Carolina University?

2	1) less than 10 miles	
	2) 10 - 25 miles	
16	3) 25 - 50 miles	
21	4) 50 - 100 miles	
11	5) more than 100 miles	(39)

APPENDIX B

Sample Questions from the Semantic Differential Test

PHYSICS IN MY LIFE

		1	2	3	4	5	
46.	STARTING	0	0	0	0	0	FINISHING
	CLUTTERED	0	0	0	0	0	ORDERLY
	REFRESHED	0	0	0	0	0	WEARY
	ENDING	0	0	0	0	0	BEGINNING
	VALUABLE	0	0	0	0	0	WORTHLESS
	BORING	0	0	0	0	0	EXCITING
	IMPORTANT	0	0	0	0	0	UNIMPORTANT
	HAPHAZARD	0	0	0	0	0	CAREFUL
		1	2	3	4	5	
	SIMPLE	0	0	0	0	0	COMPLEX
55.	NEAT	0	0	0	0	0	MESSY
	CONFUSING	0	0	0	0	0	UNDERSTANDABLE
	INTERESTING	0	0	0	0	0	DULL
	PRODUCTIVE	0	0	0	0	0	WASTEFUL
	EASY	0	0	0	0	0	HARD
	NEW	0	0	0	0	0	OLD

APPENDIX C

Sample questions from the Pupil Activity Inventory Test

THINGS I HAVE DONE THIS YEAR BECAUSE I AM INTERESTED	I HAVE DONE THIS THING: Never	Seldom	Occasionally	Frequently	Often
17. Took notes on extra science reading.	1	2	3	4	5
18. Experimented with photographic equipment or developed prints.	1	2	3	4	5
19. Used a microscope at home.	1	2	3	4	5
20. Did extra reading about inventions.	1	2	3	4	5
21. Did extra problems in my school science work.	1	2	3	4	5
22. Talked with fellow students about scientific topics, because I am interested.	1	2	3	4	5
23. Tried to find out about atomic energy.	1	2	3	4	5
24. Hung around with people who work with scientific things.	1	2	3	4	5
25. Studied pictures of scientific things in books and magazines, because I am interested.	1	2	3	4	5

APPENDIX D

Sample Questions from the Learning Environment Inventory Test

		Strongly agree	Agree	Disagree	Strongly disagree
16.	The class has rules to guide its activities.	1	2	3	4
17.	Personal dissatisfaction with the class is too small to be a problem.	1	2	3	4
18.	A student has the chance to get to know all other students in the class.	1	2	3	4
19.	The work of the class if frequently interrupted when some students have nothing to do.	1	2	3	4
20.	Students cooperate equally with all class members.	1	2	3	4
21.	Many students are dissatisfied with much that the class does.	1	2	3	4
22.	The better students are granted special privileges.	1	2	3	4
23.	The objectives of the class are not clearly recognized.	1	2	3	4
24.	Only the good students are given special projects.	1	2	3	4